

**FINAL**

**SAMPLING AND ANALYSIS PLAN  
ADDENDUM NO. 1**

***FOR THE***

**PHASE II REMEDIAL INVESTIGATION OF  
LOAD LINE 12 AT THE RAVENNA ARMY  
AMMUNITION PLANT, RAVENNA, OHIO**

***PREPARED FOR***



**US Army Corps  
of Engineers®**

**LOUISVILLE DISTRICT**

**CONTRACT No. DACA62-00-D-0001  
DELIVERY ORDER CY06**

**September 2000**



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**Prepared by**

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## CONTENTS

### PART I–FIELD SAMPLING PLAN ADDENDUM

1.0	PROJECT DESCRIPTION .....	1-1
2.0	PROJECT ORGANIZATION AND RESPONSIBILITIES .....	2-1
3.0	SCOPE AND OBJECTIVES .....	3-1
4.0	FIELD ACTIVITIES .....	4-1
5.0	SAMPLE CHAIN OF CUSTODY / DOCUMENTATION .....	5-1
6.0	SAMPLE PACKAGING AND SHIPPING REQUIREMENTS .....	6-1
7.0	INVESTIGATION-DERIVED WASTE .....	7-1
8.0	REFERENCES .....	8-1

#### APPENDICES

A	SELECTED RESULTS FROM PREVIOUS ENVIRONMENTAL INVESTIGATIONS AT LOAD LINE 12 .....	A-1
B	FIELD COLORIMETRIC ANALYTICAL PROCEDURE .....	B-1
C	HUMAN HEALTH RISK ASSESSMENT ALGORITHMS .....	C-1

### PART II–QUALITY ASSURANCE PROJECT PLAN ADDENDUM

1.0	PROJECT DESCRIPTION .....	1-1
2.0	PROJECT ORGANIZATION AND RESPONSIBILITY .....	2-1
3.0	QUALITY ASSURANCE OBJECTIVES FOR MEASUREMENT .....	3-1
4.0	SAMPLING PROCEDURES .....	4-1
5.0	SAMPLE CUSTODY .....	5-1
6.0	CALIBRATION PROCEDURES AND FREQUENCY .....	6-1
7.0	ANALYTICAL PROCEDURES .....	7-1
8.0	INTERNAL QUALITY CONTROL CHECKS .....	8-1
9.0	DATA REDUCTION, VALIDATION, AND REPORTING .....	9-1
10.0	PERFORMANCE AND SYSTEM AUDITS .....	10-1
11.0	PREVENTIVE MAINTENANCE PROCEDURES .....	11-1
12.0	SPECIFIC ROUTINE PROCEDURES TO ASSESS DATA PRECISION, ACCURACY, AND COMPLETENESS .....	12-1
13.0	CORRECTIVE ACTIONS .....	13-1
14.0	QA REPORTS TO MANAGEMENT .....	14-1
15.0	REFERENCES .....	15-1

**FINAL**

**Part I**

**Field Sampling Plan Addendum  
for the Phase II Remedial Investigation  
of Load Line 12  
at the Ravenna Army Ammunition Plant,  
Ravenna, Ohio**

**September 2000**

Prepared for

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## CONTENTS

FIGURES .....	vii
TABLES .....	vii
ACRONYMS .....	ix
1.0 PROJECT DESCRIPTION .....	1-1
1.1 INTRODUCTION .....	1-1
1.2 LOAD LINE 12 HISTORY AND CONTAMINANTS .....	1-1
1.3 SUMMARY OF EXISTING DATA .....	1-7
1.4 SPECIFIC SAMPLING AND ANALYSIS PROBLEMS .....	1-9
2.0 PROJECT ORGANIZATION AND RESPONSIBILITIES .....	2-1
3.0 SCOPE AND OBJECTIVES .....	3-1
3.1 PHASE I RI SCOPE AND OBJECTIVES .....	3-1
3.2 PHASE II RI DATA QUALITY OBJECTIVES .....	3-1
3.2.1 Conceptual Site Model .....	3-1
3.2.2 Problem Definition .....	3-4
3.2.3 Remedial Action Objectives .....	3-4
3.2.4 Identify Decisions .....	3-4
3.2.5 Define the Study Boundaries .....	3-4
3.2.6 Identify Decision Rules .....	3-4
3.2.7 Identify Inputs to the Decisions .....	3-5
3.2.8 Specify Limits on Decision Error .....	3-5
3.2.9 Sample Design .....	3-5
3.3 DATA EVALUATION METHODS .....	3-6
3.3.1 Determination of AOC Chemical Background .....	3-6
3.3.2 Definition of Aggregates .....	3-6
3.3.3 Data Screening .....	3-6
3.4 HUMAN HEALTH RISK ASSESSMENT .....	3-7
3.4.1 Selection of Chemicals of Potential Concern .....	3-14
3.4.2 Exposure Assessment .....	3-14
3.4.3 Toxicity Assessment .....	3-19
3.4.4 Risk Characterization .....	3-19
3.4.5 Uncertainty Analysis .....	3-21
3.4.6 Remedial Goal Options .....	3-21
3.5 SCREENING ECOLOGICAL RISK ASSESSMENT .....	3-21
3.5.1 Conceptual Site Model Diagram .....	3-22
3.5.2 Selection Criteria for Ecological Receptors .....	3-22
3.5.3 Terrestrial Food Web for Ecological Receptors .....	3-24
3.5.4 Assessment Endpoints, Measurements, and Decision Rules .....	3-24
3.5.5 Procedural Assumptions for Exposure, Effects, and Risk Characterization .....	3-28
3.5.6 Next Step .....	3-30
4.0 FIELD ACTIVITIES .....	4-1
4.1 GROUNDWATER .....	4-1
4.1.1 Rationales .....	4-1
4.1.2 Monitoring Well Installation .....	4-4

4.1.3	Field Measurement Procedures and Criteria .....	4-7
4.1.4	Sampling Methods for Groundwater.....	4-7
4.1.5	Sample Containers and Preservation Techniques.....	4-8
4.1.6	Field Quality Control Sampling Procedures.....	4-8
4.1.7	Decontamination Procedures .....	4-8
4.1.8	In Situ Permeability Testing.....	4-8
4.2	SUBSURFACE SOILs .....	4-9
4.2.1	Rationales .....	4-9
4.2.2	Procedures.....	4-11
4.3	SURFACE SOIL AND SEDIMENT .....	4-13
4.3.1	Rationales .....	4-13
4.3.2	Procedures.....	4-16
4.4	SURFACE WATER .....	4-19
4.4.1	Rationales .....	4-19
4.4.2	Procedures–General .....	4-20
4.5	SITE SURVEY .....	4-21
4.5.1	Building Survey .....	4-21
4.5.2	Sample Station Survey.....	4-21
4.6	Sewer Line Survey .....	4-22
4.6.1	Rationale.....	4-22
4.6.2	Procedures.....	4-22
4.6.3	OE screening.....	4-23
4.7	TEST PITS .....	4-23
5.0	SAMPLE CHAIN OF CUSTODY/DOCUMENTATION .....	5-1
5.1	FIELD LOGBOOK.....	5-1
5.2	PHOTOGRAPHS .....	5-1
5.3	SAMPLE NUMBERING SYSTEM.....	5-1
5.4	SAMPLE DOCUMENTATION.....	5-1
5.5	DOCUMENTATION PROCEDURES .....	5-1
5.6	CORRECTIONS TO DOCUMENTATION .....	5-1
5.7	MONTHLY REPORTS.....	5-16
6.0	SAMPLE PACKAGING AND SHIPPING REQUIREMENTS .....	6-1
7.0	INVESTIGATION-DERIVED WASTE .....	7-1
8.0	REFERENCES .....	8-1
APPENDICES		
A	SELECTED RESULTS FROM PREVIOUS ENVIRONMENTAL INVESTIGATIONS AT LOAD LINE 12 [PHASE I REMEDIAL INVESTIGATION (1998)] .....	A-1
B	FIELD COLORIMETRIC ANALYTICAL PROCEDURE .....	B-1
C	HUMAN HEALTH RISK ASSESSMENT ALGORITHMS .....	C-1

## FIGURES

1-1	General Location and Orientation of RVAAP .....	1-2
1-2	Ravenna Army Ammunition Plant Facility Map.....	1-3
1-3	Load Line 12 Site Map .....	1-4
1-4	Load Line 12 Phase I RI Sampling Location Map .....	1-8
2-1	Project Organization Chart for the Phase II RI for Load Line 12.....	2-2
2-2	Project Schedule for the Phase II RI for Load Line 12 .....	2-3
3-1	Exposure Pathways for Terrestrial and Aquatic Receptors .....	3-23
3-2	Food Web at RVAAP for Ecological Risk Assessment.....	3-25
4-1	Proposed Monitoring Well, Surface Water/Sediment Sample and Test Pit Locations.....	4-24
4-2	Building FF-19 Sampling Locations.....	4-25
4-3	Buildings 901, 902, and 906 Sampling Locations .....	4-26
4-4	Building FN-54 Sampling Locations .....	4-27
4-5	Building 900 Sampling Locations.....	4-28
4-6	Building 903 Sampling Locations.....	4-29
4-7	Building 905, Area North of Building 903, and Building 904 Sampling Locations .....	4-30
4-8	Load Line 12 Sanitary Sewer Lines and Transformer Pads .....	4-31
4-9	Building FE-17, Building 52, Water Works #2 Building and Water Tower Sampling Locations.....	4-32
4-10	Exposure Unit Random Sampling Grid for Surface Soil Samples .....	4-33
5-1	Load Line 12 Phase II RI Sample Identification System.....	5-2

## TABLES

1-1	Load Line 12 Operations Chronology.....	1-6
3-1	Ravenna Surface Soil (0 to 1 foot) Background (Metals Only) .....	3-8
3-2	Ravenna Subsurface Soil (>1 foot) Background (Metals Only).....	3-9
3-3	Ravenna Sediment Background (Metals Only) .....	3-10
3-4	Ravenna Surface Water Background (Metals Only) .....	3-11
3-5	Ravenna Unconsolidated Zone Groundwater Background (Filtered Metals Only).....	3-12
3-6	Ravenna Unconsolidated Zone Groundwater Background (Unfiltered Metals Only).....	3-13
3-7	Conceptual Exposure Model for Load Line 12 at RVAAP.....	3-17
3-8	Reasons for Selecting Receptors for Ecological Risk Assessment at Load Line 12.....	3-24
3-9	Policy Goals, Ecological Assessment Endpoints, Measurement Endpoints, and Decision Rules for Load Line 12 .....	3-26
3-10	Receptor Parameters for Short-tailed Shrew .....	3-28
4-1	Load Line 12 Sampling Rationale and Matrix .....	4-2
5-1	Load Line 12 Phase II RI Baseline Soil Sample Identification List.....	5-3
5-2	Load Line 12 Phase II RI Sediment and Surface Water Baseline Sample Identification List .....	5-13
5-3	Load Line 12 Phase II RI Groundwater Baseline Sample Identification List.....	5-15





## ACRONYMS

amsl	above mean sea level
AOCs	areas of concern
bgs	below ground surface
BRA	baseline risk assessment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COC	chemical of concern
COPCs	chemicals of potential concern
CSF	cancer slope factor
CSM	conceptual site model
DNT	dinitrotoluene
DQO	data quality objective
EPA	U.S. Environmental Protection Agency
ERA	ecological risk assessment
FID	flame ionization detector
FS	Feasibility Study
HHRA	human health risk assessment
HMX	octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine
HQ	hazard quotient
ID	inside diameter
IDW	investigation-derived waste
ILCR	incremental lifetime cancer risk
LOAEL	lowest observed adverse effect level
NOAEL	no observed adverse effects level
OD	outside diameter
OE	ordnance and explosives
Ohio EPA	Ohio Environmental Protection Agency
ONG	Ohio National Guard
OSC	Operations Support Command
OVA	organic vapor analyzer
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PID	photoionization detector
PPE	personal protective equipment
PRG	preliminary remediation goal
PVC	polyvinyl chloride
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
RAGS	Risk Assessment Guidance for Superfund
RDX	hexahydro-1,3,5-trinitro-1,3,5-triazine
RfD	reference dose
RGO	remedial goal option
RI	Remedial Investigation
RME	reasonable maximum exposure
RVAAP	Ravenna Army Ammunition Plant
SAIC	Science Applications International Corporation
SAP	Sampling and Analysis Plan

SRC	site-related contaminant
SVOC	semivolatile organic compound
T&E	threatened and endangered
TAL	Target Analyte List
TCLP	Toxicity Characteristic Leaching Procedure
TNB	trinitrobenzene
TNT	trinitrotoluene
UCL <sub>95</sub>	95% upper confidence limit
USACE	U.S. Army Corps of Engineers
USCS	Unified Soil Classification System
USGS	U.S. Geological Survey
VOCs	volatile organic compound
XRF	X-ray fluorescence

## 1.0 PROJECT DESCRIPTION

### 1.1 INTRODUCTION

The Phase II Remedial Investigation (RI) of Load Line 12 at the Ravenna Army Ammunition Plant (RVAAP), Ohio ([Figure 1-1](#)) will evaluate the presence and distribution of contaminants in soil, sediment, surface water, and groundwater with respect to facility-wide background criteria for all significant media.

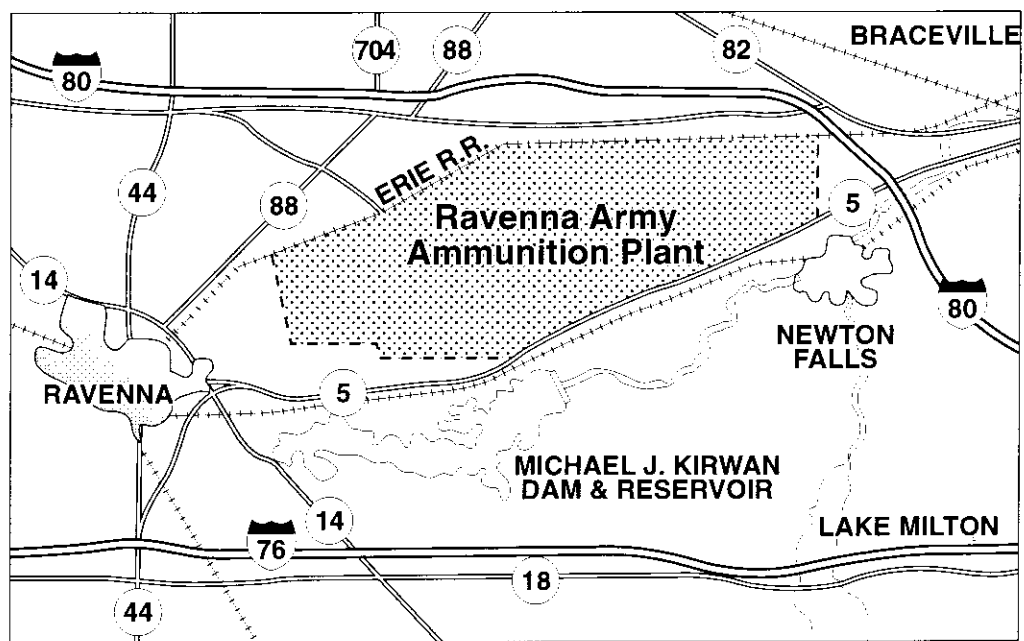
This Phase II RI Sampling and Analysis Plan (SAP) Addendum for Load Line 12 at RVAAP has been prepared by Science Applications International Corporation (SAIC) under contract DACA62-00-D-0001, Delivery Order No. CY06, with the U.S. Army Corps of Engineers (USACE), Louisville District. This SAP Addendum has been developed to tier under and supplement the *Facility-Wide Sampling and Analysis Plan for the Ravenna Army Ammunition Plant, Ravenna, Ohio* (USACE 2000). The Facility-wide SAP provides the base documentation, technical procedures, and investigative protocols for conducting RIs under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) at RVAAP, whereas this SAP Addendum includes all of the sampling and analysis objectives, rationales, planned activities, and criteria specific to the Phase II RI at Load Line 12. Consequently, the Phase II RI cannot be implemented without the guidance provided in both documents. Where appropriate, the SAP Addendum contains references to the Facility-wide SAP for standard procedures and protocols.

Both the Facility-wide SAP and this SAP Addendum have been developed following the USACE guidance document, *Requirements for the Preparation of Sampling and Analysis Plans, EM200-1-3, September 1994* (USACE 1994a), to collectively meet the requirements established by the Ohio Environmental Protection Agency (Ohio EPA), Northeast District, and the U.S. Environmental Protection Agency (EPA), Region 5, for conducting CERCLA investigations. The Facility-wide SAP is currently under revision; a draft version of the revised Facility-wide SAP is under review by the Army, USACE, and Ohio EPA. Should changes to the Facility-wide SAP occur that impact the requirements of this SAP Addendum, then the additional requirements will be added via field change order or addenda.

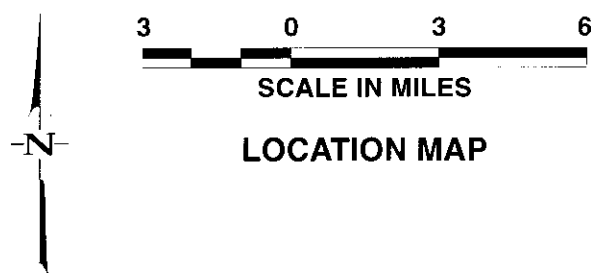
### 1.2 LOAD LINE 12 HISTORY AND CONTAMINANTS

The RVAAP is located in northeastern Ohio in Portage and Trumbull Counties and lies about 16 km (10 miles) east of Ravenna, Ohio ([Figure 1-1](#)). Operations at the facility date to September 1941 and include the storage, handling, and packing of military ammunition and explosives. The facility encompasses 8,668 hectares (21,419 acres) and is jointly operated by the Operations Support Command (OSC) of the U.S. Army and the National Guard Bureau. The OSC controls environmental areas of concern (AOCs) and bulk explosives storage areas. A detailed history of process operations and waste disposal processes for each AOC at RVAAP ([Figure 1-2](#)) is presented in the *Preliminary Assessment for the Ravenna Army Ammunition Plant, Ravenna, Ohio* (USACE 1996). The following is a summary of the history and related contaminants for Load Line 12.

Load Line 12 ([Figure 1-3](#)), designated as AOCs RVAAP-12 and -18, covers approximately 32.4 hectares (80 acres) and is situated in the southeast portion of the facility. Constructed in 1940 and 1941, Load Line 12 was originally known as the Ammonium Nitrate Plant. Operated by the Atlas Powder Company, Load Line 12 commenced production operations on November 25, 1941. Granular ammonium nitrate was prepared through an evaporation and crystallization procedure of neutral liquor that was brought into the plant in tank cars and off-loaded at the Neutral Liquor Building (FE 19). The neutral liquor was then transferred to one of seven



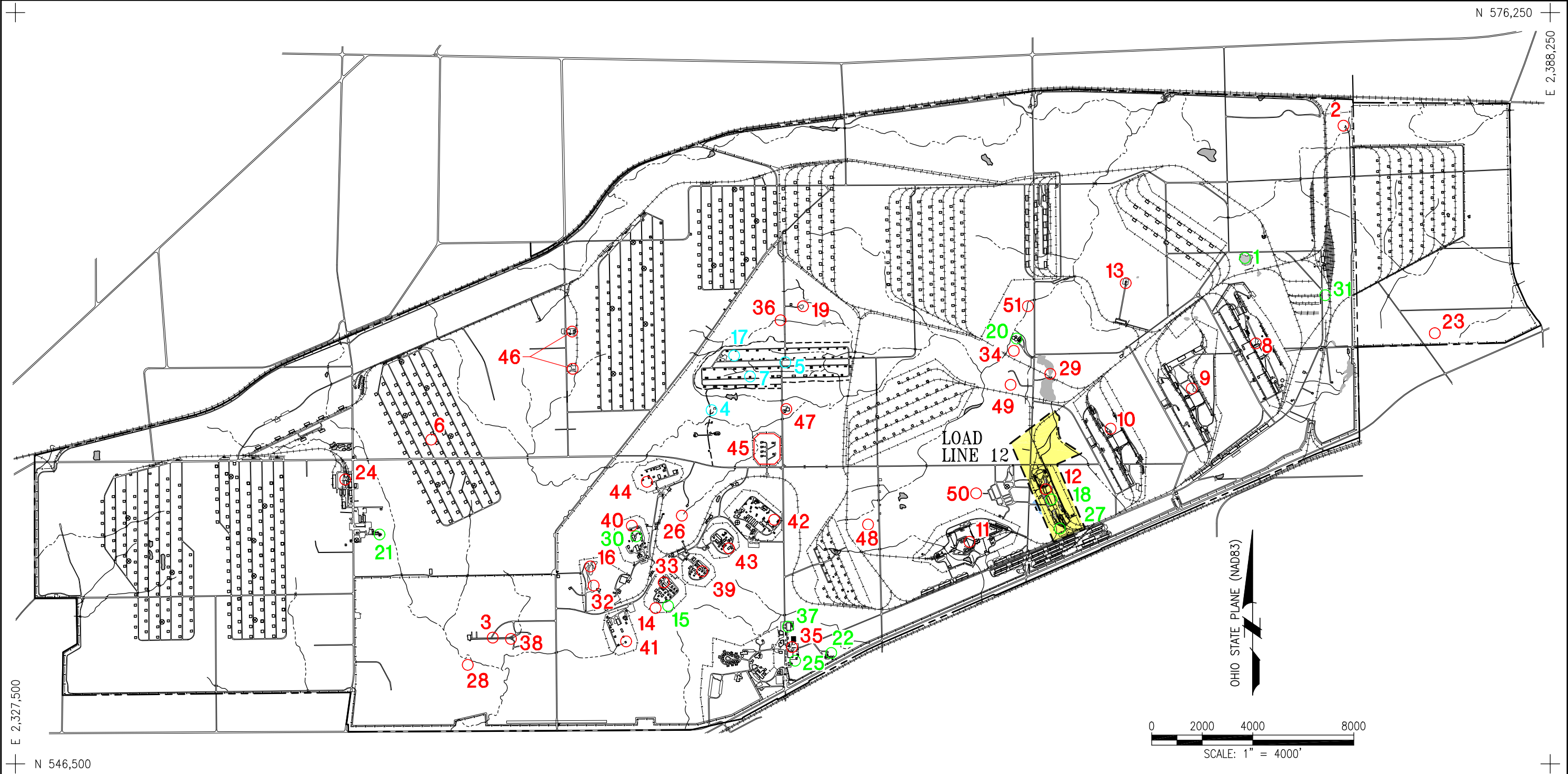
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LOCATION MAP



Figure 1-1. General Location and Orientation of RVAAP



LEGEND OF SITES:									
1	RAMSDALL QUARRY LANDFILL	13	BLDG 1200 AND DILUTION/SETTLING POND	25	BLDG 1034 MOTOR POOL WASTE OIL TANK	37	PESTICIDE STORAGE BUILDING T-4452	49	CENTRAL BURN PITS
2	ERIE BURNING GROUNDS	14	LOAD LINE 6, EVAPORATION UNIT	26	FUZE BOOSTER AREA SETTLING TANKS	38	NACA TEST AREA	50	ATLAS SCRAP YARD
3	DEMOLITIONS AREA #1	15	LOAD LINE 6, TREATMENT PLANT	27	BLDG 854-PCB STORAGE	39	LOAD LINE 5 / FUZE LINE 1	51	DUMP ALONG PARIS-WINDHAM ROAD
4	DEMOLITIONS AREA #2	16	QUARRY LANDFILL/FORMER FUZE & BOOSTER BURNING PITS	28	MUSTARD AGENT BURIAL SITE	40	LOAD LINE 7 / BOOSTER LINE 1		CERCLA
5	WINKLEPECK BURNING GROUNDS	17	DEACTIVATION FURNACE	29	UPPER AND LOWER COBBS POND COMPLEX	41	LOAD LINE 8 / BOOSTER LINE 2		RCRA
6	C BLOCK QUARRY	18	LOAD LINE 12 PINK WASTE WATER TREATMENT	30	LOAD LINE 7 PINK WASTEWATER TREATMENT PLANT	42	LOAD LINE 9 / DETONATOR LINE		OTHER REGULATORY
7	BLDG 1601 HAZARDOUS WASTE STORAGE	19	LANDFILL NORTH OF WINKLEPECK BURNING GROUND	31	ORE PILE RETENTION POND	43	LOAD LINE 10 / PERCUSSION ELEMENT		
8	LOAD LINE 1 AND DILUTION/SETTLING POND	20	SAND CREEK SEWAGE TREATMENT PLANT	32	40- AND 60-MM FIRING RANGE	44	LOAD LINE 11 / ARTILLERY PRIMER		
9	LOAD LINE 2 AND DILUTION/SETTLING POND	21	DEPOT SEWAGE TREATMENT PLANT	33	FIRESTONE TEST FACILITY	45	WET STORAGE AREA		
10	LOAD LINE 3 AND DILUTION/SETTLING POND	22	GEORGE ROAD SEWAGE TREATMENT PLANT	34	SAND CREEK DISPOSAL ROAD LANDFILL	46	BUILDINGS F-15 AND F-16		
11	LOAD LINE 4 AND DILUTION/SETTLING POND	23	UNIT TRAINING SITE WASTE OIL TANK	35	1037 BUILDING-LAUNDRY WASTEWATER SUMP	47	BUILDING T-5301 DECONTAMINATION		
12	LOAD LINE 12 AND DILUTION/SETTLING POND	24	RESERVE UNIT MAINTENANCE AREA WASTE OIL TANK	36	PISTOL RANGE	48	ANCHOR TEST AREA		

Figure 1-2. Ravenna Army Ammunition Plant Facility Map



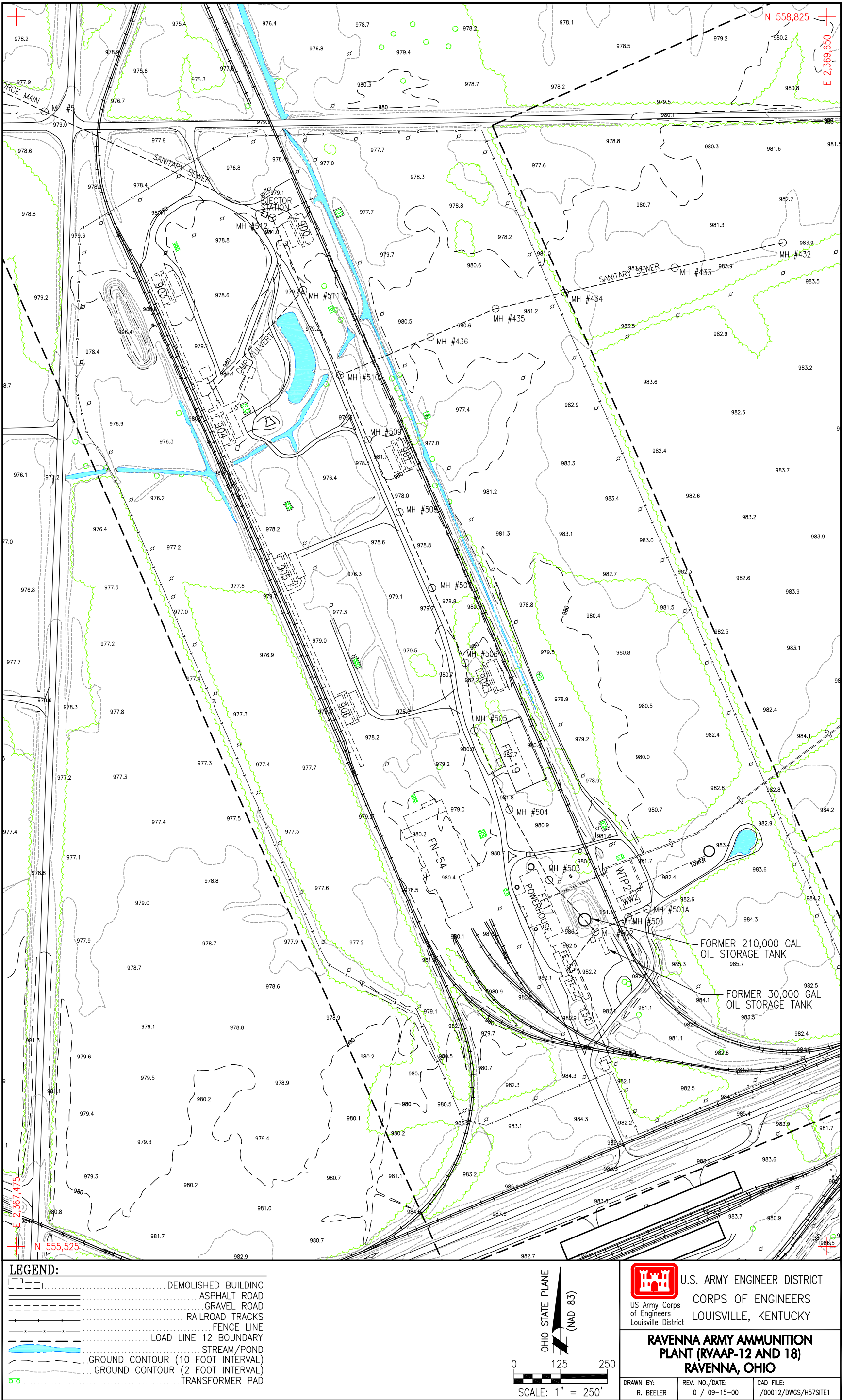


Figure 1-3. Load Line 12 Site Map

evaporation/crystallization units (Buildings 900, 901, 902, 903, 904, 905, and 906) via an above-ground 6-inch-diameter pipeline. The finished product was then transferred to the melt pour lines for blending with 2,4,6-trinitrotoluene (TNT) to produce Amatol. Production of ammonium nitrate was terminated in May 1943. Various production, renovation, and demilitarization operations were performed at a number of locations on the site after the termination of ammonium nitrate production in May 1943. The chronology listed on [Table 1-1](#) contains some of the readily available operational details for Load Line 12. Load Line 12 was leased by the Silas Mason Co. from 1946 to 1949 for the production of fertilizer grade ammonium nitrate. From 1946 to 1950, Load Line 12 was used to produce 470,080 metric tons (518,246 tons) of fertilizer grade ammonium nitrate.

Other major structures at Load Line 12 site include Water Works No. 2, Power House No. 3 (FE-17) and the bagging and shipping building (FN-54). Ancillary operations on the site included a compressor building (FA-20), an administration building (FE-53), a change house (FEWP-22), a laboratory (FE-52), and a clock house (4-51). A sanitary sewer lift station was situated near the northeast corner of the load line. At Bldg. FE-17, during conversions from coal to fuel oil in the late 1960s, two large oil storage tanks were installed. These were later removed during subsequent renovations to the powerhouse.

In order to improve the quality of TNT recovered from demilitarization operations, washout operations were converted to a melt-out process in the late 1950s ([Table 1-1](#)). Fuze and booster assemblies were removed from bomb casings and the projectiles placed in a double-jacketed steam canister. Explosives were liquefied into a tray, knocked out of the tray, packed, and shipped out. According to interviews with personnel familiar with the operation, spillage was routinely cleaned from floors and equipment with hot water/steam.

In the early years of the operation, this rinsate was allowed to flow out of the buildings and onto the ground. Later on in the operational history, a system of scuppers/gutters were installed around the building's perimeter floor level and the washdown effluent was processed through a series of two stainless steel tanks. One was used for settling and one for filtration. Prior to 1981, the tank effluent was ditched (from Building FJ-904) to a holding pond, where ultimately the water drained to Upper Cobbs and then Lower Cobbs Pond. Approximately 324,000 L (85,536 gallons) of pink water were generated per month when the plant was fully operational in the 1950s. The demilitarization effluent contained TNT, octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX), and hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX), Composition B, Ammatol (a mixture of ammonium nitrate and TNT), lead, chromium, and mercury. After 1981, the effluent was pumped to the Load Line 12 Pink Water Treatment Plant (RVAAP-18) for treatment prior to discharge.

The treatment plant consisted of a dual-mode activated-carbon filtration system. Twin 907.2-kg (2000-pound) carbon units were enclosed in a 6 × 13.2 m (20 × 40 feet) metal-sided building on a concrete slab. The plant was built in 1981, within the confines of Load Line 12. The plant was designed to treat 76 L (20 gallons) of wastewater per minute and averaged 19,000 L (5000 gallons) per day. Following the termination of demilitarization operations, the treatment plant was used under a National Pollution Discharge and Elimination System permit for the treatment of explosives-tainted stormwater from Load Line 12 and other RVAAP locations.

No above-grade structures remain at Load Line 12. A very small portion of the floor slabs remains at Building FF-19. Demolition of facilities was conducted in two phases with completion of demolition in early 2000. Buildings 901, 902, FF-19, and 906 were demolished between 1973 and 1975. Building 54 was demolished in the 1980s. The remaining structures were removed between 1998 and 2000. During the recent demolition activities, a former blast berm at Bldg. 903 was removed and placed as fill/groundcover around portions of Bldg. FE-17 and Bldg. 903.



**Table 1-1. Load Line 12 Operations Chronology**

August 1940	Construction began at Load Line 12.
September 1941	Ammonium nitrate production commenced.
May 1943	Ammonium nitrate production terminated at Load Line 12.
October 1945	RVAAP operational control transferred from the Atlas Powder Company to the U.S. Army Ordnance Department.
1946 to 1949	Load Line 12 was leased from the Ordnance Department for production of fertilizer grade ammonium nitrate.
Late 1949	Hot water washout equipment moved to Load Line 12 (Building 904/905) from Load Line 1.
1950	Operational control transferred from U.S. Army Ordnance Department to the Ravenna Arsenal, Inc., a division of the Firestone Tire and Rubber Corp., for the contractor operation of the facility.
In early 1951	A major plant renovation contract was negotiated between the Huntington District Corps of Engineers and the Hunkin-Conkey Construction Co. One of the work items performed was the relocation of “washout machinery” from Load line 2 to Building 905. Additionally, under this contract, repairs to Building FN 54 were performed along with the relocation of case cleaning equipment from Load line 2.
1951 to 1954	Cartridge case renovation in Building FN-54.
1959 to 1961	Conversion of the Building FJ-904 hot water washout operation to a steam melt out operation to improve the quality of the recovered explosive and reduce the amount of waste water generated in the process.
1965 to 1967	Hercules Alchlor leased Building FF-19, reportedly for the production of aluminum chloride. This lease was terminated prior to its expiration date due to environmental concerns.
1973 to 1974	Demilitarization of 90 mm ammunition (disassembly occurred on Load Line 1 with meltout operations performed on Load Line 12).
Early to mid 1970s	Reference is made to a fuel oil fired flashing furnace operating in Building 900 for use in the demilitarization operation. This flashing operation was converted to propane during the late 1980s. A 15,000-gallon above-grade fuel oil tank was located in the space between the kettle and pan houses that was previously occupied by a blast wall during production of ammonium nitrate.
1973	Demolition of Buildings FF-19, 901, 902 and two neutral liquor tanks to the south of FF-19. Building 903 was included in this scope of work, but it is apparent that this structure was not demolished at this time.
Late 1970s	Demilitarization equipment improvements included the addition of redwood sumps/sawdust filters for the treatment of pink water effluent.
1981	Construction of Industrial Waste Treatment Plant 01 for the treatment of pink water effluent from demilitarization operations.
1982	Operating contractor changed from Firestone to Physics International.
1984	Operating contractor changed hands from Physics International to the Olin Corporation.
1992	Operating contractor changed hands from Olin to Mason and Hanger-Silas Co., Inc., who served as operating contractor until 1998 when the caretaker contract was transferred to R&R International. R&R International subsequently sold its government operations to TolTest, Inc. in late 1999.

The potential for surface and subsurface soil contamination exists adjacent to process buildings due to explosive and metal residues. There is potential for surface soil, sediment, and surface water contamination from the release of large volumes of process effluent (pink water) containing explosive and metal constituents into unlined earthen ditches. Sediment, surface water, and shallow groundwater contamination from the earthen settling pond receiving process effluent is also a possibility. Red surface soil stains observed in the field indicate explosives adjacent to Building FJ-905. Sediment samples collected under previous investigations detected low concentrations of explosives in settling ponds (Cobbs Ponds).

### 1.3 SUMMARY OF EXISTING DATA

Two previous investigations have been conducted: (1) *Preliminary Assessment for the Ravenna Army Ammunition Plant* (USACE 1996) and (2) *Phase I Remedial Investigation of High Priority Areas of Concern at the Ravenna Army Ammunition Plant* (USACE 1998).

The Preliminary Assessment of Load Line 12 performed in 1996 included the site in the list of High Priority sites based on a relative risk ranking methodology. Reevaluation of the Load Line 12 risk ranking performed at the completion of the Phase I RI resulted in the site retaining its “High Risk” rating.

The Phase I RI sampling at Load Line 12 included surface soil and sediment sampling of areas within the AOC (Figure 1-4). In addition, one groundwater sample was collected from a temporary well point installed immediately downgradient of the settling pond. Surface soils 0.0 to 0.6 m (0 to 2 feet) below ground surface (bgs) and drainage ditch sediments were sampled to evaluate potential releases of contaminants associated with the process facilities and the discharge of pink water effluent into open ditches. The analytical data are summarized in Table A-1 presented in Appendix A of this SAP Addendum. The analytical data are presented in detail in Table 4.22 of Appendix G of the Phase I RI Report (USACE 1998).

Thirty-one surface soil samples [0 to 0.3 m (0 to 1 foot) or 0 to 0.6 m (0 to 2 feet) bgs] were collected from the AOC during the Phase I RI. Sampling locations were generally biased toward known or suspected contaminant source areas. Sampling was primarily focused on buildings used for demilitarization operations (Buildings 900, 904, and 905), the Nitrate Settling Basin and Filter Bed, and the Pink Wastewater Treatment Plant. Figure 1-4 illustrates the Phase I RI sampling locations within the AOC. Analytical parameters for surface soil included explosives and 11 process-related metals (31 samples). Additionally, eight samples were analyzed for the expanded suite metals, cyanide, pesticides/polychlorinated biphenyls (PCBs), semivolatile organic compounds (SVOCs), and volatile organic compounds (VOCs) to verify the presence or absence of these chemicals within the AOC.

Nineteen ditch and pond sediment samples were collected at Load line 12 and analyzed for explosives and the 11 process-related metals. Three of these samples were also analyzed for an expanded suite of 23 metals, cyanide, VOCs, SVOCs, and PCBs/pesticides to verify whether these chemicals were present in sediments at this load line. The sample locations for each sample are shown on Figure 1-4.

Two temporary well points were installed immediately downgradient of the settling pond in Load Line 12. Recharge was insufficient in L12wp-058 to collect a sample for analysis, and L12wp-057 yielded only enough water for VOC analysis (Figure 1-4). There were no VOCs detected in this sample.

In surface soils, explosives were detected at concentrations up to 19,000 mg/kg in three main areas within the AOC: the Building 904 demilitarization facility, the Building 900 fertilizer/demilitarization operations facility, and the Nitrate Settling Basin and Filter Bed facility. TNT was the most pervasive explosive contaminant detected, but scattered detections of HMX, RDX, and dinitrotoluene (DNT) occurred.

Inorganics were detected in soil throughout the AOC, with concentrations of cadmium, chromium, lead, and mercury occurring often at concentrations above the U.S. Geological Survey (USGS) Ohio reference values. Inorganic contamination was concentrated in the vicinity of Buildings 900, 904, FF-19, and the Nitrate Settling Basin and Filter Bed.

Organic contamination consists of scattered detections of polycyclic aromatic hydrocarbons (PAHs) at relatively low concentrations (<1 mg/kg) and low concentrations of various pesticides/PCBs. PAHs occur

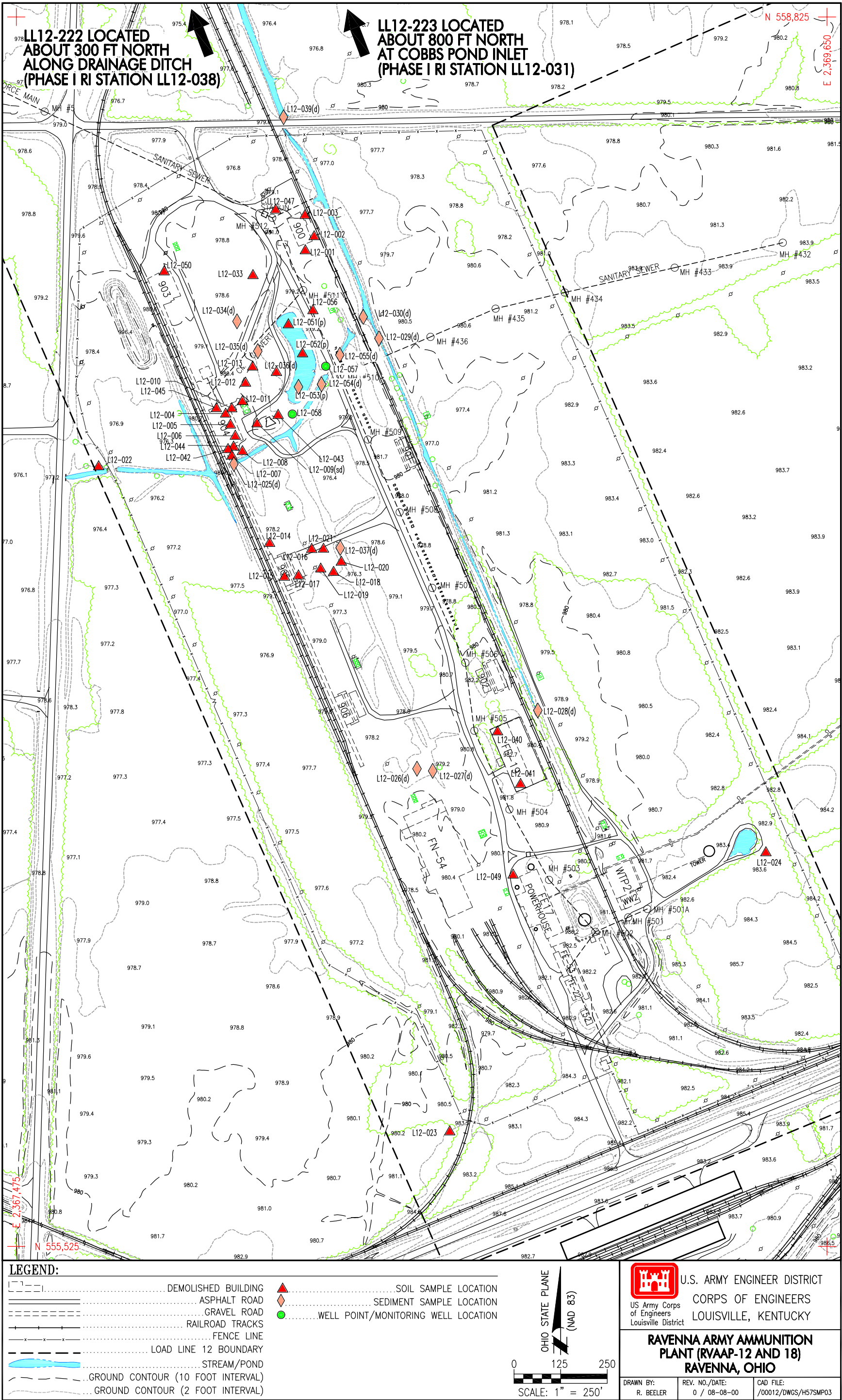


Figure 1-4. Load Line 12 Phase II RI Sampling Location Map

mainly in the vicinity of Building 904 and the demilitarization facility, while pesticides/PCBs are most numerous in the Buildings 900 and FF-19 areas.

Explosives [TNT and trinitrobenzene (TNB)] were detected in sediment samples, but the maximum detected concentration was 170 mg/kg, several orders of magnitude lower than concentrations in the soil. Maximum concentrations occurred in the sediment sample location northeast of the Settling Basin/Filter bed facility.

Inorganic analytes were detected in sediment samples throughout the AOC with concentrations in excess of the USGS Ohio reference values, but the maximum concentration for almost all metals occurred in either L12sd-028, located in the vicinity of Building FF-19, or L12sd-039, located in the main drainage leading from the AOC to the north.

Organics were detected in two of the three samples analyzed for these constituents, with the majority of detections occurring in L12sd-028, near Building FF-19. Several organic compounds were also detected in L12sd-053, which is located along the drainage running east from Building 904.

#### **1.4 SPECIFIC SAMPLING AND ANALYSIS PROBLEMS**

Ordnance and explosives (OE) was observed at the north end of the site during demolition activities; therefore, OE avoidance will be performed prior to and during the sampling effort.

No above ground structures remain at Load Line 12. A small portion of the floor slab beneath Bldg. FF-19 remains intact. Samples at this building will be placed so that coring of the remaining slab is not necessary. There is potential for contamination beneath floor slabs if the integrity of the concrete was compromised (i.e., cracks). Therefore, samples will be obtained at locations originally beneath the slab. The Phase II RI sampling strategy is dependent on identifying the former structure footprints. Without this information it will be difficult to visually locate sampling points relative to locations showing evidence of historical activity or potentially contaminated areas. It will be necessary, at a minimum, to establish the corners of the former building locations prior to locating the Phase II sampling locations. This has been addressed as a separate task and is discussed in Section 4.5.

Sampling near the headwaters of the Cobbs Pond complex may potentially involve working over or wading in water greater than a depth of 4 feet. If these conditions are encountered during sampling, personal flotation devices shall be worn as specified in the site-specific safety and health plan.

The addition of 2-3 feet of soil cover at Bldg. 903 must be considered when evaluating Phase II RI sampling data as compared to Phase I RI data. Subsurface soil samples at this area from the 0.3 to 0.6-m (1-3 ft) depth interval will essentially correspond to surface soil samples collected under the Phase I RI report. Additionally, soils have been substantially re-worked and additional fill added in locations at Bldg. FE-17. As with Bldg. 903, suitable precautions must be taken when assessing whether or not Bldg. FE-17 was a source for any observed soil contamination in this area.

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## **2.0 PROJECT ORGANIZATION AND RESPONSIBILITIES**

The Load Line 12 Phase II RI project organization and responsibilities are presented in [Figure 2-1](#). The functional responsibilities of key personnel are described in Chapter 2.0 of the Facility-wide SAP and, therefore, are not presented here. [Figure 2-1](#) shows the project organization chart for the Phase II RI for Load Line 12. [Figure 2-2](#) presents the planned project schedule.

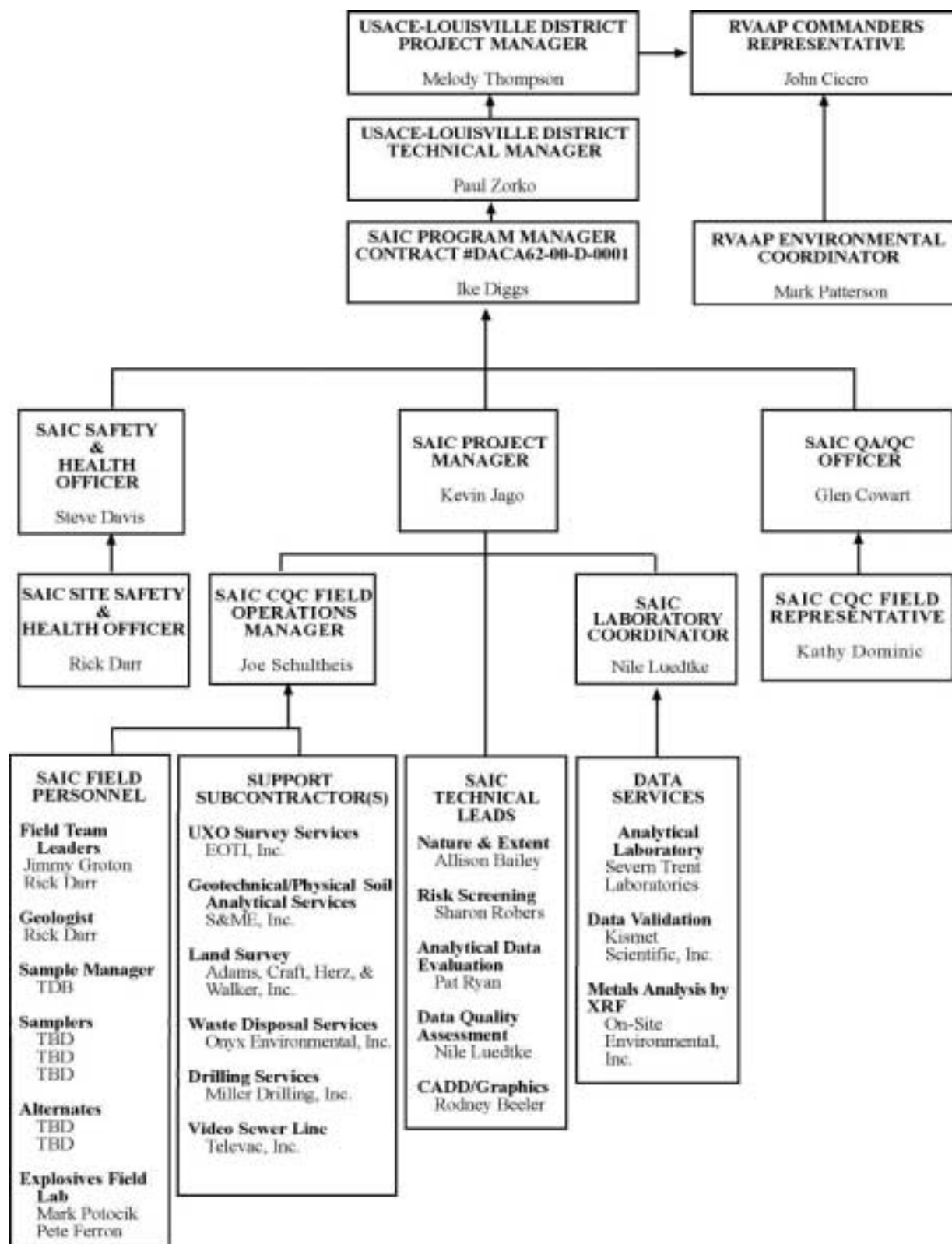


Figure 2-1. Project Organization Chart for the Phase II RI for Load Line 12



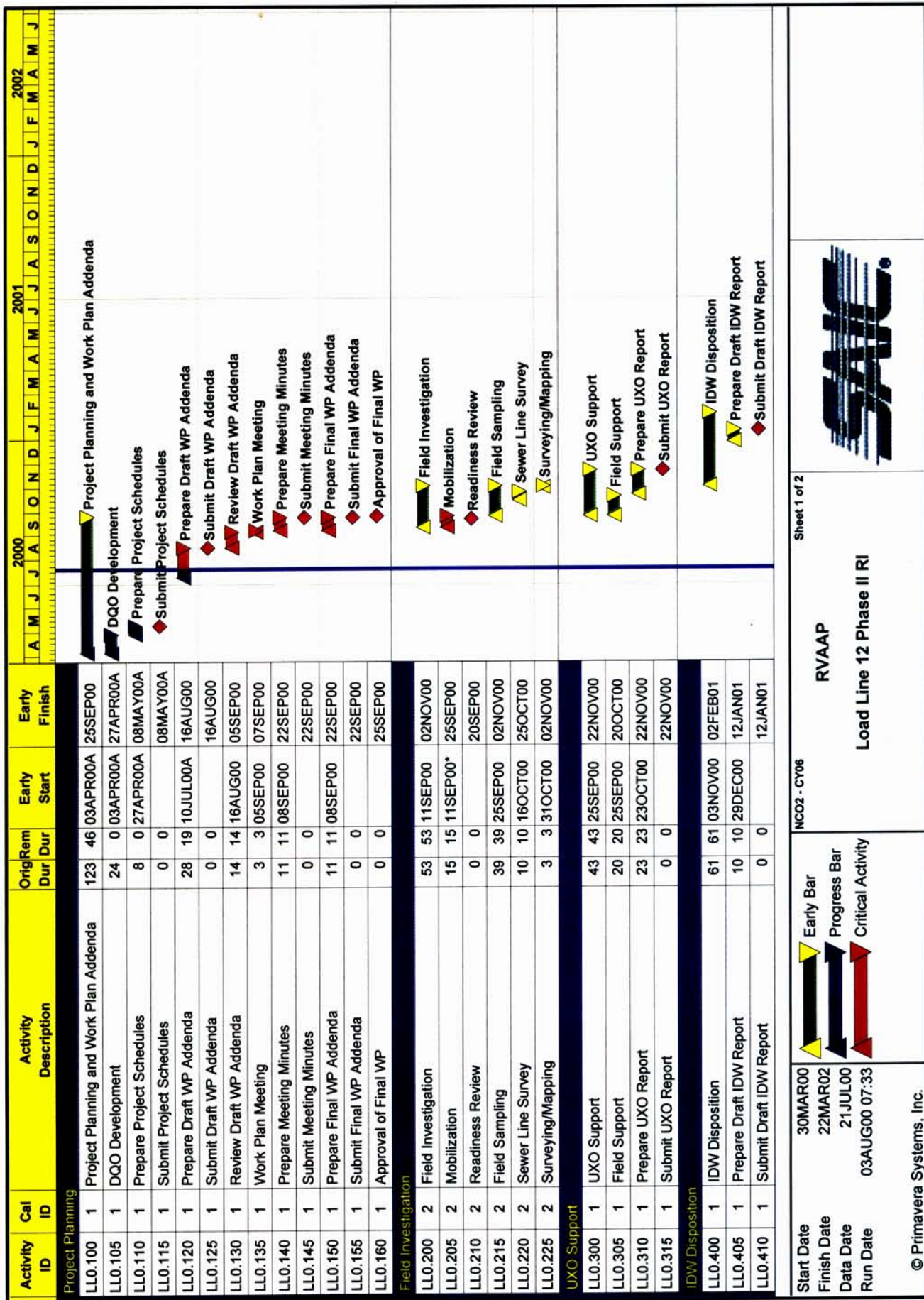


Figure 2-2. Project Schedule for the Phase II RI for Load Line 12



2-4

## **3.0 SCOPE AND OBJECTIVES**

### **3.1 PHASE II RI SCOPE AND OBJECTIVES**

The scope of this investigation is to determine the extent of contamination in affected media (soils, sediments, surface water, and groundwater) identified during the Phase I RI at Load Line 12. The primary objectives of the Phase II RI are as follows:

- Characterize the physical environment of Load Line 12 and its surroundings to the extent necessary to define potential contaminant transport pathways and receptor populations.
- Characterize the sources of contamination at Load Line 12 sufficient to screen and evaluate remedial alternatives in a subsequent feasibility study (FS). Data on source locations, types and concentrations of contaminants, potential release mechanisms, physical and chemical properties of contaminants present, and geotechnical characteristics of environmental media will be collected and evaluated.
- Identify whether releases of contamination beyond the AOC boundary are occurring, by collecting environmental samples (surface water and sediment) downstream of the AOC boundary within exit conveyances and using applicable historical information.
- Characterize nature and extent of contamination at Load Line 12 such that a baseline risk assessment can be conducted to evaluate the potential threats to human health and the environment and to develop risk-based remedial goal options (RGOs) for use in determining areas that may require remediation and evaluating remedial alternatives in a subsequent FS.
- Provide preliminary recommendations for any additional investigations and/or actions.

Investigation-specific objectives have been developed using the data quality objective (DQO) approach presented in the Facility-wide SAP. Project-specific sampling objectives are presented for each environmental medium in Chapter 4.0 of this SAP Addendum.

### **3.2 PHASE II RI DATA QUALITY OBJECTIVES**

The project DQO is to provide sufficient high-quality data to address the primary project objectives identified in Section 3.1.

#### **3.2.1 Conceptual Site Model**

The facility-wide hydrogeologic conceptual site model (CSM) for RVAAP, presented in the Facility-wide SAP, is applicable to Load Line 12 for this Phase II RI, based on current knowledge. The CSM for RVAAP, operational information, analytical data collected during historical environmental investigations, and data collected during the Phase I RI at Load Line 12 (USACE 1997) have been used to refine the CSM specific to Load Line 12 as follows:

## ***Soils***

Previous sampling data at Load Line 12 indicate that contamination is present in soil surrounding former operations areas, such as buildings, the Bldg. 904 settling basin, and the Bldg. 905 settling basin and filter bed. During the Phase I RI, 31 surface soil samples only were collected at several known or suspected source areas, which showed elevated explosives primarily around Bldg. 904 and the Pink Wastewater Treatment Plant, Bldg. 900, and the Bldg. 905 settling basin and filter bed complex. Metals above Phase I RI background values (primarily barium, cadmium, lead, and zinc) were detected throughout the AOC, but were concentrated around Bldgs. FF-19, 900, and 904. Low levels of organic compounds (PAHs and pesticides/PCBs) were also detected near some of the former process buildings. Phase I RI samples were analyzed for only a limited suite of metals (process-related); therefore, all metal contaminants above background may not have been identified at the AOC.

Based on characterization data to date, the CSM considers contaminated soils within and adjacent to former process areas as potential secondary sources of contamination to sediment, surface water, and groundwater. Contaminants may be released from soil and migrate in storm runoff either in dissolved phase or adsorbed to particulates and/or colloids. Further horizontal characterization of known areas of soil contamination are planned to define contaminant nature and extent and to provide sufficient data for remedial alternatives analysis in a subsequent feasibility study. Vertical characterization is planned for the same reasons and to determine if leaching processes may be contributing to groundwater contamination. The Phase I RI and other historical sampling did not characterize all of the former process areas. Thus, those areas not previously characterized are specifically targeted for biased sampling in the Phase II RI. In addition, to investigate whether soil contamination is present in those portions of the AOC outside of the former process areas, random grid sampling is planned.

## ***Sediment***

Sediment within ditches and tributaries represents a receptor media for contaminants eroded or leached from soils and transported by storm runoff. In addition, sediment may function as a transport mechanism considering that contaminants adsorbed to particulates may be mobilized by surface water flow. Operational data suggest that the ditches in the vicinity of former process areas represent the most likely locations where contaminants may have accumulated through erosional transport and accumulation. Site characteristics and available field data show that the primary surface water and sediment exit pathway from Load Line 12 is to the northwest via an unnamed tributary to upper Cobbs Pond. This tributary is also a potential accumulation point for contaminants. These elements of the CSM have been largely confirmed by previous Phase I RI sampling of sediment (see Section 1.2) at 19 locations within drainage ditches and the tributary to upper Cobbs Pond. These data showed detectable explosives at five locations, primarily near former process areas. The maximum values for explosives occur in the vicinity of the Bldg. 905 settling basin/filter bed complex. Metals contaminants were concentrated at levels above risk-based screening criteria primarily around former process areas (especially Bldg. FF-19) and in the tributary to upper Cobbs Pond. Considering the available data and the CSM, both confirmed and additional suspected source areas, as well as the exit pathway, are specifically targeted for biased sampling.

## ***Surface Water***

Sampling of surface water from conveyances within and adjacent to Load Line 12 was not conducted during the Phase I RI. No defined surface water conveyance exists that flows to the south and off of the AOC. Overall surface water drainage patterns at Load Line 12 are to the north–northwest. Because of these factors, potential transport of contaminants from Load Line 12 off of RVAAP is not an element of the CSM addressed by the Phase II RI. Site characteristics and available field data show that the primary surface water exit pathway from Load Line 12 is to the northwest via the unnamed tributary to upper Cobbs Pond. Historical sampling

conducted under the Water Quality Surveillance Program did not include this tributary to upper Cobbs Pond. Potential contaminants would be expected to leach or erode from source areas into drainage ditches, particularly from former operations buildings and the Bldg. 904 and Bldg. 905 settling basins, and migrate toward the exit point. Migration along the ditches within the AOC is primarily episodic and related to storm events that produce flushing of the surface water system and mobilization of contaminated sediment. Based on the CSM, and lack of previous sampling at the exit pathway, ditches near several former process buildings and the tributary exiting Load Line 12, are specifically targeted for biased sediment sampling.

### ***Groundwater***

Very limited hydrogeologic and analytical data exist for groundwater at Load Line 12 (see Section 1.2); therefore, an accurate assessment of groundwater flow patterns is not possible at present. Ground surface elevations fall from about 985 ft above mean sea level (amsl) in the southeastern portion of the site to about 977 ft amsl in the northwestern portion of the site. Surface water drainage patterns are also to the north. For the purposes of DQO development and investigation planning, the CSM presumes that the general groundwater flow patterns mimic the site topography and surface water drainage patterns, which indicates a gentle overall gradient to the north–northwest towards Cobbs Pond. Because of the heterogeneous nature of the unconsolidated glacial deposits beneath the site, localized variants in the overall flow patterns and preferred migration pathways (i.e., gravel or sand stringers) likely exist at the site. Also, based on topographic patterns, a flow divide may exist in the southern portion of the AOC, resulting in the potential for groundwater flow to the south and off of the facility.

Analytical evidence for groundwater contamination by SRCs identified in source area soils (i.e., explosives, metals, SVOCs) does not presently exist at Load Line 12. Because of the limited available data, contaminant migration from source areas to groundwater (via leaching or surface water infiltration) is an unknown element of the conceptual model at present. Potential source area SRCs identified to date have low mobility in groundwater. However, the concentrations of some of the principal soil SRCs are substantially elevated above background indicating that the potential exists for groundwater contamination.

Considering the uncertainties associated with the CSM noted above, the presence of groundwater contamination and potential migration pathways will be evaluated as part of the Phase II RI. Groundwater characterization efforts include installation of monitoring wells and piezometers in a configuration that will provide data on general hydrogeologic characteristics and groundwater flow patterns. Wells will be specifically installed in the vicinity of known and suspected source areas to evaluate whether contaminants are leaching to groundwater. Monitoring wells are also specifically planned along the southern boundary of Load Line 12 to determine whether groundwater flow and potential contaminant transport off of the AOC is occurring.

### ***Utilities***

Approximately 1,540 m (4,700 linear feet) of 28-cm (8-inch) and 35-cm (10-inch) sanitary sewer system remain in place at Load Line 12. Storm sewers were not installed at Load Line 12; all stormwater runoff is directed through surface ditches. The sanitary sewer system may represent an accumulation point for contaminants introduced to the system via building floor and sink drains during AOC operations. Portions of the system are suspected to be below the water table as almost all of the lines are flooded at present. Considering the age of the system, cracks or gaps in the piping likely allow groundwater influx. Thus, if the piping contains accumulated contaminants in sludges or sediment, it may represent a source term to groundwater. Also, the system may function as a preferential migration pathway for shallow groundwater transport. Accordingly, a visual and video camera survey is planned to investigate the condition of the system. Sludge or sediment samples are planned at identified accumulation points to investigate if contaminants

migrated into the system from process area. Also, samples of accumulated water will be collected to determine if any identified contaminants are partitioning from sediment or sludge to shallow groundwater.

### **3.2.2 Problem Definition**

The operation of ammonium nitrate production facilities and subsequent demilitarization facilities has contaminated surface and subsurface soils. Soil contaminants include explosives, inorganic analytes, low levels of PAHs, and sporadic detections of low levels of pesticides and PCBs. Sediment contamination by explosives and inorganics as a result of accumulation of contaminants within low-lying areas (i.e., ditches) was documented in the Phase I RI. Some evidence exists that sediment contamination extends beyond the AOC boundary. Surface water represents the most probable contaminant exit pathway beyond Load Line 12; consequently this medium is a specific focus of the Phase II RI. The likelihood of contaminant migration to groundwater via leaching of soils or infiltration of surface water is presently unknown due to the very limited groundwater sampling that was performed during the Phase I RI. Contaminant migration potential to groundwater will be evaluated based on the results of this Phase II RI.

### **3.2.3 Remedial Action Objectives**

See Section 3.2.3 of the Facility-wide SAP.

### **3.2.4 Identify Decisions**

The key decisions for all investigations at RVAAP have been identified in Section 3.2.4 and in [Table 3-1](#) of the Facility-wide SAP. Phase II RI data inclusive of the risk assessment results are necessary for sound remedial decision making and to determine whether additional investigation is needed or what types of response actions are most appropriate.

### **3.2.5 Define the Study Boundaries**

The investigation area boundary for Load Line 12 is that presented in [Figure 1-3](#). This boundary was established to encompass all known or reported historical burning operations, adjacent support areas, and potential surface water exit pathways.

### **3.2.6 Identify Decision Rules**

Decision rules used to guide remediation decisions are provided in Section 3.2.6 of the Facility-wide SAP. Phase I data were not sufficient to fully define the nature and extent of contamination; therefore, risk of exposure to these contaminants could not be fully ascertained. The purpose of the Phase II RI data is to determine the presence, type, concentration, and extent of contamination. These data will be used to conduct a quantitative baseline human health and ecological risk assessment to identify areas requiring remediation and areas where additional characterization may be needed.

Phase I RI data are of sufficient quality for incorporation into the assessment of contaminant nature and extent and risk assessment. Because the Phase I RI data were not originally screened against facility-wide background, the data will be pooled with Phase II RI data and screened as discussed in Section 3.3. Demolition activities at Load Line 12 resulted in some areas being covered with fill. The Phase II RI presumes that contamination identified in the Phase I RI is still present beneath any fill. Soils were excavated and re-worked extensively around the powerhouse (Bldg. FE-17) and the water tower; therefore, any Phase II data from these areas must be considered using appropriate precautions. Additionally, a large volume of soil was

removed from the Bldg. 400 vicinity for treatability studies. This removed soil volume will have to be accounted for in any remedial alternatives presented in an FS.

### 3.2.7 Identify Inputs to the Decisions

Inputs to the decision process are the analytical results, risk-assessment results, and refined site-specific conceptual model developed from field observations and environmental data.

### 3.2.8 Specify Limits on Decision Error

Limits on decision errors are addressed in Section 3.2.8 of the Facility-wide SAP.

### 3.2.9 Sample Design

The sample design for the Phase II RI of Load Line 12 is described in detail in Chapter 4.0 of this SAP Addendum. Suspected source areas and contaminant accumulation points represent specific focus areas for sampling. The known surface water exit pathway is also specifically targeted. A minimal number of contingency samples are planned for suspected source areas or exit points identified during the field effort.

The overall Phase I RI findings for Load Line 12 identified several former process buildings that require additional characterization data in order to determine the extent (horizontal and vertical) of soil contamination. The guidelines outlined below applied to the Phase I RI data are used for the purpose of selecting areas where the extent of contamination in soils needs to be further delineated:

- areas having greater than 1 mg/kg of explosives, or
- areas having greater than 100 mg/kg of lead and 35 mg/kg chromium (2 times background), or
- areas having greater than 1 mg/kg of PCBs.

These levels are known to be protective of human health [e.g., 1.48 mg/kg is 1/10 of the EPA Region 9 preliminary remediation goal (PRG) for protection of human health for 2,4,6-TNT]. Using these criteria and the results from the Phase I RI, the areas listed below require additional sampling to characterize extent of contamination.

Criterion	Areas Exceeding Criterion
Explosives > 1 mg/kg	Bldg. 900, Bldg. 904 vicinity, and Bldg. 905 settling basin and filter bed.
Lead > 100 mg/kg and/or chromium > 35 mg/kg	Bldg. 900, Bldg. FF-19, Bldg. 904, Bldg. 905 and settling basin/filter bed.
PCBs > 10 mg/kg	Bldg. 900 and Bldg. FF-19.
Area not characterized during the Phase I RI.	Nonproduction areas; sewer system; FE-17 Power House; Bldg. FN-54; Bldgs. 901, 902, and 906; water works; and Bldg. 51 (site quality assurance laboratory).

NA = not applicable

In addition, soils in the vicinity of several key functional areas/buildings not sampled during the Phase I RI will be characterized during the Phase II RI. As noted in Section 3.2.1, sediment, surface water, and groundwater characterization will be conducted to identify potential impacts to these receptor media and to determine whether contaminant transport off of the AOC is occurring.

### **3.3 DATA EVALUATION METHODS**

The methods for identifying AOC-related chemicals are described in the following sections. The data evaluation methods are consistent with those established for the *Phase I RI for 11 High Priority AOCs at RVAAP* (USACE 1998) and the *Phase II RI for the Winklepeck Burning Grounds* (USACE 1999a). The general process for identifying AOC-related chemicals involves: initial data reduction, defining data aggregates, data quality assessment, and screening of data against statistical, background, and weight-of-evidence criteria. Analytical results are reported by the laboratory in electronic form and loaded into a database. Site data are extracted from the database so that only one result is used for each station and depth sampled. Quality control data such as sample splits and duplicates and laboratory re-analyses and dilutions will not be included in the determination of contaminant nature and extent or in the risk assessment. Samples rejected in the validation process also will be excluded. If it is found that a significant number of samples is rejected, the entire data set will be evaluated to determine if a representative data set exists without the rejected data. The percentage of rejected data will be presented in the data quality assessment section of the Phase I RI report.

#### **3.3.1 Determination of AOC Chemical Background**

The Load Line 12 Phase II RI will not require determination of separate AOC-specific chemical background. Analytical results will be screened against final facility-wide background values for RVAAP in the *Phase II RI Report for the Winklepeck Burning Grounds* (USACE 1999a). These facility-wide background criteria and the processes used to generate them are currently under review by USACE and Ohio EPA. The final criteria as presented in the final Phase II RI report will be used in this study at Load Line 12. This screening step will be used to determine if detected metals are site-related contaminants (SRCs) or if they are naturally occurring.

#### **3.3.2 Definition of Aggregates**

Data collected from Load Line 12 will be aggregated by environmental medium (soil, sediment, surface water, and groundwater). Soil data will be aggregated by depth interval [surface soils from 0- to 0.3 m (0- to 1- foot) bgs] and subsurface soil greater than 0.3 m (1 foot) bgs. Data will be evaluated on an AOC-wide scale. Summary statistics [i.e., minimum detect, maximum detect, frequency of detection, mean detect, and 95% upper confidence limit (UCL<sub>95</sub>)], will be developed for the entire Load Line 12 data set. Source areas (“hot spots”) will be identified spatially from the soil and sediment data. Evaluation of the spatial distribution of groundwater and surface water contaminants will remain on an AOC-wide scale and include factors such as proximity to sources and surface and groundwater flow patterns within Load Line 12. Focused discussions of any identified source areas and contamination at surface water exit points will be developed in the nature and extent assessment and the risk evaluation.

#### **3.3.3 Data Screening**

Data screening prior to the risk evaluation will consist of four steps: (1) data quality assessment, (2) frequency of detection screen, (3) background screening, and (4) screening of essential human nutrients. These screens will be used to identify SRCs. Those constituents identified as SRCs will then be screened in the risk evaluation. The application of these screens to the Phase II RI risk assessment is presented in Section 3.4.



- A detailed assessment of the quality of the Phase II RI analytical results will take place. Data that are rejected as a result of the data quality assessment will not be evaluated further in the screening process.
- Each chemical within each environmental medium (aggregate) will be evaluated to determine its frequency of detection. Chemicals that are never detected will be eliminated as SRCs. For sample aggregations with greater than 20 samples and a frequency of detection of less than 5%, a weight-of-evidence approach will be used to determine if the chemical is an SRC. The magnitudes and locations (clustering) of the detected values will be evaluated. Additionally, the occurrence of the constituent in other environmental media will be considered as part of the weight of evidence. If the detected results for a chemical show no clustering, concentrations are not substantially elevated relative to the detection limit, and the constituent is not an SRC in another aggregate, it will be considered spurious and the chemical eliminated as an SRC.
- For each inorganic constituent passing the frequency of detection screen, concentrations will be screened against available naturally occurring background levels. If the maximum concentration of a constituent exceeds the background value, the constituent will be considered as an SRC. These background levels are presented in **Tables 3-1 through 3-6** for surface soils, subsurface soils, sediment, surface water, and groundwater within the unconsolidated interval. If groundwater samples are collected from wells installed into bedrock, the RVAAP background values for this groundwater zone will be employed for data screening. Note that in the event a constituent was never detected in the background data set, its background level is assigned as zero. This process ensures that a particular chemical detected at Load Line 12 in a particular medium cannot be eliminated simply because the chemical was never detected in background. All detected organic compounds will be considered as SRCs, evaluated as to their nature and extent, and screened using the risk evaluation.

Chemicals that are considered as essential nutrients (calcium, chloride, iodine, iron, magnesium, potassium, phosphorous, and sodium) will not be evaluated as SRCs, unless grossly elevated relative to background. These chemicals are an integral part of the country's food supply, and are often added to foods as supplements; thus, these constituents are not generally addressed as contaminants (EPA 1989 and 1995). Data on essential elements, however, will be used to evaluate the subsurface geochemistry.

### 3.4 HUMAN HEALTH RISK ASSESSMENT

Using the results of the Phase II RI sampling at Load Line 12, a baseline human health risk assessment (HHRA) will be performed. The purpose of the risk assessment is to define the potential health risks associated with various current and future uses of the land at Load Line 12. The risk assessment will be performed in accordance with methods presented in the *Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual, (Part A)* (RAGS) (EPA 1989). Additional methodology will be taken from:

*Dermal Exposure Assessment: Principles and Applications* (EPA 1992);  
*Human Health Evaluation Manual, Supplemental Guidance "Standard Default Exposure Factors"* (EPA 1991);  
*Exposure Factors Handbook* (EPA 1989);  
*U.S. EPA Integrated Risk Information System* (EPA 1997a); and  
*Health Effects Summary Tables* (EPA 1997b).

The process used to accomplish the objectives of this risk assessment are:

- identify all chemicals of potential concern (COPCs) at the site,
- conduct an exposure assessment for site-related COPCs,



**Table 3-1. Ravenna Facility-Wide Surface Soil (0 to 1 foot) Background (Metals Only)**

Analyte (Units)	Results > Detection Limit	Minimum Detect	Maximum Detect	Average Result	STD	Dist.	95% Upper Tolerance Limit	Nonparametric 95% UTL	99 <sup>th</sup> Percentile	Background Criteria
Aluminum (mg/kg)	11/11	4,920.00	17,700.00	10,700.00	4,045.85	N	22,100.00	17,700.00	17,700.00	17,700.00
Antimony (mg/kg)	0/11			0.32	0.03	O		0.78	0.78	0.96 <sup>a</sup>
Arsenic (mg/kg)	11/11	7.00	15.40	10.50	2.59	L	20.20	15.40	15.40	15.40
Barium (mg/kg)	11/11	47.90	88.40	65.20	13.03	L	112.00	88.40	88.40	88.40
Beryllium (mg/kg)	0/11			0.25	0.06	O		0.82	0.82	0.88 <sup>a</sup>
Cadmium (mg/kg)	0/11			0.32	0.03	O		0.78	0.78	0.00
Calcium (mg/kg)	11/11	238.00	15,800.00	4,300.00	4,583.63	L	97,300.00	15,800.00	15,800.00	15,800.00
Chromium (mg/kg)	11/11	6.30	17.40	12.10	4.30	N	24.20	17.40	17.40	17.40
Cobalt (mg/kg)	11/11	4.10	10.40	7.53	2.36	N	14.20	10.40	10.40	10.40
Copper (mg/kg)	11/11	9.10	17.70	11.50	2.22	X		17.70	17.70	17.70
Cyanide (mg/kg)	0/11			0.32	0.03	O		0.78	0.78	0.00
Iron (mg/kg)	11/11	10,000.00	23,100.00	17,200.00	3,697.96	N	27,600.00	23,100.00	23,100.00	23,100.00
Lead (mg/kg)	11/11	12.80	26.10	18.40	4.00	L	32.80	26.10	26.10	26.10
Magnesium (mg/kg)	11/11	1,140.00	3,030.00	1,970.00	604.42	L	4,410.00	3,030.00	3,030.00	3,030.00
Manganese (mg/kg)	11/11	147.00	1,450.00	638.00	349.99	L	3,050.00	1,450.00	1,450.00	1,450.00
Mercury (mg/kg)	7/11	0.03	0.04	0.04	0.02	X		0.16	0.08	0.04
Nickel (mg/kg)	10/11	9.00	21.10	13.60	4.41	L	29.40	21.10	21.10	21.10
Potassium (mg/kg)	11/11	303.00	927.00	621.00	176.64	N	1,120.00	927.00	927.00	927.00
Selenium (mg/kg)	2/11	0.69	1.40	0.45	0.33	D		1.40	1.40	1.40
Silver (mg/kg)	0/11			0.65	0.07	O		1.60	1.60	0.00
Sodium (mg/kg)	1/11	123.00	123.00	42.80	27.35	D		123.00	123.00	123.00
Thallium (mg/kg)	0/11			0.32	0.03	O		0.78	0.78	0.00
Vanadium (mg/kg)	11/11	9.10	31.10	19.00	7.74	N	40.80	31.10	31.10	31.10
Zinc (mg/kg)	11/11	38.40	61.80	51.20	8.38	N	74.80	61.80	61.80	61.80

<sup>a</sup>Subsurface antimony and beryllium background used.

Results less than the detection limit were set to 1/2 the reported detection limit.

Dist. Codes: L = Distribution most similar to lognormal.

N = Distribution most similar to normal.

X = Distribution significantly different from normal and lognormal.

D = Nonparametric distribution: frequency of detection <50%.

O = Zero detects: background criteria set to 0.00.

If background criteria > maximum detect, then background criteria = maximum detect.

If distribution determined normal or lognormal and fewer than 3 samples, then background criteria = maximum detect.

**Table 3-2. Ravenna Facility-Wide Subsurface Soil (>1 foot) Background (Metals Only)**

Analyte (Units)	Results > Detection Limit	Minimum Detect	Maximum Detect	Average Result	STD	Dist.	95% Upper Tolerance Limit	Nonparametric 95% UTL	99 <sup>th</sup> Percentile	Background Criteria
Aluminum (mg/kg)	27/27	1,380.00	19,500.00	11,600.00	4,917.52	N	22,900.00	19,500.00	19,500.00	19,500.00
Antimony (mg/kg)	8/27	0.27	0.96	0.34	0.14	D		0.96	0.96	0.96
Arsenic (mg/kg)	27/27	3.50	19.80	12.10	4.04	N	21.40	19.80	19.80	19.80
Barium (mg/kg)	27/27	10.70	134.00	58.60	28.68	N	124.00	134.00	134.00	124.00
Beryllium (mg/kg)	12/27	0.26	0.88	0.37	0.25	D		0.88	0.88	0.88
Cadmium (mg/kg)	0/27			0.29	0.01	O		0.62	0.62	0.00
Calcium (mg/kg)	22/27	416.00	35,500.00	4,880.00	9,339.26	L	44,800.00	35,500.00	35,500.00	35,500.00
Chromium (mg/kg)	27/27	4.10	27.20	16.90	6.24	N	31.30	27.20	27.20	27.20
Cobalt (mg/kg)	27/27	2.30	23.20	9.94	4.97	L	31.00	23.20	23.20	23.20
Copper (mg/kg)	27/27	2.90	32.30	19.50	6.34	N	34.10	32.30	32.30	32.30
Cyanide (mg/kg)	0/27			0.29	0.01	O		0.62	0.62	0.00
Iron (mg/kg)	27/27	3,690.00	35,200.00	23,200.00	7,299.72	N	39,900.00	35,200.00	35,200.00	35,200.00
Lead (mg/kg)	27/27	2.50	19.10	11.60	3.20	X		19.10	19.10	19.10
Magnesium (mg/kg)	27/27	216.00	8,790.00	3,350.00	2,054.14	X		8,790.00	8,790.00	8,790.00
Manganese (mg/kg)	27/27	107.00	3,030.00	400.00	551.13	X		3,030.00	3,030.00	3,030.00
Mercury (mg/kg)	4/27	0.03	0.04	0.04	0.02	D		0.12	0.12	0.04
Nickel (mg/kg)	27/27	3.80	60.70	23.60	12.01	L	76.10	60.70	60.70	60.70
Potassium (mg/kg)	27/27	333.00	3,560.00	1,520.00	798.94	N	3,350.00	3,560.00	3,560.00	3,350.00
Selenium (mg/kg)	8/27	0.61	1.50	0.49	0.34	D		1.50	1.50	1.50
Silver (mg/kg)	0/27			0.58	0.03	O		1.20	1.20	0.00
Sodium (mg/kg)	7/23	29.90	145.00	59.50	55.32	D		524.00	524.00	145.00
Thallium (mg/kg)	3/27	0.77	0.91	0.35	0.17	D		0.91	0.91	0.91
Vanadium (mg/kg)	27/27	5.20	37.60	19.70	7.90	N	37.80	37.60	37.60	37.60
Zinc (mg/kg)	27/27	7.60	93.30	60.50	17.18	N	99.90	93.30	93.30	93.30

Results less than the detection limit were set to 1/2 the reported detection limit.

Dist. Codes: L = Distribution most similar to lognormal.

N = Distribution most similar to normal.

X = Distribution significantly different from normal and lognormal.

D = Nonparametric distribution: frequency of detection <50%.

O = Zero detects: background criteria set to 0.00.

If background criteria > maximum detect then background criteria = maximum detect.

If distribution determined normal or lognormal and fewer than 3 samples, then background criteria = maximum detect.

**Table 3-3. Ravenna Facility-Wide Sediment Background (Metals Only)**

Analyte (Units)	Results > Detection Limit	Minimum Detect	Maximum Detect	Average Result	STD	Dist.	95% Upper Tolerance Limit	Nonparametric 95% UTL	99 <sup>th</sup> Percentile	Background Criteria
Aluminum (mg/kg)	7/7	1,710.00	13,900.00	6,430.00	4,801.40	L	75,900.00	13,900.00	13,900.00	13,900.00
Antimony (mg/kg)	0/7			0.48	0.18	O		1.50	1.50	0.00
Arsenic (mg/kg)	7/7	3.70	19.50	9.34	5.32	L	54.40	19.50	19.50	19.50
Barium (mg/kg)	7/7	15.20	123.00	62.00	46.05	N	219.00	123.00	123.00	123.00
Beryllium (mg/kg)	2/7	0.15	0.38	0.24	0.12	D		0.64	0.64	0.38
Cadmium (mg/kg)	0/7			0.48	0.18	O		1.50	1.50	0.00
Calcium (mg/kg)	5/7	920.00	5,510.00	2,320.00	2,117.85	L	50,300.00	5,510.00	5,510.00	5,510.00
Chromium (mg/kg)	7/7	2.60	18.10	8.99	6.19	L	91.50	18.10	18.10	18.10
Cobalt (mg/kg)	7/7	2.10	9.10	5.61	2.84	L	34.20	9.10	9.10	9.10
Copper (mg/kg)	7/7	2.50	27.60	12.40	9.27	L	198.00	27.60	27.60	27.60
Cyanide (mg/kg)	0/7			0.48	0.18	O		1.50	1.50	0.00
Iron (mg/kg)	7/7	5,170.00	28,200.00	15,500.00	9,328.75	L	123,000.00	28,200.00	28,200.00	28,200.00
Lead (mg/kg)	7/7	3.40	27.40	13.00	9.13	N	44.00	27.40	27.40	27.40
Magnesium (mg/kg)	7/7	434.00	2,760.00	1,450.00	854.43	L	11,200.00	2,760.00	2,760.00	2,760.00
Manganese (mg/kg)	7/7	154.00	1,950.00	694.00	636.28	L	12,100.00	1,950.00	1,950.00	1,950.00
Mercury (mg/kg)	2/7	0.04	0.06	0.07	0.03	D		0.28	0.28	0.06
Nickel (mg/kg)	5/7	4.00	17.70	9.00	5.48	L	68.20	17.70	17.70	17.70
Potassium (mg/kg)	7/7	195.00	1950.00	745.00	607.23	L	8,070.00	1,950.00	1,950.00	1,950.00
Selenium (mg/kg)	1/7	1.70	1.70	0.62	0.50	D		1.70	1.70	1.70
Silver (mg/kg)	0/7			0.96	0.37	O		3.00	3.00	0.00
Sodium (mg/kg)	4/7	22.40	112.00	56.80	34.01	L	923.00	174.00	112.00	112.00
Thallium (mg/kg)	1/7	0.89	0.89	0.56	0.23	D		1.50	1.50	0.89
Vanadium (mg/kg)	7/7	3.30	26.10	12.50	8.85	L	139.00	26.10	26.10	26.10
Zinc (mg/kg)	7/7	16.20	532.00	123.00	183.06	L	3,090.00	532.00	532.00	532.00

Results less than the detection limit were set to 1/2 the reported detection limit.

Dist. Codes: L = Distribution most similar to lognormal.

N = Distribution most similar to Normal.

X = Distribution significantly different from normal and lognormal.

D = Nonparametric distribution: frequency of detection <50%.

O = Zero detects: background criteria set to 0.00.

If background criteria > maximum detect, then background criteria = maximum detect.

If distribution determined normal or lognormal and fewer than 3 samples, then background criteria = maximum detect.

**Table 3-4. Ravenna Facility-Wide Surface Water Background (Metals Only)**

Analyte (Units)	Results > Detection Limit	Minimum Detect	Maximum Detect	Average Result	STD	Dist.	95% Upper Tolerance Limit	Nonparametric 95% UTL	99 <sup>th</sup> Percentile	Background Criteria
Aluminum (mg/kg)	5/6	661.00	3,370.00	1,450.00	1,138.27	N	5,670.00	3,370.00	3,370.00	3,370.00
Antimony (mg/kg)	0/7			2.50	0.00	O		5.00	5.00	0.00
Arsenic (mg/kg)	1/7	3.20	3.20	2.70	0.42	D		6.80	6.80	3.20
Barium (mg/kg)	7/7	12.50	47.50	28.50	10.69	N	64.90	47.50	47.50	47.50
Beryllium (mg/kg)	0/7			2.00	0.00	O		4.00	4.00	0.00
Cadmium (mg/kg)	0/7			2.50	0.00	O		5.00	5.00	0.00
Calcium (mg/kg)	7/7	13,500.00	41,400.00	23,100.00	10,554.28	L	92,700.00	41,400.00	41,400.00	41,400.00
Chromium (mg/kg)	0/7			5.00	0.00	O		10.00	10.00	0.00
Cobalt (mg/kg)	0/7			25.00	0.00	O		50.00	50.00	0.00
Copper (mg/kg)	4/7	3.50	7.90	5.94	3.56	L	62.40	25.00	12.50	7.90
Cyanide (mg/kg)	0/7			0.01	0.00	O		0.01	0.01	0.00
Iron (mg/kg)	7/7	440.00	2,560.00	1,370.00	715.43	L	8,420.00	2,560.00	2,560.00	2,560.00
Lead (mg/kg)	0/7			1.50	0.00	O		3.00	3.00	0.00
Magnesium (mg/kg)	7/7	3,240.00	10,800.00	5,520.00	2,703.77	L	22,300.00	10,800.00	10,800.00	10,800.00
Manganese (mg/kg)	7/7	33.60	391.00	153.00	125.29	L	1,820.00	391.00	391.00	391.00
Mercury (mg/kg)	0/7			0.10	0.00	O		0.20	0.20	0.00
Nickel (mg/kg)	0/7			20.00	0.00	O		40.00	40.00	0.00
Potassium (mg/kg)	7/7	519.00	3,170.00	1670.00	797.67	N	4,390.00	3,170.00	3,170.00	3,170.00
Selenium (mg/kg)	0/7			2.50	0.00	O		5.00	5.00	0.00
Silver (mg/kg)	0/7			5.00	0.00	O		10.00	10.00	0.00
Sodium (mg/kg)	6/7	4,770.00	21,300.00	11500.00	8,285.01	N	39,600.00	21,300.00	21,300.00	21,300.00
Thallium (mg/kg)	0/7			0.93	0.19	O		2.00	2.00	0.00
Vanadium (mg/kg)	0/7			25.00	0.00	O		50.00	50.00	0.00
Zinc (mg/kg)	4/7	14.60	42.00	17.40	11.73	X		42.00	42.00	42.00

Results less than the detection limit were set to 1/2 the reported detection limit.

Dist. Codes: L = Distribution most similar to lognormal.

N = Distribution most similar to normal.

X = Distribution significantly different from normal and lognormal.

D = Nonparametric distribution: frequency of detection <50%.

O = Zero detects: background criteria set to 0.00.

If background criteria > maximum detect, then background criteria = maximum detect.

If distribution determined normal or lognormal and fewer than 3 samples, then background criteria = maximum detect.

**Table 3-5. Ravenna Facility-Wide Unconsolidated Zone Groundwater Background (Filtered Metals Only)**

Analyte	Results > Detection Limit	Minimum Detect	Maximum Detect	Average Result <sup>a</sup>	Std. Dev. <sup>a</sup>	Distr. <sup>b</sup>	Parametric 95% UTL	Nonparametric 95% UTL	Background Criteria <sup>c</sup>
<i>Metals (µg/L)</i>									
Antimony	0/ 7			2.50	0.0	O		5.00	0.00
Arsenic	1/ 7	11.70	11.70	4.29	3.49	D		11.70	11.70
Barium	4/ 7	13.80	82.10	27.40	24.43	L	218.00	82.10	82.10
Beryllium	0/ 7			2.00	0.0	O		4.00	0.00
Cadmium	0/ 7			2.50	0.0	O		5.00	0.00
Calcium	7/ 7	15200.00	115000.00	78300.00	40269	N	215000.00	115000.00	115000.00
Chromium	1/ 7	7.30	7.30	5.33	0.87	D		10.00	7.30
Cobalt	0/ 7			25.00	0.0	O		50.00	0.00
Copper	0/ 4			10.10	4.90	O		25.00	0.00
Cyanide (mg/L)	0/ 7			0.01	0.0	O		0.01	0.00
Iron	3/ 7	208.00	279.00	136.00	113.7	D		279.00	279.00
Lead	0/ 7			1.50	0.0	O		3.00	0.00
Magnesium	7/ 7	4900.00	43300.00	24500.00	15180	N	76100.00	43300.00	43300.00
Manganese	6/ 7	273.00	1020.00	414.00	308.5	N	1460.00	1020.00	1020.00
Mercury	0/ 7			0.10	0.0	O		0.20	0.00
Nickel	0/ 7			20.00	0.0	O		40.00	0.00
Potassium	7/ 7	726.00	2890.00	1640.00	213.6	L	7000.00	2890.00	2890.00
Selenium	0/ 7			2.50	0.0	O		5.00	0.00
Silver	0/ 7			5.00	0.0	O		10.00	0.00
Sodium	7/ 7	2530.00	45700.00	17000.00	14794	L	305000.00	45700.00	45700.00
Thallium	0/ 7			0.86	0.23	O		2.00	0.00
Vanadium	0/ 7			25.00	0.0	O		50.00	0.00
Zinc	2/ 7	41.40	60.90	26.20	19.12	D		60.90	60.90
<i>VOCs (µg/L)</i>									
Chloroform	1/ 2	0.74	0.74	1.62	1.24	N	0.74	5.00	NA

<sup>a</sup>Results less than the detection limit were set to one-half the reported detection limit.

<sup>b</sup>Dist. Codes: L = Distribution most similar to lognormal.  
 N = Distribution most similar to normal.  
 X = Distribution significantly different from normal and lognormal.  
 D = Non-parametric distribution – frequency of detection <50%.  
 0 = Zero detects – background criteria set to 0.00.

<sup>c</sup>If 95% UTL > max. detect then background criteria = max. detect.

If distribution determined not normal or lognormal or fewer than 3 results then background criteria = max. detect.

Background criteria was set to zero if there were no detects.

NA - Not applicable. Background criteria were determined for metals only.

**Table 3-6. Ravenna Facility-Wide Unconsolidated Zone Groundwater Background (Unfiltered Metals Only)**

Analyte	Results > Detection Limit	Minimum Detect	Maximum Detect	Average Result <sup>a</sup>	Std. Dev. <sup>a</sup>	Distr. <sup>b</sup>	Parametric 95% UTL	Nonparametric 95% UTL	Background Criteria <sup>c</sup>
<i>Metals (µg/L)</i>									
Aluminum	7/ 7	5180.00	48000.00	23100.00	105088.	N	74400.00	48000.00	48000.00
Antimony	1/ 7	4.30	4.30	2.76	0.68	D		5.00	4.30
Arsenic	7/ 7	7.90	215.00	63.20	72.6	L	1760.00	215.00	215.00
Barium	7/ 7	59.60	327.00	164.00	90.9	L	1080.00	327.00	327.00
Beryllium	0/ 7			1.45	0.69	O		4.00	0.00
Cadmium	0/ 7			2.50	0.0	O		5.00	0.00
Calcium	7/ 7	17200.00	194000.00	100000.00	58152	N	298000.00	194000.00	194000.00
Chromium	6/ 7	15.50	85.20	37.80	27.2	L	400.00	85.20	85.20
Cobalt	4/ 7	24.60	46.30	31.40	8.96	X		50.00	46.30
Copper	6/ 7	16.00	289.00	94.40	97.9	L	2050.00	289.00	289.00
Cyanide (mg/l)	0/ 7			0.01	0.0	O		0.01	0.00
Iron	7/ 7	10700.00	195000.00	73700.00	65818	L	1620000.00	195000.00	195000.00
Lead	7/ 7	8.00	183.00	53.80	61.9	L	1460.00	183.00	183.00
Magnesium	7/ 7	14000.00	58400.00	35000.00	17887	L	195000.00	58400.00	58400.00
Manganese	7/ 7	306.00	2860.00	1410.00	917	L	14700.00	2860.00	2860.00
Mercury	4/ 7	0.08	0.25	0.12	0.06	L	0.69	0.25	0.25
Nickel	6/ 7	24.40	117.00	60.60	38.48	L	445.00	117.00	117.00
Potassium	7/ 7	2290.00	7480.00	5840.00	2137	X		7480.00	7480.00
Selenium	1/ 7	5.70	5.70	2.96	1.21	D		5.70	5.70
Silver	0/ 7			5.00	0.0	O		10.00	0.00
Sodium	7/ 7	4710.00	44700.00	18000.00	14090	L	205000.00	44700.00	44700.00
Thallium	1/ 7	2.40	2.40	1.21	0.58	D		3.00	2.40
Vanadium	7/ 7	7.90	98.10	43.80	31.4	L	633.00	98.10	98.10
Zinc	5/ 7	131.00	888.00	306.00	307	L	4710.00	888.00	888.00

<sup>a</sup>Results less than the detection limit were set to one-half the reported detection limit.

<sup>b</sup>Dist. Codes: L = Distribution most similar to lognormal.

N = Distribution most similar to normal.

X = Distribution significantly different from normal and lognormal.

D = Non-parametric distribution – frequency of detection <50%.

0 = Zero detects – background criteria set to 0.00.

<sup>c</sup>If 95% UTL > max. detect then background criteria = max. detect.

If distribution determined not normal or lognormal or fewer than 3 results then background criteria = max. detect.

Background criteria were set to zero if there were no detects.

- assess the toxicity of site-related COPCs,
- quantify risks to human health, and
- identify health-based remediation cleanup goals.

### **3.4.1 Selection of Chemicals of Potential Concern**

The first step in the risk process involves identifying the COPCs. This step involves:

- screening data against available background data,
- screening data against risk-based screening levels, and
- evaluating remaining chemicals using various additional screens, as defined below.

Only validated data will be used for the assessment. Data flagged with an “R” qualifier during the analytical validation process will be evaluated for their usability. “Unusable” data will be excluded from the data set. The major data quality issue during the Phase I RI stemmed from the need to dilute samples for explosives analysis because of the high concentrations of TNT in the samples. As the samples were diluted (generally 10 or 100 times) in order to be able to quantify results, the detection limit increased, generally on the same order as the dilution. The dilutions resulted in unacceptable detection limits for several analytes, primarily DNT. Several of the elevated detection limits exceed the risk-based screening criteria. In this situation, it is impossible to determine whether the analyte is present in the sample at levels above or below the risk-based screening values. Thus, the results cannot be used to determine if action is necessary to address that analyte, and the results will be excluded from risk estimates.

The first step is to screen results against frequency of detection criteria, naturally occurring, or “background” concentrations, and essential nutrient criteria. Chemicals detected at levels below background concentrations will not be considered COPCs. This screening process is described in detail in Section 3.3.3. Background concentrations of COPCs will also be carried through the risk assessment.

The second step of the process is to screen data against the risk-based screening value. These values are very conservative [based on  $10^{-7}$  risk levels and a hazard quotient (HQ) of 0.1]. Chemicals detected below these concentrations are screened from further consideration. The risk-based screening levels will be the most current residential PRGs published by EPA Region 9. The maximum detected concentration of each chemical will be compared to the PRG.

Once all screens have been performed, a list of COPCs will be developed for each data aggregate. The COPCs will be further evaluated in the remaining steps of the baseline risk assessment (BRA).

### **3.4.2 Exposure Assessment**

This section describes the exposure setting, develops information on exposure pathways, estimates the contaminant concentrations at points of human exposure, and determines receptor intakes.

#### **3.4.2.1 Site Setting**

The RVAAP installation is located in two counties of northeastern Ohio, Portage County and Trumbull County, with a majority of the facility lying in Portage County. According to the 1990 Census, the total population of Portage and Trumbull counties was 142,585 and 227,813, respectively. The largest population centers in the area are the town of Ravenna (population 12,069), located approximately 3.2 km (2 miles) to the west, and Newton Falls (population 4866), located approximately 1.6 km (1 mile) to the southeast.

Land use within the facility is restricted access industrial. At the present time, RVAAP is an inactive facility maintained by a contracted caretaker, TolTest, Inc. Site workers infrequently visit the AOCs for maintenance purposes, e.g., mowing. The Ohio National Guard (ONG) also occupies parts of RVAAP and conducts training exercises. Personnel from the ONG may occasionally travel through AOCs at RVAAP but generally restrict training to areas outside of AOCs. No training exercises are known to be conducted within Load Line 12. The land use immediately surrounding the facility is primarily rural. Approximately 55% of Portage County is either woodland or farmland (Portage County Soil and Water Conservation District Resources Inventory 1985; Census Bureau 1992). To the south of the facility is the Michael J. Kirwan Reservoir, which serves as a potable water source and is used for recreational purposes. The Reservoir is south of the site, across State Route 5. The Reservoir is fed by the West Branch of the Mahoning River, which flows south along the western edge of the installation. Hinkley Creek flows south across the western portion of the facility and eventually flows into the West Branch of the Mahoning River. The major surface drainages at RVAAP, Sand Creek and the South Fork of Eagle Creek, exit the facility property and eventually flow east to the Mahoning River.

Residential groundwater use occurs outside of the facility, with most of the residential wells tapping into either the Sharon Conglomerate or the surficial unconsolidated aquifer. Groundwater from on-site production wells was used during operations at the facility (USACE 1996); however, all but two production wells have been abandoned at the facility. These wells, located in the central portion of the facility, provide sanitary water to the facility. The Sharon Conglomerate is the major producing aquifer at the facility.

Currently surface water is primarily used by only wildlife. Based on conversations with site personnel, it is likely that some recreational trespasser use of surface water occurs on a limited basis outside of Load Line 12, primarily associated with fishing. It is unlikely that any fishing occurs near Load Line 12 since the drainages at the site are small and intermittent.

Future uses of RVAAP are currently being determined; potential future uses include:

- continued storage of bulk explosives short term (<5 years);
- continued use of certain areas for training purposes by the ONG;
- expanded training and occupancy by the ONG to encompass the entire facility (long term) >5 years; and
- recreational use, e.g., hunting, fishing, hiking.

#### **3.4.2.2 Selected Exposure Pathways**

A complete exposure pathway consists of the following four elements: (1) a source and mechanism of contaminant release to the environment; (2) an environmental transport mechanism (fate and transport) for the released contaminants; (3) a point of human contact with the contaminated media (exposure point); and (4) a route of entry of the contaminant into the human receptor (exposure route) at the exposure point. An integration of sources and releases, fate and transport mechanisms, exposure points, and exposure routes is evaluated for complete exposure pathways.

Based on ongoing activities at RVAAP, current human receptors include:

- maintenance workers/Security Guard;
- military personnel, specifically ONG Training personnel; and
- recreational users (e.g., hunters, trespassers).



Future potential receptors include all of the above plus

- industrial workers and
- resident farmers.

Table 3-7 indicates potential pathways associated with each of the receptors. The National Guard receptor is assumed to conduct activities that result in contact with subsurface, as well as surface, soil. This receptor is also assumed to use groundwater as a potable water supply. Because incidental contact with groundwater while digging will result in much less exposure than potable use, only potable use is included in this scenario. A complete summary of exposure parameters and models proposed for use in the risk assessment are presented in Appendix C.

### 3.4.2.3 Exposure Point Concentration

The exposure point concentration is regarded as a reasonable maximum average concentration in an environmental medium that a receptor will encounter over the exposure period. The Load Line 12 risk assessment will evaluate the reasonable maximum exposure (RME). The RME is an estimate of the highest exposure reasonably expected to occur at a site. Because of the uncertainty associated with any estimate of exposure concentration, the UCL<sub>95</sub> for either a normal or lognormal distribution is the recommended statistic (EPA 1992a). A UCL<sub>95</sub> for surface soil and for the combined surface and subsurface soil data will be used to represent the exposure point concentrations for receptors at Load Line 12. In cases where the UCL<sub>95</sub> exceeds the maximum detected concentration, the maximum concentration will be used as an estimate of the RME. Background concentrations of inorganic chemicals detected at Load Line 12 will be evaluated in a similar manner.

### 3.4.2.4 Quantification of Exposure

For estimating exposures at Load Line 12, typical exposure models and parameter values from the Risk Assessment Guidance for Superfund (RAGS) and from other regulatory guidance documents will be used. Parameter values include exposure frequencies, exposure times, and exposure durations, as well as chemical-specific values to describe chemical partitioning and uptake. Some site-specific parameters will be used, primarily associated with ONG training personnel and for recreational users. Parameter values for use in the risk assessment are provided in Table 3-7.

The most likely pathways that will be quantified for exposures to contaminants at Load Line 12 are soil ingestion, dermal contact with soil, and inhalation of soil particles. For the future resident farmer, ingestion of foodstuff will also be addressed. For the industrial worker, only partial ingestion exposure to groundwater will be included. Additional pathways may be quantified as needed (e.g., inhalation of volatiles) but are not discussed below. The methodology used to estimate intakes is provided in Appendix C. Summaries of these equations are provided below. Intakes from ingestion are:

$$\text{Chemical Intake (mg/kg - d)} = \frac{C \times IR \times CF \times EF \times ED}{BW \times AT},$$

where:

- C = chemical concentration in environmental media (mg/kg; mg/L),
- IR = ingestion rate (mg/d; L/d),
- CF = conversion factor (10<sup>-6</sup> kg/mg - soils only),
- EF = exposure frequency (days/year),

Table 3-7. Conceptual Exposure Model for Load Line 12 at RVAAP

Pathway	Modified Caretaker – Managed Recreational			National Guard – Managed Recreational			Open Recreational	Open Industrial	Open Residential <sup>a</sup>	
	Security Guard (1)	Hunter/ Trapper (2)	Trespasser (3)	National Guard (4)	Hunter/ Trapper (2)	Trespasser (3)	Recreator (5)	Industrial Worker (6)	Resident Farmer – Adult (7)	Resident Farmer – Child (8)
<i>Surface Soil</i>										
Incidental soil ingestion	●	●	●	●	●	●	●	●	●	●
Dermal contact with soil	●	●	●	●	●	●	●	●	●	
Inhalation of VOCs and dust	●	●	●	●	●	●	●	●	●	
<i>Subsurface Soil</i>										
Incidental soil ingestion				●				●	●	●
Dermal contact with soil				●				●	●	
Inhalation of VOCs and dust				●				●	●	
<i>Sediment</i>										
Incidental sediment ingestion		●	●	●	●	●	●		●	●
Dermal contact with sediment		●	●	●	●	●	●		●	
Inhalation of VOCs and dust		●	●	●	●	●	●		●	
<i>Surface Water</i>										
Incidental ingestion while swimming		●	●	●	●	●	●		●	
Dermal contact while swimming		●	●	●	●	●	●		●	
Inhalation of VOCs		●	●	●	●	●	●		●	
<i>Groundwater</i>										
Ingestion				●					●	
Dermal contact				●					●	
Inhalation of VOCs				●					●	
<i>Foodstuff</i>										
Ingestion of venison, game		●			●				●	
Ingestion of beef, pork									●	
Ingestion of milk products									●	●
Ingestion of vegetables									●	
Ingestion of fish		●			●				●	

<sup>a</sup>A conservative approach is taken to evaluate the open residential land use. In most cases, since the adult farmer produces larger risks and hazards than the child farmer, the adult is predominantly evaluated. In scenarios where the child receptor results in greater exposures than the adult receptor, the child is also evaluated. Consequently, the noncarcinogenic effects for a child and adult are evaluated for soil/sediment ingestion, as well as for the ingestion of milk products (the child ingestion rates are higher than the adult ingestion rates for these exposures). The carcinogenic effects for these exposures are evaluated using a weighted average of the child and adult parameter values (which results in a larger exposure than evaluating only the adult).

ED = exposure duration (years),  
 BW = body weight (kg),  
 AT = averaging time (carcinogens: 25,550 days; noncarcinogens: ED × 365 days).

The absorbed dose from **dermal contact with soil** is calculated using the method presented in the EPA Dermal guidance (1992) as follows:

$$\text{Chemical DAD (mg/kg - d)} = \frac{C_s - CF - SA - AF - ABS - EF - ED}{BW - AT},$$

where:

DAD = dermally absorbed dose,  
 C<sub>s</sub> = chemical concentration in soil (mg/kg),  
 CF = conversion factor (10<sup>-6</sup> kg/mg),  
 SA = skin surface area exposed to soil (cm<sup>2</sup>/day),  
 AF = soil to skin adherence factor (mg/cm<sup>2</sup>),  
 ABS = absorption factor (chemical-specific),  
 EF = exposure frequency (days/year),  
 ED = exposure duration (years),  
 BW = body weight (kg),  
 AT = averaging time (carcinogens: 25,550 days; noncarcinogens: ED × 365 days).

The **contaminant concentration as particulated dust** is calculated using a dust loading factor based on typical site activity by the following equation (DOE 1989):

$$C_d = C_s * K,$$

where:

C<sub>d</sub> = concentration in dust (mg/m<sup>3</sup>),  
 C<sub>s</sub> = concentration in soil (mg/kg),  
 K = dust loading factor (kg of soil/m<sup>3</sup> of air).

The **intake for inhalation of soil particulates** was calculated as follows:

$$\text{Chemical Intake (mg/kg - d)} = \frac{C_d - IR - ET - EF - ED}{BW - AT},$$

where:

C<sub>d</sub> = contaminant concentration in air (mg/m<sup>3</sup>),  
 IR = inhalation rate (m<sup>3</sup>/hr),  
 ET = exposure time (hr/day),  
 EF = exposure frequency (days/year),  
 ED = exposure duration (years),  
 BW = body weight (kg),  
 AT = averaging time (25,550 days for carcinogens, ED × 365 days for noncarcinogens).

Evaluation of ingestion of foodstuff will be based on modified equations presented in Baes et al. (1984).

### 3.4.3 Toxicity Assessment

The toxicity assessment will be performed using standard EPA-derived toxicity factors. Toxicity factors have not been developed for several explosives derivatives. In these cases, EPA, and Army toxicologists will be consulted. The two primary toxicity factors used in the risk assessment include the cancer slope factor (CSF) and the reference dose (RfD). The CSF is defined as a plausible upper-bound estimate of the probability of a response (e.g., cancer) per unit intake of a chemical over a lifetime (EPA 1989). Slope factors are specific for each contaminant and route of exposure. The potential for noncarcinogenic health effects resulting from exposure to chemicals is assessed by comparing an intake or dose to a RfD. The chronic RfD is defined as an estimate of daily exposure level for the human population, including sensitive subpopulations, that is likely to be without an appreciable risk of deleterious effects during a lifetime (EPA 1989). An RfD is also specific to a chemical and route of exposure.

Oral and inhalation CSF and RfDs are currently available. The inhalation values take into consideration a fractional amount of chemical absorbed by the mucus membranes into the blood. The oral values take into consideration a fractional amount of contaminant absorbed across the gastrointestinal (gi) tract into the bloodstream when estimating toxic doses. Dermal CSFs and RfDs will be estimated from the oral toxicity values using chemical-specific gut absorption factors to calculate the total absorbed dose by the following equations (EPA 1992b):

$$RfD_{dermal} = RfD_{oral} - ABS_{gi} ,$$

$$CSF_{dermal} = CSF_{oral} / ABS_{gi} ,$$

where:

- CSF = chemical-specific cancer slope factors (mg/kg-day)<sup>-1</sup>,
- RfD = chemical-specific reference doses (mg/kg-day),
- ABS<sub>gi</sub> = chemical-specific gut absorption factor (unitless).

Chemical-specific ABS<sub>gi</sub> values available from EPA Region V will be used whenever possible. When chemical-specific values are not available a default ABS<sub>gi</sub> of 1 will be used for organic COPCs (USACE 2000b).

### 3.4.4 Risk Characterization

Risk characterization integrates the findings of the exposure assessment to estimate the likelihood that receptors experience adverse effects as a result of exposure to COPCs (EPA 1991). Risks will be calculated from toxicity information and the results of the exposure assessment. For carcinogens, incremental lifetime cancer risks (ILCRs), or the increased lifetime probability of cancer, will be calculated. These ILCRs represent the increase chance above the background of contracting cancer. In the United States, the background chance is approximately 3 chances in 10, or  $3 \times 10^{-1}$  (American Cancer Society 1990). The resulting ILCRs are compared to the range specified in the National Contingency Plan (EPA 1990) of  $10^{-6}$  to  $10^{-4}$ , or 1 in 1 million to 1 in 10,000 persons developing cancer. ILCRs below  $10^{-6}$  are considered negligible. ILCRs above  $10^{-4}$ , are considered unacceptable risks. For risks between  $10^{-6}$  and  $10^{-4}$  any decisions to address the risk further either through further study or engineered control measures should carefully weight the risk benefit and cost impact of the action.

Risk results will be presented for the total concentration of inorganic COPCs detected at the site and background concentrations of inorganic COPCs.

The risk of developing cancer will be estimated as follows (EPA 1989):

$$ILCR = I \times CSF ,$$

where:

ILCR = Incremental Lifetime Cancer Risk (unitless probability),  
 I = chronic daily intake or dermally absorbed dose from exposure assessment (mg/kg-day or pCi),  
 CSF = Cancer Slope Factor (mg/kg-day)<sup>-1</sup>.

For a given pathway, with simultaneous exposure of a receptor to several carcinogens, the total risk to a receptor is estimated as the sum of the ILCRs for each carcinogen encountered in all sources and each pathway. The equation that will be used to calculate the total ILCR is :

$$ILCR_{total} = \sum ILCR_i ,$$

where:

ILCR<sub>total</sub> = total chance of cancer incidence,  
 ILCR<sub>i</sub> = ILCR for the i<sup>th</sup> contaminant.

In addition to developing cancer from exposure to contaminants, an individual may experience toxic effects from exposures to hazardous substances. The term “toxic effects” describes 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 risks associated with toxic chemicals are evaluated by comparing an exposure level or intake to a reference dose. The reference dose is the threshold level below which no toxic effects are expected to occur in a normal population, including sensitive subpopulations. The ratio of intake over the reference dose is termed the hazard quotient (HQ) (EPA 1989) and is defined as:

$$HQ = \frac{I}{RfD} ,$$

where:

HQ = Hazard Quotient (unitless ratio),  
 I = daily intake of a contaminant (mg/kg-day),  
 RfD = Reference Dose (mg/kg-day).

The HQs for each contaminant are summed to obtain a hazard index (HI). An HI >1 has been defined as the level of concern for potential adverse noncarcinogenic health effects (EPA 1989). This approach is different from the probabilistic approach used to evaluate carcinogens. An HQ of 0.01 does not imply a 1 in 100 chance of an adverse effect, but indicates only that the estimated intake is 100 times less than the threshold level at which adverse health effects may occur. In the case where simultaneous exposure of a receptor to several

chemicals occurs, a total HI is calculated as the sum of the individual HQs for all noncarcinogens encountered in all sources for each pathway as follows:

$$HI = \sum HQ_i,$$

where:

HI = Total Hazard Index for toxic effects,  
HQ = Hazard Quotient for the  $i^{\text{th}}$  contaminant.

A total ILCR and a total HQ associated with each medium for each receptor will be estimated by summing the pathway-specific values. HQs will be summed where multiple chemicals affect the same organ or affect similar processes, or have similar methods of toxicity.

Chemicals of concern (COCs) will be identified as those COPCs that exceed acceptable risk criteria for each receptor and pathway. The COCs will be specific to medium and receptor. These chemicals represent the main contributors to human health risks at the site that will need to be addressed during remedial action.

### **3.4.5 Uncertainty Analysis**

There is uncertainty associated with every risk assessment. Assumptions built into the risk assessment tend in general to overestimate rather than underestimate potential risks, but occasionally can result in underestimating risk. For example, it is assumed that the toxic and carcinogenic effects of the COCs are additive with respect to pathway and media. This assumption can result in an underestimation of risks due to synergistic toxic effects, or an overestimation of risks due to antagonistic toxic effects. In addition, the risk parameters typically used reflect an upper bound for the population. These upperbound assumptions compounded for each parameter may result in an overestimation of risks to the typical population.

As part of the risk evaluation for Load Line 12, uncertainties will be identified and addressed where ever possible in order to better understand the risk results.

### **3.4.6 Remedial Goal Options**

The Baseline HHRA will develop RGOs for COCs that may potentially require remediation. RGOs will only be used if a remedial action is warranted. If necessary, RGOs will be developed using RAGS Part B equations and parameters developed in conjunction with the risk manager prior to completing the Draft Phase II RI Report. These values are risk-based criteria that are used in the FS to define the extent of contamination in an area that must be remediated to help cost various alternatives. The results of the ERA as well as land use decisions are also a factor in evaluating remedial alternatives. Stakeholders will work together to determine the best land use/pathway combinations from the risk assessment for developing the RGOs should they be necessary.

## **3.5 SCREENING ECOLOGICAL RISK ASSESSMENT**

The planned ecological risk assessment (ERA) at RVAAP will follow the general framework recommended by EPA (1992a, 1997) and by the Army (Wentzel et al. 1996). Briefly, this framework consists of four interrelated activities: problem formulation, exposure assessment, effects assessment, and risk characterization. Additional guidance, as provided in the Scope of Work (USACE 2000) and the Ohio EPA during finalization of this Work Plan Addendum, will be followed as well.

There are a number of site- or RVAAP-specific matters whose resolution is part of the problem formulation activity. This plan presents how these site-specific matters will be addressed. Current consensus is based on meetings in May 1997 through March 2000 at RVAAP with ecologists and risk assessors from Ohio EPA, USACE, RVAAP, and SAIC. More precisely, these meetings and conversations have occurred in December 1997, January 1998, and several in 1999. The following shows the results of this process.

### **3.5.1 Conceptual Site Model Diagram**

The CSM for Load Line 12 describes how receptors present or likely to be present at the site are potentially exposed to contaminants present in one or more source media. The transport and exposure pathways linking contaminated source media and potential ecological receptors are diagramed in [Figure 3-1](#). Potential routes of exposure to contaminants in potential exposure media (e.g., air, soil, surface water/sediment, and food) are indicated and evaluated for terrestrial and aquatic receptor classes. For example, there are year-round streams inside the boundary of Load Line 12 and sediments are also present as well in dry material in shallow water conveyances. Therefore, exposure is possible to fish and sediment-dwelling organisms inside Load Line 12. Surface water is able to leave Load Line 12 and carry contaminated soil particles to a stream outside Load Line 12. Many terrestrial plants and animals will be exposed to soil as well as food. For example, mammals and birds directly ingest soil, and the soil fraction of diet will be used in the exposure equations. Such fractions as 5 and 10% are typical. The principal source of these data will be the Wildlife Exposures Handbook (EPA 1993). However, this source as well as knowledge of terrestrial top predators' (hawk and fox) diet shows a soil fraction of diet at 0%. Top predators are exposed indirectly from soil via their prey organisms. For each type of receptor, potential exposure routes or pathways are classified as complete or incomplete depending on how likely is exposure by that route. Complete pathways are further classified as being evaluated quantitatively or qualitatively. Quantitatively means the use of numbers for exposure and effects. Qualitatively means the use of words, logic, and technical common sense.

### **3.5.2 Selection Criteria for Ecological Receptors**

Receptors for the ERA for Load Line 12 were selected based on three criteria specified in *Proposed Guidelines for Ecological Risk Assessment* (EPA 1997) and previous documents. Receptors were selected according to their ecological relevance, susceptibility to known or potential stressors, and representativeness of management goals ([Table 3-8](#)). Ecological relevance means that the receptor has or represents a role in energy flow (e.g., plants); nutrient cycling (e.g., earthworms); or population regulation (e.g., hawk, owl, and fox). Susceptibility means that the receptor is known to be sensitive to chemicals (e.g., rabbits) and/or exposure because food preference is high (e.g., shrews). Management goals mean the sustaining of ecosystems and ecological processes while maintaining the central mission of RVAAP, which is to store bulk explosives and inert materials. The large tracts of natural land, needed as safety buffers, provide the natural resource base to be managed. Such management goals as the following support the mission and natural resource management plan: erosion control through vegetation, population management through hunting of such animals as deer, and protection of rare, threatened and endangered (T&E) species such as the barn owl.

The selected receptors are ecologically relevant because they represent important elements of the ecosystems at RVAAP, contributing to the structure, function, and biodiversity. These receptors interact as resources and consumers, forming a food web through which both nutrients and contaminants move through the ecosystem. Due to their range of habitats, body sizes, diets, life spans, reproductive rates, home ranges, and taxonomic relationships, these receptors represent a range of potential susceptibilities to contaminants at Load Line 12. All of these receptors are potentially exposed to contaminants at Load Line 12 because they are present or likely occur there, and they ingest or live in direct contact with contaminated media. The selected receptors are judged to be consistent with general management goals of protecting the environment, including T&E or

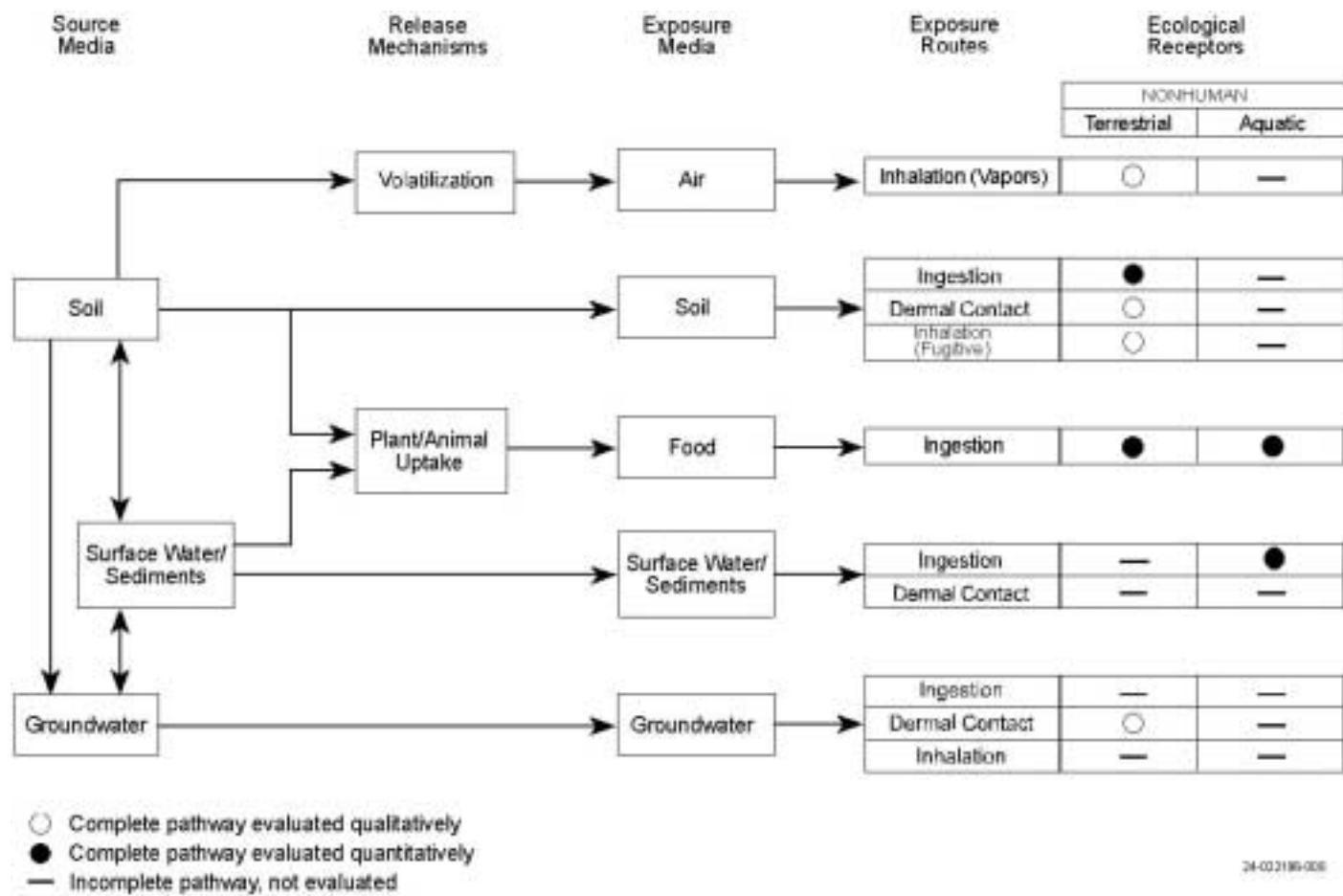


Figure 3-1. Exposure Pathways for Terrestrial and Aquatic Receptors



**Table 3-8. Reasons for Selecting Receptors for Ecological Risk Assessment at Load Line 12**

Receptor	Selection Criteria (EPA 1996)		
	Criterion 1  Ecological Relevance	Criterion 3  Susceptibility	Criterion 3  Represents Management Goals <sup>a</sup>
Plants ( <i>various species</i> )	+++	+	+++
Earthworms ( <i>various species</i> )	++	+	+
Short-tailed shrew ( <i>Blarina brevicauda</i> )	+	++	+
American robin ( <i>Turdus migratorius</i> )	+	++	+
Meadow vole ( <i>Micotus pennsylvanicus</i> )	++	++	++
White-tailed deer ( <i>Odocoileus virginianus</i> )	+	+	+++
Eastern cottontail ( <i>Sylvilagus floridanus</i> )	+	++	+
Red-tailed hawk ( <i>Buteo jamaicensis</i> )	++	+	++
Barn owl ( <i>Tyto alba</i> ) endangered species	+	+	+++
Red fox ( <i>Vulpes vulpes</i> )	++	+	+

<sup>a</sup> Includes protection of T&E or other special status species.

+++ = receptor very strongly meets criterion; ++ = receptor strongly meets criterion; and + = receptor meets criterion.

other species with special status. Regarding T&E species, other species of federal and status interest have been identified (ODNR 1993). For example, the Indiana bat (*Myotis sodalis*) was captured on the RVAAP installation. These T&E species will be handled qualitatively, and the barn owl will be handled quantitatively in the ERA.

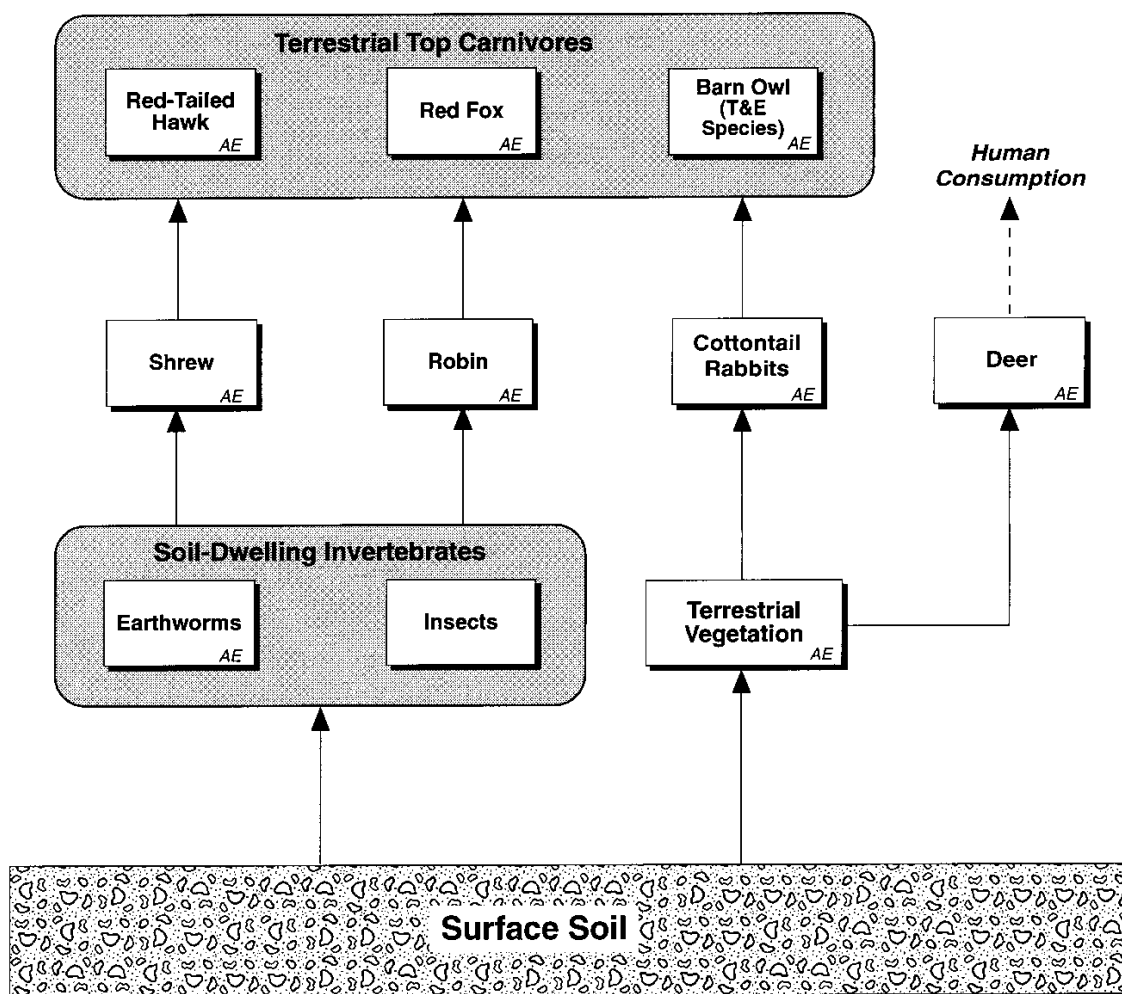
### 3.5.3 Terrestrial Food Web for Ecological Receptors

Figure 3-2 provides ingestion pathways for a variety of receptors in the terrestrial food web. Note that there are fewer receptors than really exist at RVAAP. The planned ERA is a screening level assessment. As such, it is satisfactory to deal with representatives of groups of organisms (e.g., shrew and robin for all insectivorous and worm-eating organisms). Appropriate receptors and food webs, as well as assessment and measurement endpoint in the planning or problem formulation activity, were developed cooperatively with Ohio EPA and the Army in successive meetings held between 1997 and 2000.

### 3.5.4 Assessment Endpoints, Measurements, and Decision Rules

Table 3-9 emphasizes the relationships among policy goals, assessment endpoints, measurement endpoints, and the decisions relative to HQs. Each type of receptor has separate assessment endpoints, measurement endpoints, and decision criteria. An assessment endpoint is defined by EPA (EPA 1992a) as “an explicit expression of the environmental value that is to be protected.” A measurement endpoint is defined by EPA (1992a) as “a measurable ecological characteristic that is related to the valued characteristic chosen as the assessment endpoint.” Further explanations about these terms are found in Wentzel (1996) and EPA (1997).

Table 3-9 provides information on home range, feeding habits, and other characteristics for each endpoint species or receptor in the food web. Table 3-10 shows examples of such data for the shrew that will be organized for each receptor modeled or used in the ecological risk assessment.



AE = assessment endpoint; organisms with no AE in box means they are intermediate in terms of transfers.

Figure 3-2. Food Web at RVAAP for Ecological Risk Assessment

**Table 3-9. Policy Goals, Ecological Assessment Endpoints, Measurement Endpoints, and Decision Rules for Load Line 12**

<b>Policy Goals</b>	<b>Assessment Endpoint</b>	<b>Measurement Endpoint</b>	<b>Decision Rule</b>
<b>Policy Goal 1:</b> The preservation and conservation of T&E species and their critical habitats.	<b>Assessment Endpoint 1:</b> Preservation of any state- or federally designated, threatened, or endangered species.  Endpoint Species: Barn owl	<b>Measurement Endpoint 1:</b> Modeled contaminant concentrations in prey (shrews, robins, and rabbits) based on measured soil concentrations.	<b>Decision Rule for Assessment Endpoint 1:</b> If T&E species are not present, or RME concentrations in the media do not contribute to chronic NOAEL exceedance (i.e., HQs <1), then it is indicated that the contaminant alone is unlikely to cause adverse ecological effects and, therefore, the T&E species should be preserved. If the HQ >1, a weight-of-evidence evaluation will be conducted to determine the potential for ecological risk and the need for any additional measurements or calculations.
<b>Policy Goal 2:</b> The maintenance and protection of terrestrial populations and ecosystems.	<b>Assessment Endpoint 2:</b> Maintenance of plant community for erosion control and energy production.  Endpoint Species: plants of various species	<b>Measurement Endpoint 2:</b> Measured soil contaminant concentrations.	<b>Decision Rule for Assessment Endpoint 2:</b> If the HQ is <1, then it is indicated that the contaminant alone is unlikely to cause adverse ecological effects and, therefore, maintain the plant populations and communities. If the HQ >1, a weight-of-evidence evaluation will be conducted to determine the potential for ecological risk and the need for any additional measurements or calculations.
	<b>Assessment Endpoint 3:</b> Maintenance of soil-dwelling invertebrate community for nutrient and energy processing.  Endpoint Species: earthworms	<b>Measurement Endpoint 3:</b> Measured soil contaminant concentrations	<b>Decision Rule for Assessment Endpoint 3:</b> If the HQ is <1, then it is indicated that the contaminant alone is unlikely to cause adverse ecological effects and, therefore, maintain the soil invertebrate community. If the HQ >1, a weight-of-evidence evaluation will be conducted to determine the potential for ecological risk and the need for any additional measurements or calculations.
	<b>Assessment Endpoint 4:</b> Maintenance of populations of herbivorous animals.  Endpoint Species: meadow voles, cottontail rabbits and deer	<b>Measurement Endpoint 4:</b> Modeled contaminant concentrations in food chain based on measured soil contaminant concentrations.	<b>Decision Rule for Assessment Endpoint 4:</b> If the HQ is <1, then it is indicated that the contaminant alone is unlikely to cause adverse ecological effects and, therefore, populations of the herbivores, e.g., voles, cottontail rabbits, and deer, are maintained. If the HQ >1, a weight-of-evidence evaluation will be conducted to determine the potential for ecological risk and the need for any additional measurements or calculations.
	<b>Assessment Endpoint 5:</b> Maintenance of worm-eating and/or insectivorous animals.  Endpoint Species: mammal - shrew; bird – robin	<b>Measurement Endpoint 5:</b> Modeled contaminant concentrations in earthworms and other prey based on measured soil contaminant concentrations.	<b>Decision Rule for Assessment Endpoint 5:</b> If the HQ is <1, then it is indicated that the contaminant alone is unlikely to cause adverse ecological effects and, therefore, populations of worm-eating and/or insectivorous animals are maintained. If the HQ >1, a weight-of-evidence evaluation will be conducted to determine the potential for ecological risk and the need for any additional measurements or calculations.

**Table 3-9. Policy Goals, Ecological Assessment Endpoints, Measurement Endpoints, and Decision Rules for Load Line 12 (continued)**

<b>Policy Goals</b>	<b>Assessment Endpoint</b>	<b>Measurement Endpoint</b>	<b>Decision Rule</b>
	<b>Assessment Endpoint 6:</b> Maintenance of terrestrial predators.  Endpoint Species: mammal - red fox; bird - red-tailed hawk	<b>Measurement Endpoint 6:</b> Modeled contaminant concentrations in prey (shrews, robins, and rabbits) based on measured soil contaminant concentrations.	<b>Decision Rule for Assessment Endpoint 6:</b> If the HQ is <1, then it is indicated that the contaminant alone is unlikely to cause adverse ecological effects, and, therefore, populations of terrestrial predators are maintained. If the HQ >1, a weight-of-evidence evaluation will be conducted to determine the potential for ecological risk and the need for any additional measurements or calculations.
<b>Policy Goal 3:</b> The maintenance and protection of aquatic populations and ecosystems.	<b>Assessment Endpoint 5:</b> Maintenance of sediment-dwelling organisms.  Endpoint Species: sediment-dwelling organisms	<b>Measurement Endpoint 5:</b> Measured sediment contaminant concentrations.	<b>Decision Rule for Assessment Endpoint 5:</b> If the HQ is <1, then it is indicated that the contaminant alone is unlikely to cause adverse ecological effects and, therefore, populations of sediment-dwelling organisms are maintained. If the HQ >1, a weight-of-evidence evaluation will be conducted to determine the potential for ecological risk and the need for any additional measurements or calculations.
	<b>Assessment Endpoint 6:</b> Maintenance of aquatic organisms.  Endpoint Species: aquatic organisms	<b>Measurement Endpoint 6:</b> Measured surface water contaminant concentrations.	<b>Decision Rule for Assessment Endpoint 6:</b> If the HQ is <1, then it is indicated that the contaminant alone is unlikely to cause adverse ecological effects, and, therefore, populations of aquatic organisms are maintained. If the HQ >1, a weight-of-evidence evaluation will be conducted to determine the potential for ecological risk and the need for any additional measurements or calculations.
	<b>Assessment Endpoint 7:</b> Maintenance of aquatic organism and fish-eating predator population for population regulation.  Endpoint Species: raccoon and great blue heron	<b>Measurement Endpoint 7:</b> Measured concentrations of contaminant concentrations in surface water for raccoon and modeled contaminant concentrations in prey fish based on measured surface water concentrations for the great blue heron..	<b>Decision Rule for Assessment Endpoint 7:</b> If the HQ is <1, then it is indicated that the contaminant alone is unlikely to cause adverse ecological effects, and, therefore, populations of terrestrial predators are maintained. If the HQ >1, a weight-of-evidence evaluation will be conducted to determine the potential for ecological risk and the need for any additional measurements or calculations.

RME = Reasonable maximum exposure.  
T&E = Threatened and endangered.  
NOAEL = No observed adverse effects level.  
HQ = Hazard (risk) quotient.

**Table 3-10. Receptor Parameters for Short-tailed Shrew**

Parameter	Definition	Receptor: Short-tailed shrew ( <i>Blarina brevicauda</i> )	
		Value	Reference / Notes
BW	Body weight (kg)	0.017	Arithmetic mean of means, both sexes, fall and summer, western Pennsylvania (EPA 1993)
HR	Home range (ha)	0.36	Maximum, adult female, summer, Michigan (EPA 1993)
TUF	Temporal use factor	1	Will be 1 unless a specific value exists for a receptor
AUF	Area use factor	1	Will be 1 to maximize exposure
IR <sub>F</sub>	Food ingestion rate (g/g-d = kg/kgBW/d) <sup>a</sup>	0.56	Arithmetic mean of adults, both sexes, 25°C, Wisconsin (EPA 1993)
PF	Plant fraction of diet	0.13	June through October, New York (EPA 1993); assuming vegetative parts and fungi
AF	Animal fraction of diet	0.87	June through October, New York (EPA 1993); assuming 100% earthworms
SF	Soil fraction of diet	0.13	Talmage and Walton (1993)
IR <sub>w</sub>	Water ingestion rate (g/g-d = L/kgBW/d)	0.223	Adult, both sexes, Illinois, lab (EPA 1993)

<sup>a</sup> Food ingestion rate (g/g-d) re-expressed as kg/kgBW/d is assumed not to include ingested soil; therefore, PF+AF = 1.0.

### 3.5.5 Procedural Assumptions for Exposure, Effects, and Risk Characterization

This section provides in bulleted form the important technical assumptions to be used in the screening ERA.

- RME concentrations will be used during the screening risk assessment. The RME is the smaller of the maximum detected concentration and the UCL<sub>95</sub>. RMEs will be used for soil, sediment, and surface water. When the UCL<sub>95</sub> percent confidence interval cannot be calculated, the measured maximum concentration will be used. Modeled tissue concentrations based on the RMEs based on measured abiotic media concentrations will be used in food chains.
- The screening of site-wide concentrations was done for soil, sediment, and surface water. The Ohio EPA recommended hierarchy for toxicity screening values for the Load Line 12 ERA.

#### For Soil:

- Efroymson et al. (1997a). Preliminary Remediation Goals for Ecological Endpoints. ES/ER/TM-162/R2.
- Efroymson et al. 1997b). Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Soil and Litter Invertebrates and Heterotrophic Processes: 1997 Revision. ES/ER/TM-126/R2.
- Efroymson et al. (1997c). Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Terrestrial Plants: 1997 Revision. ES/ER/TM-85/R3.

- Ecological Data Quality Levels (EDQL), U.S. EPA, Region 5, Final Technical Approach for Developing EDQLs for RCRA Appendix IX Constituents and Other Significant Contaminants of Ecological Concern, April 1998.

**For Sediment:**

- USEPA January 1996. *Ecotox Thresholds. ECO Update*. EPA 40/F-95/038. Refer to Region 5 Guidance on the use of Ecotox Thresholds.
- Persaud et al. 1994. *Guidelines for the Protection and Management of Aquatic Sediment Quality in Ontario*. Ontario Ministry of the Environment and Energy.
- Ingersoll, C. G., Haverland, P. S., Brunson, E. L., Canfield, T. J., Dwyer, F. J., Henke, C. E., Kemble, N. E., Mount, D. R., Fox, R. G. 1996. Calculation and Evaluation of Sediment Effect Concentrations for the Amphipod *Hyaella azteca* and the Midge *Chironomus riparus*. J. Great Lakes Res 22:602-623.

**For Surface Water:**

- Ohio Chronic Water Quality Criteria (Ohio Administrative Code Chapter 3745-1 as amended on October 31, 1997).
- National Ambient Water Quality Criteria (40 CFR Part 131, 1992).
- Tier II Chronic Screening Values (Suter and Tsao 1996).
- When the first value is available, it is used, regardless if a lower number exists from another source. When the first listed source has no number, reliance is given the second source and so forth.
- The area use factor will be 1.0 regardless of the size of home range area relative to exposure unit area.
- Exposure or transfer factors will be used extensively. For example, soil to plant uptake factors as well as plant to animal bioaccumulation factors will be used as published in the technical literature. This will provide estimated contaminant concentrations in prey based on measured soil, sediment, and water concentrations at Winklepeck Burning Grounds. The primary sources are Baes et al. (1984), Travis and Arms (1988), and ATSDR (various years). A good secondary source is HAZWRAP (1994). When there is no value, the default value will be 1.0 for inorganic chemicals and 1.0 for organic chemicals.
- Bioavailability is assumed to be the same as that in the controlled laboratory/field exposure studies. There will be no adjustments.
- No Observed Adverse Effect Level (NOAEL), especially chronic NOAELs, from controlled laboratory/field exposure studies will be the appropriate toxicological data for toxicity thresholds in the food web modeling of the screening ecological risk assessment. When chronic NOAELs are not available and subchronic NOAELs are available, a conversion factor of 10 will be used to convert sub-chronic to chronic NOAEL. When no NOAEL is available and a Lowest Observed Adverse Effect Level (LOAEL) is available, a conversion factor of 10 will be used to convert a LOAEL to a NOAEL.

- Body weight conversions from the test organism (usually a laboratory organism) to the receptors at RVAAP (usually wildlife) have a technical basis (metabolic) and will be used to adjust toxicity thresholds. Allometric or body-scaling will be done only after all conversions of toxicity values, e.g., LOAEL to NOAELs.
- An HQ >1.0 suggests unacceptable risk or the need for further work.

### **3.5.6 Next Step**

Dialogue among USACE, Army, Ohio EPA, the public, risk assessors, and risk managers will determine what the findings of the screening ecological risk assessment mean. Such professional judgments and discussions need to clarify what to protect and what, if any, additional definitive ecological risk characterization is warranted.

The development of professional judgment criteria can take different approaches. The most likely approach is a weight-of-evidence one that consists of such principles as:

- temporal association,
- spatial association,
- strength of dose response association, or
- biological plausibility.

These are based on three types of evidence:

- biological and habitat surveys at RVAAP,
- contaminant body burden measurements (if available) at RVAAP, and
- chemical specific toxicity information from the literature.

Note that many of these considerations will be part of a future installation-wide plan and implementation.

## 4.0 FIELD ACTIVITIES

In order to organize and track sampling efforts for the Phase II RI at Load Line 12, the AOC has been separated into 21 functional areas based on the results of the Phase I RI, operational data, available maps, and historical aerial photographs. These functional areas, along with a summary of the environmental matrices, number of sampling locations and sampling rationale, are listed in [Table 4-1](#). The selection of these functional areas for biased sampling is based on the project DQOs and CSM described in Chapter 3.0. The sampling locations for each of the functional areas are shown on [Figures 4-1 through 4-10](#), which are located at the end of this chapter.

### 4.1 GROUNDWATER

#### 4.1.1 Rationales

Limited hydrogeologic and analytical data exist for groundwater at Load Line 12; therefore, an accurate assessment of flow patterns is not possible at present. Accordingly, monitoring wells will be installed as part of the Load Line 12 Phase II RI to assess groundwater impacts and potential migration pathways. Groundwater characterization efforts include installation of monitoring wells and piezometers in a configuration that will provide data on general hydrogeologic characteristics and groundwater flow patterns. Monitoring wells will also be specifically installed in the vicinity of known and suspected source areas to evaluate whether contaminants are leaching to groundwater. Monitoring wells are also specifically planned along the southern boundary of Load Line 12 to determine whether groundwater and potential contaminant transport is occurring off of the AOC.

##### 4.1.1.1 Monitoring Well Locations and Installation

Fourteen new monitoring wells will be installed as a part of the Phase II RI to monitor shallow groundwater at Load Line 12. Six of these monitoring wells will be located adjacent to known or suspected source areas within the Load Line 12 boundaries ([Figure 4-1](#)). Locations for the remaining wells will be determined once a better understanding of the flow regime within the AOC has been defined on the basis of the data collected from 10 temporary piezometers to be installed across the site. [Table 4-1](#) describes the rationale for the placement of the monitoring wells. The proposed locations were selected on the basis of DQOs, the Phase I RI results, and the CSM developed for Load Line 12 (Chapter 3.0).

Water level measurements will be collected from the piezometers on three occasions over a one-week period after which time they will be abandoned. Groundwater samples will be collected from each of the 14 monitoring wells. The individual samples identified, as well as the required chemical analyses, are provided in Chapter 5.0 in [Table 5-1](#). The primary functional areas of interest are as follows:

- Building FF-19,
- Building FN-54,
- Building 900,
- Building 905, and
- Building 904.



Table 4-1. Load Line 12 Sampling Rationale and Matrix

Sub-Area Number	Description	Target Analytes	Sampling Rationale	Sample Matrix			
				Surface Soil/ Subsurface Boring Station	Sediment/ Surface Water Station	Monitoring Well Boring/ Groundwater Station	Applicable Figure Number
1	Building FF-19 - Former Neutral Liquor Building/Hercules Alchlor Unit	Explosives, PAHs, Metals	Further define horizontal and vertical extent of contamination identified during Phase I and identify possible contamination in groundwater.	29	2	1	4-1 and 4-2
2	Building 901 - Former Ammonium Nitrate Production Building	Explosives, PAHs, Metals	Identify possible contamination in soil.	4			4-3
3	Building 902 - Former Ammonium Nitrate Production Building	Explosives, PAHs, Metals	Identify possible contamination in soil.	4			4-3
4	Building 906 - Former Ammonium Nitrate Production Building	Explosives, PAHs, Metals	Identify possible contamination in soil.	4			4-3
5	Building FN-54 - Old Shipping Building/Cartridge Case Renovation Operations	Metals	Further define horizontal and vertical extent of contamination identified during Phase I and identify possible contamination in groundwater.	6	2	1	4-1 and 4-4
6	Building 900 - Former Ammonium Nitrate Production Building/Flashing Furnace for Demil Operations	Explosives, PAHs, Metals	Further define horizontal and vertical extent of contamination identified during Phase I and identify possible contamination in groundwater.	5	2	1	4-1 and 4.5
7	Building 903 - Former Ammonium Nitrate Production Building/Receiving Area for Demil Operations	Explosives, PAHs, Metals	Identify possible contamination in soil.	4			4-6
8	Building 905 - Former Ammonium Nitrate Production Building/Demil Washout Operations	Explosives and Metals	Further define horizontal and vertical extent of contamination identified during Phase I and identify possible contamination in groundwater.	10	4	1	4-1 and 4-7
9	Area North of Building 903 - Site of Suspect OEW	Explosives and Metals	Identify possible contamination in soil.	3			4-7
10	Transformer Area	PCBs	Identify possible PCB contamination in soil.	3 (Surface Soil Only)			4-8
11	Building FE-17 - Power House	PAHs and PCBs	Identify possible contamination in soil.	7 (Subsurface Soil Only)			4-9
12	Building 52- Former QA Laboratory	Full Suite	Identify possible contamination in soil.	1			4-9

Table 4-1. Load Line 12 Sampling Rationale and Matrix (continued)

Sub-Area Number	Description	Target Analytes	Sampling Rationale	Sample Matrix			
				Surface Soil/ Subsurface Boring Station	Sediment/ Surface Water Station	Monitoring Well Boring/ Groundwater Station	Applicable Figure Number
13	Building 904 - Former Ammonium Nitrate Production/Washout/Meltout Building	Explosives and Metals	Identify possible contamination in soil and groundwater	10		2	4-1
14	Water Works #2	Explosives and Metals	Identify possible contamination in soil.	3			4-9
15	Water Tower	Metals (Lead)	Identify possible contamination in soil.	2 (Surface Soil Only)			4-9
16	Sanitary Sewer Line	Full Suite	Identify possible contamination.		5 Sediment, 2 Surface water		4-8
17	Test Pits/Piezometers	NA	To provide a better understanding of the flow regime and assist in selecting optimal locations for monitoring wells.				NA
18	Resample of Sediment Sample Locations 31, 38, and 39		Further define contamination identified during Phase I.		3		4-1
19	Downstream Sediment Locations		Further define contamination identified during Phase I.		6		4-1
20	Additional Monitoring Wells	Full Suite	Identify possible contamination in groundwater.			8	NA
21	Non-Production Area (Random Sampling Grid)	Explosives and Metals	Address potential contamination outside of the process areas, but within the AOC.	22 (Surface Soil Only)			4-10

All monitoring wells and piezometers will be installed using conventional drilling techniques (hollow-stem auger and air rotary, if required) as described in Section 4.1.2.1, and will be installed to screen across the top of the water table or 3 m (~ 10 feet) into bedrock. Bedrock is not anticipated to be encountered. However, if encountered prior to intercepting the water table, the bedrock interval in each monitoring well borehole will be cored using NQ size conventional coring to characterize the bedrock lithology. It is anticipated that the depth to the water table will vary between 1.5 m (5 feet) and 5.5 m (18 feet) below the ground surface, based on existing monitoring well information from Phase I RI and other previous studies. The maximum depth of each shallow monitoring well and piezometer is expected to be ~ 9.1 m (30 feet) bgs or less. It is anticipated that the depth to bedrock will range between 8 m (26.5 feet) and 15.1 m (50 feet).

#### **4.1.1.2 Sample Collection for Field and Laboratory Analysis**

All monitoring wells will be field screened for VOCs prior to sample collection using a hand-held photo-ionization detector (PID) or flame ionization detector (FID) organic vapor analyzer (OVA). Screening will be accomplished by monitoring the headspace vapors at the top of the riser pipe. Field measurement of pH, temperature, specific conductance, and dissolved oxygen will be recorded for each groundwater sample. No samples will be collected for additional headspace analysis. Water level measurements will be collected immediately prior to groundwater sampling.

An unfiltered groundwater sample will be collected from each monitoring well and submitted for laboratory analysis of explosives, propellants, cyanide, SVOCs, VOCs, pesticides/PCBs, and nitrates. An ample volume of water will be collected so that filtered Target Analyte List (TAL) metals can be analyzed. Filtering will be performed in the field according to Section 4.3.5 of the Facility-wide SAP. [Table 5-2](#) and [Table 5-3](#) in Chapter 5.0 provide the number of samples and the types of chemical analyses to be performed.

#### **4.1.1.3 Quality Assurance/Quality Control, and Blank Samples and Frequency**

Quality control (QC) duplicates, USACE quality assurance (QA) split groundwater samples, equipment rinsate samples, and trip blanks will be collected during the Phase II RI. Duplicates and QA splits will be selected randomly and analyzed for the same parameters as the environmental samples. Duplicate and QA split samples will be collected at a frequency of 10% of environmental samples. Equipment rinsate samples will be collected at a frequency of 5% of groundwater samples. Trip blanks will accompany shipment of all VOC groundwater samples and will be analyzed for VOCs only.

One source blank will be collected from the potable water source, which will be used for all potable wash and rinse water for equipment decontamination during the Phase II RI. One source blank will also be collected from the deionized/distilled (ASTM Type I) water source used. The source blanks will be analyzed for the same constituents as the environmental samples.

#### **4.1.2 Monitoring Well Installation**

In general, monitoring wells to be installed during the Phase II RI will be 2.0-inch, Schedule 40 polyvinyl chloride (PVC) wells with standard above-grade completions. Specifications for drilling, installation, completion, and development of monitoring wells are contained in the following subsections. Piezometers will be installed by placing 2.0-inch, Schedule 40 PVC screen (10-foot length) and riser into the boring and allowing the formation to collapse around the screen. In cases where the formation does not collapse, sand filter pack may be added to stabilize the piezometer.

#### **4.1.2.1 Drilling Methods and Equipment**

##### ***4.1.2.1.1 Equipment Condition and Cleaning***

Requirements for the condition and cleaning of equipment used for well installation are described in Section 4.3.2.1.1 of the Facility-wide SAP. These requirements, as applicable, will be employed for equipment used to install monitoring wells in the Phase II RI.

##### ***4.1.2.1.2 Drilling Methods***

Conventional drilling techniques (hollow-stem auger and air rotary) will be used to install monitoring wells, as described in Section 4.3.2.1.2 of the Facility-wide SAP. It is anticipated that the third drilling scenario, described under Section 4.3.2.1.3, will be applicable for the installation of the monitoring wells to be drilled as part of the Phase II RI at Load Line 12. Monitoring well boreholes will be drilled to sufficient depth to install the bottom of a 3-m (10-feet) well screen, ~2.1 m (7 feet) below the current water table elevation. It is anticipated that the depth to the water table will range from 1.5 m (5 feet) to 5.5 m (18 feet) below the ground surface, based on existing information. The maximum depth of each monitoring well is expected to be ~9.1 m (30 feet) bgs or less. It is anticipated that the depth to bedrock will range between 8 m (26.5 feet) and 15.1 m (50 feet).

In all groundwater monitoring well boreholes, NQ-size coring shall be performed in the bedrock interval prior to 10.2-cm (4-inch)-diameter air-rotary drilling to install wells. The purpose of coring is to determine lithologies and the degree and nature of weathering and fracturing in bedrock. All rock cores will be stored in wooden boxes in such a manner as to preserve their relative positions by depth. Intervals of lost core shall be noted in the core sequence with wooden or styrofoam blocks. Boxes will be marked on the outside to provide the boring number, cored interval, and box number, if there are multiple boxes. All cores collected during Phase II of the RI will be documented (including photographing the core after it has been properly placed and labeled in the core boxes), and temporarily stored at RVAAP in accordance with Ohio EPA Technical Guidance for Hydrogeologic Investigations and Groundwater Monitoring (1995) and EM-1110-1-4000, Monitoring Well Design, Installation, and Documentation at Hazardous and/or Toxic Waste Sites (USACE 1994b).

#### **4.1.2.2 Materials**

##### ***4.1.2.2.1 Casing/Screen***

The casing and screen materials for monitoring wells will be as presented in Section 4.3.2.2.1 of the Facility-wide SAP.

##### ***4.1.2.2.2 Filter Pack, Bentonite, and Grout***

The filter pack, bentonite, and grout materials for monitoring wells will be as presented in Section 4.3.2.2.2 of the Facility-wide SAP.

##### ***4.1.2.2.3 Surface Completion***

All wells will be constructed as above-ground installations, as described in Section 4.3.2.2.3 of the Facility-wide SAP.

#### **4.1.2.2.4 Water Source**

Potable water from a commercial source will be used during this investigation for monitoring well and decontamination purposes. The collection and evaluation of the source water sample will follow Section 4.3.2.2.4 of the Facility-wide SAP.

#### **4.1.2.2.5 Delivery, Storage, and Handling of Materials**

All monitoring well construction materials will be delivered, stored, and handled following Section 4.3.2.2.5 of the Facility-wide SAP.

#### **4.1.2.3 Installation**

All monitoring well installation will be in accordance with the procedures for above-ground installations as presented in Section 4.3.2.3 of the Facility-wide SAP. Unconsolidated surficial material in each location will be drilled using a 10.8-cm (4.25-inch) inside diameter (I.D.) hollow-stem auger having an outside diameter (O.D) of at least 16.5-cm (6.25 inches). Soil samples will be collected continuously from the surface to bedrock refusal or borehole termination, using a split-barrel sampler, for stratigraphic logging. If bedrock is encountered before borehole termination, the bedrock interval in a borehole will be drilled using air rotary with an NQ-size coring device as described in Section 4.1.2.1.2 above. Following coring, rock drilling will continue with a tricone roller bit.

#### **4.1.2.4 Documentation**

##### **4.1.2.4.1 Logs and Well Installation Diagrams**

###### **4.1.2.4.1.1 Boring Logs**

Boring logs will be completed for all monitoring well boreholes following Section 4.3.2.4.1.1 of the Facility-wide SAP. Visually determined Unified Soil Classification System (USCS) of each soil sample taken will be recorded on each boring log.

###### **4.1.2.4.1.2 Well Construction Diagrams**

All monitoring well activities will be documented according to the procedures presented in Section 4.3.2.4 of the Facility-wide SAP.

#### **4.1.2.5 Well Abandonment**

Any monitoring wells or borehole abandoned during the Phase II RI will be abandoned according to the procedures presented in Section 4.3.2.5 of the Facility-wide SAP.

#### **4.1.2.6 Water Level Measurement**

Water level measurements will follow the procedure presented in Section 4.3.2.6 of the Facility wide SAP.

#### **4.1.2.7 Well Development**

Development of monitoring wells will be accomplished with a pump following Section 4.3.2.3.11 of the Facility-wide SAP. Pumps may be replaced with bottom-filling bailers where well size or slow recharge rates restrict pump usage. Development will proceed until the criteria specified in the Facility-wide SAP are met:

- the water is clear to the unaided eye,
- the sediment thickness remaining in the well is less than 1% of the screen length or <30 mm (0.1 foot),
- a minimum of five times the standing water volume in the well (to include the well screen and casing plus saturated annulus, assuming 30% porosity), and
- indicator parameters (pH, temperature, and specific conductance) have stabilized to  $\pm 10\%$  over three successive well volumes.

For each monitoring well developed during the Phase II RI, a record will be prepared to include the information specified in Section 4.3.2.4.2 of the Facility-wide SAP:

#### **4.1.3 Field Measurement Procedures and Criteria**

All field measurement procedures and criteria will follow Section 4.3.3 of the Facility-wide SAP. All monitoring wells will be field screened for VOCs using a PID or OVA during groundwater sample collection. Screening will be accomplished by monitoring the headspace vapors at the top of the riser pipe.

#### **4.1.4 Sampling Methods for Groundwater**

Groundwater sampling from monitoring wells will follow the procedures presented in Section 4.3.4 of the Facility-wide SAP.

##### **4.1.4.1 Well Purging Methods**

In order to minimize the quantity of liquid investigation-derived waste (IDW) generated as a result of well purging, wells will be micro-purged where conditions permit, in accordance with Ohio EPA technical guidance (OEPA 1995), as follows:

- a dedicated bladder or submersible pump is used for purging;
- the purge rate should not exceed 100 mL/min unless it can be shown that higher rates will not disturb the stagnant water column above the well screen (i.e., will not result in water level drawdown);
- the volume purged is either two pump and tubing volumes or a volume established through in-line monitoring and stabilization of water quality indicators such as dissolved oxygen and specific conductance;
- sample collection should occur immediately after purging.

Where micro-purging cannot be accomplished for any reason, then purging of all monitoring wells installed during the Phase II RI will be conducted in accordance with procedures discussed in Section 4.3.4 of the Facility-wide SAP.

#### **4.1.4.2 Filtration**

Per Section 4.3.5 of the Facility-wide SAP, groundwater samples collected for dissolved metals will be filtered by negative pressure using a hand-operated pump, collection flask, polytetrafluoroethylene tubing, and a pre-sterilized, disposable 0.45- $\mu$ m pore size filter assembly. Before collecting the water sample, the pump and filter apparatus will be assembled. A bailer will then be lowered into the monitoring well, filled with groundwater, and raised to the surface. The groundwater will be transferred from the bailer to a decontaminated collection flask and poured into the filter funnel portion of the filter assembly. Care will be taken to avoid transferring solids that may have settled to the bottom of the collection flask. The hand-operated pump will be used to create a vacuum in the assembly to start filtration. Sample bottles will be filled with the filtered water. Filters will be replaced as they become restricted by solids buildup as well as between sample collection sites.

#### **4.1.5 Sample Containers and Preservation Techniques**

Requirements for sample containers and preservation techniques for groundwater samples are presented in Section 4.3.6 of the Facility-wide SAP.

#### **4.1.6 Field Quality Control Sampling Procedures**

Quality control samples for monitoring well groundwater sampling activities will include duplicates and split groundwater samples, equipment rinsates, and trip blanks as described in Section 4.1.1.3 above. Split samples will be submitted to the following USACE contract laboratory for independent analyses: GP Environmental, Inc., 202 Perry Parkway, Gaithersburg, MD 20877, (301) 926-6802.

#### **4.1.7 Decontamination Procedures**

Decontamination of equipment associated with groundwater sampling will be in accordance with the procedure presented in Section 4.3.8 of the Facility-wide SAP.

#### **4.1.8 In Situ Permeability Testing**

A slug test will be performed in each of the 14 monitoring wells installed as part of the Phase II RI, to determine the hydraulic conductivity of the geologic material surrounding each well. The slug test method involves lowering or raising the static water level in a well bore by the removal or insertion of a cylinder (slug) of known volume. The return of the water level to a pre-test static level is then measured over time. The change in water level over time is plotted on a logarithmic scale to determine hydraulic conductivity (K). K is a function of the formation permeability and the fluid in the formation. K is influenced by well construction.

At a minimum, a slug removal (rising head) test will be used for this investigation. Where possible, a falling head test will also be run to obtain a corresponding K value for comparative purposes. If possible, the slug test will be performed in such a manner to prevent the water level in the well from dropping below the top of the screened interval when the slug is removed. All tests will be performed after the groundwater has been sampled as described in Section 4.1.4, and will be contingent upon a monitoring well containing sufficient water to allow testing.

Slug tests will only be initiated after the well has recovered from groundwater sampling, or a minimum of 12 hours has elapsed since sampling. The pressure transducer and decontaminated slug will be inserted into the well and the water level allowed to equilibrate to static conditions or until at least six hours have elapsed. A slug that displaces 0.3 m (1 foot) of water should be sufficient to provide an adequate response for the analysis. Prior to the start of the test, plastic sheeting will be placed around the well in a manner to minimize water

contact with the ground surface. The static water level will be measured with an electronic water level indicator and recorded to the nearest 0.003 m (0.01 foot) below top of casing. The total depth of the well will be measured with an electronic water level indicator and recorded to the nearest 0.003 m (0.01 foot) below top of casing. These measurements will be used to calculate the water column height in the well. Use of the electronic water level meter will follow procedures outlined in Section 4.3.3.1 of the Facility-wide SAP.

To begin the test, the slug will be withdrawn quickly from the well without surging. The time of the test will begin as soon as the slug leaves the water column. Water level measurements will be recorded continuously during the test with a pressure transducer and data logger programmed to make measurements to within 0.003 m (0.01 foot) and record them on a logarithmic scale. Water level change will be recorded for a period of six hours or until the well re-equilibrates to 90% of the pre-test water level, whichever occurs first.

The test data will be evaluated by the Bouwer and Rice method (1976, 1989) or the Cooper, et al. method (1967). If the test geometry is not conducive to analysis to either of these two methods, an alternate method will be used subject to RVAAP team approval (USACE and Ohio EPA).

## **4.2 SUBSURFACE SOILS**

### **4.2.1 Rationales**

Subsurface soil samples will be collected during the Phase II RI at Load Line 12 to investigate (1) potential subsurface contamination occurring as a result of activities at former operations areas and (2) transport pathways to deeper soil horizons for such contaminants as described in the DQOs (Chapter 3.0, Section 3.2).

#### **4.2.1.1 Soil Boring Locations**

Subsurface soil samples will be collected at a total of 43 planned locations. At these locations, subsurface soil samples will be collected from the 0.3- to 0.9-m (1- to 3-foot) interval. At 29 of these locations, subsurface soil samples are also planned to be collected from the 0.9 to 1.5-m (3- to 5-foot) interval. In addition, subsurface soil samples may also be collected at other locations to be determined in the field based on results of field explosives analyses of surface soil samples (see Section 4.2.1.3). [Table 4-1](#) describes the rationale for the placement of surface soil sampling locations within each functional area. The proposed locations were selected on the basis of DQOs, the Phase I RI results, and the CSM developed for Load Line 12 (Chapter 3.0). The proposed sampling locations are shown on [Figures 4-2 through 4-9](#). The number of sample stations identified for each area are summarized on [Table 4-1](#) and detailed in Chapter 5.0 ([Table 5-1](#)). The final sample locations will be marked in the field based on site conditions, access, considerations, visual survey of the area, and OE considerations. As noted in Section 1.4, care must be exercised when sampling in certain areas in order to obtain samples that represent targets of interest (i.e., native soils) or when evaluating data.

Planned subsurface soil samples will be collected from the following functional areas:

- Building FF-19,
- Building 900,
- Building FE-17,
- Building 52,
- Building 904, and
- Water Works #2.



#### **4.2.1.2 Discrete/Composite Soil Sampling Requirements**

Subsurface soil sample will be collected during the Load Line 12 Phase II RI from each of two depth intervals [0.3- to 0.9-m (1- to 3-foot) and 0.9- to 1.5-m (3- to 5-foot)] at each soil boring location. The subsurface sample will be a vertical composite extracted from soil that is homogenized over the depth interval. Subsurface samples will be collected in the approximate center of the three surface soil composite samples collected for explosives and/or propellant analyses (See Section 4.3). All VOC samples will be collected as discrete aliquots from the middle of the interval without homogenization. All remaining samples will be derived from homogenized soil collected in a bucket hand auger over the depth interval. Soil will be collected over the depth interval, placed into a stainless steel pan or bowl, homogenized, and representative aliquots placed into sample containers in accordance with Section 4.4.2.5.2 of the Facility-wide SAP.

#### **4.2.1.3 Sample Collection for Laboratory Analysis**

All subsurface soil samples will be field screened for VOCs using a hand-held PID OVA during collection. No samples will be collected for headspace analysis of VOCs.

Unless otherwise specified, subsurface soil samples will be collected as dictated by results of surface soil field colorimetric analysis for TNT and RDX per Section 4.3.1.4. The purpose of this analysis is to define the extent of contamination. Off-site laboratory analysis for explosive compounds will also be performed. The following strategy will be used.

- If the field method indicates TNT or RDX is present at  $\geq 1$  ppm in the surface soil sample, the boring will be deepened and subsurface soil samples collected. These will be subjected to screening as noted in Section 4.2.2.2. In addition, a specified number (15%) of subsurface samples will be collected regardless and submitted to the laboratory for verification.

The criteria used to determine the number of samples to be analyzed for explosives and propellants for each area is provide on [Table 5-1](#). All samples collected will be screened in the field for metals using X-ray fluorescence (XRF), and will be submitted for TAL metals analysis at the off-site laboratory regardless of the field result. The remaining chemical analysis to be performed on the subsurface soil samples is dependent on the requirements for each area to be sampled and may include VOCs, SVOC, Pesticides/PCBs, cyanide, and nitrate. The type of chemical analyses and the number of samples to be analyzed for each area are provided on [Table 5-1](#).

Requirements for sample containers and preservation techniques for surface soil and sediment samples are presented in Section 4.4.2.6 of the Facility-wide SAP and the Load Line 12 Phase II QAPP Addendum.

#### **4.2.1.4 Organic Vapor Screening**

All soil borings will be field screened for VOCs using a hand-held PID OVA during sample collection. All OVA readings will be recorded in field logbooks. No samples will be collected for headspace analysis of VOCs.

#### **4.2.1.5 Field Quality Control Sampling Procedures**

Subsurface soil QA/QC samples will be collected during the Phase II RI. Duplicate and split soil samples will be collected at a frequency of 10% (1 per 10 environmental samples). Split samples will be submitted to the following USACE contract laboratory for independent analysis: GP Environmental, Inc., 202 Perry Parkway, Gaithersburg, MD 20877, (301) 926-6802.

No field or rinsate blanks will be collected for subsurface soils. Chapter 8.0 of the Load Line 12 Phase II RI Quality Assurance Project Plan (QAPP) Addendum summarizes QA/QC sampling.

## **4.2.2 Procedures**

### **4.2.2.1 Drilling Methods**

A hand-operated power auger will be used in conjunction with bucket hand augers to create the subsurface borings. The power auger will be used to advance the soil boring to the top of the target depth interval, if necessary, as discussed in Sections 4.4.2.4.2 and 4.4.2.5.2 of the Facility-wide SAP.

Once the boring has been advanced to the top of the specified sampling interval with the power auger, a bucket hand auger will be used for the collection of the soil sample. After the sample is collected, the power auger will be used to advance the boring to the top of the next interval, if possible. A hand auger will then be used to collect the soil sample.

#### **4.2.2.1.1 Equipment Condition and Cleaning**

Requirements for the condition and cleaning of equipment used for subsurface soil borings are described in Section 4.3.2.1.1 of the Facility-wide SAP. These requirements, as applicable, will be employed for equipment used to drill soil borings during the Phase II RI.

### **4.2.2.2 Field Measurement Procedures and Criteria**

All field measurement procedures and criteria will follow Section 4.4.2.3 of the Facility-wide SAP, except headspace gases will not be screened in the field for organic vapors. In addition, field screening methods will be used to make preliminary determinations of the concentrations of explosives (TNT and RDX) and metals in subsurface soils.

Colorimetric analysis of all subsurface soils for TNT and RDX will be performed following the field method presented in Appendix A of this Phase II SAP Addendum. The purpose of this analysis is to define the extent of contamination. Residual ammonium nitrate has the potential to interfere with the field colorimetric analysis of TNT and RDX. Therefore, Alumina-A cartridges will be employed for sample clean up prior to color development. Discrete subsurface soil samples will be collected at each soil boring location (where soil thickness is sufficient) and submitted for field colorimetric analysis of explosives. Off-site laboratory analysis for explosive compounds will also be performed. The following strategy will be used.

- If the concentration of TNT is  $\geq 1$  ppm, based on field colorimetric analysis, the sample will be sent to the off-site laboratory for analysis of explosives and propellants.
- If the concentration of TNT is  $< 1$  ppm, the field colorimetric analysis for RDX will be performed.
- If the concentration of RDX is  $\geq 1$  ppm with the field colorimetric method, the sample will be sent to the off-site laboratory for analysis of explosives and propellants.
- 15% of all subsurface samples that show non-detects for explosives with the field method will also be sent to the off-site laboratory for confirmatory analysis.

XRF analysis of soils for metals will be performed by an approved subcontractor using procedures described in their QAPP. The purpose of the metals screening is to demonstrate the suitability of field-portable XRF

spectrometry for performing real-time analysis of metals of comparable quality to laboratory analytical data. Therefore, soil samples collected from a subsurface depth interval will be submitted for field XRF determinations of metals, and will be sent to the off-site laboratory for TAL metals analysis regardless of the field XRF result.

Off-site laboratory analysis for cyanide, nitrate, pesticides/PCBs, VOCs, and SVOCs will be performed according to [Table 5-1](#), which summarizes the analytical parameters and methods that will be used during the Phase II RI. Analytical laboratory methods, analytes, and procedures are further discussed in the Phase II RI QAPP Addendum.

#### **4.2.2.3 Sampling for Geotechnical Analysis**

Undisturbed subsurface soil samples will be collected from each of the 14 monitoring wells to be installed as part of the Load Line 12 RI using a thin-walled (Shelby) tube sampler. Samples will be collected using this device as part of hollow-stem auger drilling of boreholes for monitoring well installation. Shelby tube sampling will proceed as discussed in Section 4.4.2.4.1 of the Facility-wide SAP.

In seven of the borings, two shelly tube samples will be collected. The first sample will be collected from the 0.0 to 0.6 m (0 to 2 foot) interval and second sample will be collected from the center of the planned screened interval of each well, which is estimated to be about 7.3 to 7.9 m (24 to 26 feet) bgs. In the remaining seven borings, shelly tube samples will only be collected from the 7.3 to 7.9 m (24 to 26 feet) interval. [Table 5.1](#) in Chapter 5.0 provides the specific number of geotechnical samples to be collected from each monitoring well boring by investigation area. All samples will be analyzed for grain size distribution, moisture content, Atterburg limits, unified soil classification, bulk density, porosity, total organic carbon, hydraulic conductivity, specific gravity, redox potential, hydrometer classification, and pH.

#### **4.2.2.4 Sampling for Chemical Analysis**

Procedures for sampling of subsurface soils for chemical analysis using the Bucket Hand Auger Method are presented in Section 4.4.2.5.2 of the Facility-wide SAP.

All subsurface soil samples will be analyzed for TAL metals. Subsurface soil samples will be analyzed for explosives and propellants based on field colorimetric results as discussed in Section 4.2.2.2. The criteria used to determine the number of samples to be analyzed for explosives and propellants for each area is provide on [Table 5-1](#). The remaining chemical analysis to be performed on the subsurface soil samples is dependent on the requirements for each area to be sampled. The type of chemical analyses and the number of samples to analyzed for each area are provided on [Table 5-1](#). In general, 10% of the subsurface soil samples collected will be also be analyzed for VOCs, SVOCs, Pesticides/PCBs, cyanide and nitrate.

#### **4.2.2.5 Sample Containers and Preservation**

Requirements for sample containers and preservation techniques for subsurface soil samples are presented in Section 4.4.2.6 of the Facility-wide SAP and the Load Line 12 Phase II RI QAPP Addendum.

Efforts will be made to ensure proper refrigeration of soil samples en route to the off-site laboratory via courier. Because of the short transit time between the field and the analytical laboratory for some samples, it is not always possible for the containerized soils to reach 4° C before they are delivered to the laboratory. In the unlikely event of this occurrence, the sample manager will make a notation on the chain-of-custody form to document that the samples have been on ice less than the time it takes for them to reach preservation temperatures.

#### **4.2.2.6 Decontamination Procedures**

The decontamination procedure for subsurface soil sampling activities presented in Section 4.4.2.8 of the Facility-wide SAP will be followed.

#### **4.2.2.7 OE Screening**

OE support staff will be present during all field operations. The OE Team Leader will train all field personnel to recognize and stay away from propellants and OE. Safety briefings for OE will also be provided to all site personnel and site visitors. All sample locations and access routes into the locations will be cleared for potential OE prior to entry. The OE Team Leader will clearly mark the boundaries of the cleared soil sampling locations and access routes. If surface OE is encountered, the approach path will be diverted away from the OE, the area clearly marked, and the OE Team Leader notified immediately. In any area where surface metallic OE is encountered, a magnetometer will be used to ensure that no subsurface OE exists within the approach path. Prior to collection of the surface soil sample [0 to 0.3 m (0 to 1 foot) bgs], the OE team will verify that the location is anomaly free using a magnetometer. Where subsurface soil sampling or drilling is to be conducted [0.3 to 0.9 m (1 to 3 feet) bgs], the auger will be withdrawn at the top of the subsurface interval [0.3 m (1 foot) bgs] and the magnetometer lowered into the borehole to screen for subsurface magnetic anomalies. Should special circumstances dictate that the borehole be deepened beyond 0.9 m (3 feet) bgs, then a magnetometer reading will be taken at the top of each subsequent 0.6-m (2-foot) interval prior to augering. Magnetometer equipment will be decontaminated between borings, or in the case of hand-held magnetometers, a plastic sleeve may be used and replaced between borings.

### **4.3 SURFACE SOIL AND SEDIMENT**

#### **4.3.1 Rationales**

Surface soil samples will be collected during the Phase II RI at Load Line 1 to (1) further define contaminant nature and extent of surface soil contamination; and (2) investigate potential source areas not sampled in Phase I. The soil sampling program will employ both biased (targeted to known hot spots) and statistical (random-grid) sampling to characterize not only the known problem areas but the spaces in between them.

The sampling program also incorporates collection of sediments from drainage ditches and catch basins from confirmed and additional suspected source areas, and exit pathways, in order to assess the potential for contaminant migration via leaching or erosion from surface soils to surface water and sediment. The sanitary sewer system is also a focal point for sediment sampling. The sanitary sewer system may represent an accumulation point for contaminants introduced to the system via building floor and sink drains during AOC operations. A visual and video camera survey is planned to investigate the conditions of this system (see discussion in Section 4.6). Samples of accumulated sludge or sediment will be collected at accumulation points to investigate if the system is impacted.

##### **4.3.1.1 Surface Soil Sampling Locations**

Surface soil samples will be collected at a total of 110 locations from the 0- to 0.3-m (0- to 1-foot) interval. Of this total, six are contingency surface soil samples, which will be used to evaluate the horizontal extent of contaminated areas based on visual observations. [Table 4-1](#) describes the rationale for the placement of surface soil sampling locations within each functional area. The proposed locations were selected on the basis of DQOs, the Phase I RI results, and the CSM developed for Load Line 12 (Chapter 3.0). The proposed sampling

locations are shown on [Figures 4-2 through 4-9](#). The number of samples identified for each area, as well as the required chemical analyses, is provided in Chapter 5.0 in [Table 5-1](#). The final sample locations will be marked in the field based on site conditions, access considerations, visual survey of the area, and OE considerations. As noted in Section 1.4, care must be exercised when sampling in certain areas in order to obtain samples that represent targets of interest (i.e., native soils) or when evaluating data.

The primary functional areas of interest are the following:

- Building FF-19,
- Building 901,
- Building 902,
- Building 906,
- Building FN-54,
- Building 900,
- Building 903,
- Building 905,
- Area North of Building 903,
- Transformer Pads,
- Building FE-17,
- Building 52,
- Building 904,
- Water Works #2, and
- Water Tower.

In addition to the biased surface soil sampling described above, 22 random-grid samples will be collected at Load Line 12 ([Figure 4-10](#)). The objective of random-grid sampling is to characterize areas outside the former operations area of the load line. This sampling approach will be used to confirm that no contamination in soils associated with Load Line 12 has been overlooked in the RI. Random grid sampling will be accomplished following the method described by Gilbert 1987 as referenced in Section 3.2.9.2 of the Facility-wide SAP.

As noted previously, contingency surface soil samples will be used to characterize any additional identified areas exhibiting obvious visual evidence of contamination at Building 901, 902, 906 and at the Transformer Pads. The rationale for locating contingency surface soil samples is to target areas of obvious staining or discoloration, evidence of OE, or areas in which additional sampling is deemed necessary based on field observations. If field testing indicates no explosives are present, no further sampling will be performed in that area. However, if colorimetry shows explosives  $\geq 1$  mg/kg (TNT or RDX), then additional subsurface soil sampling (Section 4.2.1.1) may be performed to determine vertical extent. Additional surface soil contingency samples may also be located progressively outward from the identified contamination.

#### **4.3.1.2 Sediment Sampling Locations**

Sediment samples will be collected from 24 locations during the Phase II RI. Nineteen of the samples will be collected from drainage ditches from the 0- to 0.15-m (0- to 0.5-foot) interval. Five of the sediment samples will be collected from the sewer line at locations determined by field observations made during the video camera survey. [Table 4-1](#) describes the rationale for the placement of sediment sampling locations within each functional area. The proposed locations were selected on the basis of DQOs, the Phase I RI results, and the CSM developed for Load Line 12 (Chapter 3.0). The proposed sampling locations are shown on [Figure 4-1](#). The number of samples identified for each area as well as the required chemical analyses is provided in

Chapter 5.0 in [Table 5-2](#). The final sample locations will be marked in the field based on soil conditions and site access.

The primary functional areas of interest are the following:

- Building FF-19;
- Building FN-54;
- Building 900;
- Building 905;
- Sanitary Sewer Line;
- Resample of Phase I RI sampling locations 031, 038 and 039; and
- Downstream of the AOC.

#### **4.3.1.3 Discrete/Composite Soil and Sediment Sampling Requirements**

All surface soil [0 to 0.3 m (0 to 1 foot)] and dry ditch sediment samples [0 to 0.15 m (0 to 0.5 foot)] to be analyzed for explosives and propellants will be composited and homogenized from three subsamples collected about 0.9 m (3 feet) from one another in a roughly equilateral triangle pattern. Each subsample will be augered to a depth of 30.48 cm (1.0 foot). Equal portions of soil from each of the subsamples will be homogenized in a stainless steel bowl following protocols in Section 4.5.2.5 of the Facility-wide SAP. Aliquots for explosives and propellant analyses will be extracted from the homogenized mixture. Once the subsamples are composited, a portion will be analyzed with the colorimetry method described in Appendix A, and another portion will be sent for laboratory analysis as described in Section 4.3.1.4.

A point located at the approximate center of the triangle will be selected for the collection of the remaining samples. Aliquots for VOC analyses will be collected at the center of the interval [15.24 cm (0.5 foot)] immediately upon extraction from the boring. No VOC sample will be collected from homogenized or composited soil sample volumes. Surface soils to be analyzed for metals, cyanide, SVOCs, and PCBs will then be collected, placed in a stainless steel bowl, and homogenized. Sample volumes will be taken from the approximate center of the [0 to 0.3-m (0 to 1-foot)] interval unless a zone of obvious contamination is observed.

Because of the potential difficulty in gathering soils and sediment for samples from beneath any remaining floor slabs and from the storm and sanitary sewer lines, composite sampling is not required for these sampling locations.

All subaqueous sediment samples will be discrete samples. Sediments from streams or surface water basins will be collected using a stainless steel trowel or spoon, hand auger, or sediment coring device, where necessary. Sediment samples will be collected from downstream locations first and moving upstream relative to overall flow patterns. Sediment samples will not be collected from areas exhibiting turbid or rapid flow. Where sediment and surface water stations are co-located, surface water samples will be collected first.

#### **4.3.1.4 Sample Collection for Field and Laboratory Analysis**

All surface soil and sediment samples will be field screened for VOCs using a hand-held PID OVA during collection. No samples will be collected for headspace analysis of VOCs.

All surface soil will be subject to field colorimetric analysis for TNT and RDX. The purpose of this analysis is to define the extent of contamination. Off-site laboratory analysis for explosive compounds will also be performed. The following strategy will be used.

- If the field method indicates TNT is present at  $\geq 1$  ppm, the composite sample will be sent to the off-site lab for analysis of explosives and propellants.
- If the concentration of TNT is  $< 1$  ppm, the analysis for RDX will be performed.
- If RDX is present at concentrations  $\geq 1$  ppm, the sample will be sent to the off-site laboratory for analysis of explosives and propellants.
- In addition, 15% of the samples showing non-detects of TNT or RDX will be sent to the off-site laboratory for analysis of explosives and propellants.

All samples collected will be screened in the field for metals using XRF, and will be submitted for TAL metals analysis at the off-site laboratory regardless of the field result. However, the contract capacity for analyses as defined in [Table 5-1](#) will not be exceeded.

Disturbed geotechnical samples will only be collected at the sediment locations. These samples will be analyzed for grain-size distribution, USCS classification, and total organic carbon. Geotechnical logging will be performed for all samples including estimates of USCS classification.

#### **4.3.1.5 Field Quality Control Sampling Procedures**

Surface soil/sediment QA/QC samples will be collected during the Load Line 12 Phase II RI. Duplicate and split soil samples will be collected at a frequency of 10% (1 per 10 environmental samples). Split samples will be submitted to the USACE contract laboratory for independent analysis, as denoted in Section 4.2.1.5. Duplicate and split samples will be selected on a random statistical basis and submitted for the same analyses as the environmental samples. No field or rinsate blanks will be collected for surface soils/sediments. Chapter 8.0 of the Phase II QAPP Addendum summarizes QA/QC sampling.

### **4.3.2 Procedures**

#### **4.3.2.1 Sampling Methods for Soil/Dry Sediments**

##### ***4.3.2.1.1 Bucket Hand Auger Method***

Surface soil and dry sediment samples will be collected with a bucket hand auger in accordance with Section 4.5.2.5 of the Facility-wide SAP. In this investigation, auger buckets 15.24 cm (6.0 inch) in length and 7.62 cm (3.0 inch) in diameter will be used. At each location, an auger will be advanced in 15.24-cm (6.0-inch) increments. As noted in Section 4.3.1.3, composite surface soil or dry sediment samples for explosives and propellant analyses will be created from three subsamples collected in a roughly equilateral triangle pattern with the subsamples positioned about 0.9 m (3 feet) apart from each other. The remaining analyte fractions will be collected from a point in the middle of the triangle formed by the three subsamples, with the volatile fraction collected first from unhomogenized material.



#### **4.3.2.1.2 Trowel/Scoop Method**

A stainless steel trowel or scoop may be used, as presented in Section 4.5.2.1.2 of the Facility-wide SAP, to collect surface soil or dry sediment samples in soft, loose soil, if feasible. The protocol for compositing, homogenization, and discrete VOC sample collection will follow that described in Section 4.3.2.1.1 for bucket hand augers.

The trowel will be used to manually obtain soil to a depth of 30.48 cm (1.0 foot) bgs or dry sediment to a depth of 15.24 cm (0.5 foot) bgs. Extracted material will be placed into a stainless steel bowl. At sample locations where VOC fractions are to be collected, the VOC containers will be immediately filled with the first materials obtained.

#### **4.3.2.2 Sampling Methods for Subaqueous Sediments from Streams and Surface Water Basins**

##### **4.3.2.2.1 Trowel/Scoop Method**

Sediment samples in locations where water depth does not exceed 15.24 cm (0.5 foot) will be collected with a stainless steel trowel or scoop. The trowel will be used to manually obtain sediment to a depth of 15.2 cm (0.5 foot) below the sediment surface. Sediment will be placed into a stainless steel bowl as it is collected. At sample locations where VOC fractions are to be collected, the VOC containers will be immediately filled with the first sediment obtained. Sample containers for the remaining nonvolatile analytes will be filled as described in Section 4.5.2.5 of the Facility-wide SAP.

##### **4.3.2.2.2 Hand Core Sampler Method**

A sediment core sampler will be used to collect sediment at locations where the depth of the surface water exceeds 15.24 cm (0.5 foot) or the depth to sediment in a confined space (e.g., sanitary sewer) is too great to be accessed directly with trowels and scoops.

All samples collected with the sludge sampler will be obtained following the guidelines presented in Section 4.5.2.5 of the Facility-wide SAP. The sludge sampler consists of a stainless steel, 8.26-cm (3.25-inch) outside diameter (OD), 30.48-cm (12-inch)-long capped tube, which can be fitted with either an auger- or core-type sampler end. Each sampler end is equipped with a butterfly valve to prevent loss of sample upon retrieval. In this investigation, the core-type end will be preferentially used. The auger-type sampler end will be used only in the event that the sediment becomes too gravelly or consolidated for the efficient use of the core type-end. The sludge sampler will be extended to the sampling depth by connecting 60.96-, 91.44-, 121.92-, or 152.40-cm (2-, 3-, 4-, or 5-foot) stainless steel extension rods to the sampler. The extension rods will be attached to a cross handle and will be pushed or augered by hand.

Sediment will be placed into a stainless steel bowl as it is collected. At sample locations where VOC fractions are to be collected, the VOC containers will be immediately filled with the first sediment obtained. Sample containers for the remaining nonvolatile analytes will be filled as described in Section 4.5.2.5 of the Facility-wide SAP.

#### **4.3.2.3 Field Measurement Procedures and Criteria**

##### **4.3.2.3.1 Field determinations of explosive and metals**

Colorimetric analysis of surface soils for TNT and RDX, discussed in detail in Section 4.3.1.4, will be performed following the field method presented in Appendix A of this SAP Addendum. One composite soil



sample will be collected from each of the surface soil sampling locations and submitted for field colorimetric analysis of explosives. If results exceed the designated screening criteria, then the center boring at each station will be deepened and subsurface soil samples collected.

XRF analysis of surface soil samples for metals will be performed according to the field procedures established by the subcontracted field laboratory. Both in situ field measurements and field laboratory XRF analyses will be conducted. In situ measurements of surface soil will be done at each of the three sampling points from which composite samples are collected for explosives analysis. An additional in situ measurement will be taken at the center sampling point. Sample crews will subsequently collect soils from the sampling points for field and fixed-base laboratory analyses. One discrete soil sample will be collected from the center sampling point and submitted for field XRF analysis of metals.

Sediment samples will not be submitted for field analysis of explosives or metals. [Table 5-1](#) summarizes the analytical parameters and methods that will be used during the Phase II RI. Analytical laboratory methods, analytes, and procedures are further discussed in the Phase II RI QAPP Addendum.

#### **4.3.2.3.2 Organic Vapor Screening**

All field measurement procedures and criteria will follow Section 4.4.2.3 of the Facility-wide SAP, with the following exception. Headspace gases will not be screened in the field for organic vapors. Because there were no notable detections of VOCs during the Phase I RI soil sampling, organic vapor monitoring of headspace gases is not necessary in Phase II. All OVA readings will be noted in the field boring logs.

#### **4.3.2.4 Sampling for Geotechnical Analysis**

Surface soil samples collected using the hand auger, scoop, or sediment corer methods are classified as disturbed samples. Therefore, geotechnical analysis of samples collected using these methods will be limited. Sediment samples will be submitted for geotechnical analysis for grain size distribution, USCS classification, and total organic carbon ([Table 5-2](#)). Procedures for sampling for geotechnical analysis using the above sampling methods are presented in Section 4.5.2.4 of the Facility-wide SAP.

#### **4.3.2.5 Sampling for Chemical Analysis**

Procedures for sampling of surface soils and sediment for chemical analysis using the bucket hand auger/trowel and hand core sampler methods are presented in Sections 4.5.2.1.1, 4.5.2.1.2, and 4.5.2.2.2 of the Facility-wide SAP. Sediments samples will be analyzed for explosives, TAL metals, VOCs, SVOCs, Pesticides/PCBs, cyanide, nitrate, and total organic carbon. Two of the sediment samples, or 10% of the total sediment samples collected, will be analyzed for propellants. [Table 5-2](#) provides a summary of the chemical analyses for this media by functional area.

All surface soil samples will be analyzed for TAL metals. Surface soil samples will be analyzed for explosives and propellants based on field colorimetric results as discussed in Section 4.3.1.5. The criteria used to determine the number of samples to be analyzed for explosives and propellants for each area is provided on [Table 5-1](#). The remaining chemical analysis to be performed on the surface soil samples is dependent on the requirements for each area to be sampled. The type of chemical analyses and the number of samples to be analyzed for each area are provided on [Table 5-1](#). In general, 10% of the surface soil samples collected will be also be analyzed for VOCs, SVOCs, Pesticides/PCBs, cyanide and nitrate.

Requirements for sample containers and preservation techniques for surface soil and sediment samples are presented in Section 4.4.2.6 of the Facility-wide SAP and the Load Line 12 Phase II QAPP Addendum.

#### **4.3.2.6 Decontamination Procedures**

The decontamination procedure for surface soil and sediment sampling activities is presented in Section 4.4.2.8 of the Facility-wide SAP, except that a 2% HCl rinse will be used instead of at 10% solution.

#### **4.3.2.7 OE Screening**

OE support staff will be present during all field operations. The OE Team Leader will train all field personnel to recognize and stay away from propellants and OE. Safety briefings for OE will also be provided to all site personnel and site visitors. All sample locations and access routes into the locations will be cleared for potential OE prior to entry. The OE Team Leader will clearly mark the boundaries of the cleared soil sampling locations and access routes. If surface OE is encountered, the approach path will be diverted away from the OE, the area clearly marked, and the OE Team Leader notified immediately. In any area where surface metallic OE is encountered, a magnetometer will be used to ensure that no subsurface OE exists within the approach path. Prior to collection of the surface soil sample [0 to 0.3 m (0 to 1 foot) bgs], the OE team will verify that the locations is anomaly free using a magnetometer. Where subsurface soil sampling or drilling is to be conducted [0.3 to 0.9 m (1 to 3 feet) bgs], the auger will be withdrawn at the top of the subsurface interval [0.3 m (1 foot) bgs] and the magnetometer lowered into the borehole to screen for subsurface magnetic anomalies. Should special circumstances dictate that the borehole be deepened beyond 0.9 m (3 feet) bgs, then a magnetometer reading will be taken at the top of each subsequent 0.6-m (2-foot) interval prior to augering. Magnetometer equipment will be decontaminated between borings, or in the case of hand-held magnetometers, a plastic slip sleeve may be used and replaced between borings.

### **4.4 SURFACE WATER**

#### **4.4.1 Rationales**

Sampling of the surface water from conveyances within and adjacent to Load Line 12 was not conducted during the Phase I RI. Site characteristics and available field data show that the primary exit pathway from Load Line 12 is to the northwest via the unnamed tributary to upper Cobbs Pond and that no defined surface water conveyance exists that flows to the south and off of the AOC. Therefore, the major focus for the surface water sampling activities is at locations where potential contaminants would be expected to leach or erode from source areas into drainage ditches, particularly from former operations buildings and the Building 904 and Building 905 settling basins, and migrate toward the exit point. Nineteen surface water samples will be co-located with sediment samples near several former process buildings and the tributary existing Load Line 12. It is recognized that any contaminants identified in surface water during this phase of the investigation may result from the reworking and mobilization of contaminated soils during the recent demolition activities.

The sanitary sewer system is also a focal point for surface water sampling. The sanitary sewer system may represent an accumulation point for contaminants introduced to the system via building floor and sink drains during AOC operations. Portions of the system are suspected to be below the water table as almost all of the system is flooded at present. A visual and video camera survey is planned to investigate the condition of this system (see discussion in Section 4.6). Two samples of accumulated water will be collected at two co-located sediment locations to determine if contaminants are partitioning from sediment or sludge and potentially contaminating shallow groundwater.

#### **4.4.1.1 Locations**

Surface water sampling locations throughout the AOC are shown on [Figure 4-1](#). The locations for the surface water samples to be collected from the sewer line will be determined in the field based on observed conditions during the video camera survey. The number of sample stations identified for each area is summarized on [Table 4-1](#) and detailed in Chapter 5.0 ([Table 5-2](#)). The samples are to be collected from the following functional areas:

- Building FF-19;
- Building FN-54;
- Building 900;
- Building 905;
- Sanitary Sewer Line;
- Resample of Phase I RI sampling locations LL12sd-031, -038, and -039; and
- Downstream of the AOC.

#### **4.4.2 Procedures–General**

All surface water sampling will be conducted as described in Section 4.6.2.1.1 of the Facility-wide SAP. The hand-held bottle method will be used to sample water in ditches where water is flowing. The sample container will be submerged, with the cap in place, into the surface water flow. Then container will then be slowly and continuously filled using the cap to regulate the rate of sample entry into the container. The sample container will be removed from the flow with minimal disturbance to the sample. Immediately after collection of the sample and proper labeling, the container will be placed into a sealable plastic bag and placed into an ice-filled cooler to ensure preservation.

Where possible, the surface water sample will be collected from areas of active flow, rather than from pools. All surface water sample collection will begin at the sampling point furthest downstream in the channel and proceed upstream, to minimize the effects of sediment turbidity on surface water quality. Surface water sample will be collected prior to sediment samples at co-located sites.

##### **4.4.2.1 Sampling Methods for Surface Water–Filtration**

Surface water collected during the Load Line 12 Phase II RI will not be filtered prior to analysis.

##### **4.4.2.2 Field Measurement Procedures and Criteria**

Surface water field measurements to be performed during the Load Line 12 Phase II RI will include determination of pH, conductivity, dissolved oxygen content, and temperature. These measurements will be performed in the same manner as described in Section 4.3.3 of the Facility-wide SAP. All field measurements will be recorded in the sampling logbooks.

##### **4.4.2.3 Sampling for Chemical Analysis**

All unfiltered surface water samples will be submitted to the analytical laboratory for analysis of explosives, TAL metals, cyanide, VOCs, SVOCs, PCBs, and nitrate as shown in [Table 5-2](#). In addition, two samples, or 10 % of the total, will be submitted for propellant analysis. The selection of the two samples will be based on field observations

#### **4.4.2.4 Sample Containers and Preservation Techniques**

Information regarding sample containers and preservation techniques for surface water samples collected for chemical analysis during the Load Line Phase II RI is presented in the Load Line 12 Phase II RI QAPP Addendum. All sample containers will be provided by the contracted laboratory, including pre-preserved containers for VOC samples.

#### **4.4.2.5 Field Quality Control Sampling Procedures**

Surface water QA/QC samples will be collected during the Load Line 12 Phase II RI. Duplicate samples will be collected at a frequency of 10% (1 per 10 environmental samples). Split samples will be submitted to the USACE contract laboratory for independent analysis as denoted in Section 4.2.1.5. Split samples will be collected at a frequency of 10% (1 per 10 environmental samples). Duplicate and split samples will be selected based on a random statistical basis and submitted for the same analyses as the environmental samples. One field blank or rinsate for surface water will be collected (frequency of 5%). The QAPP Addendum summarizes required QA/QC sampling.

#### **4.4.2.6 Decontamination Procedures**

Decontamination of any equipment used for collection of surface water samples during the Load Line 12 Phase II RI will be conducted in the same manner as described for nondedicated sampling equipment in Section 4.3.8 of the Facility-wide SAP.

In addition to the surface water sampling equipment, field measurement instruments will also be decontaminated between sampling locations. Only those portions of each instrument that come into contact with potentially contaminated surface water will be decontaminated. This will be accomplished with a deionized-water rinse of the measurement probe and the collection cup.

### **4.5 SITE SURVEY**

#### **4.5.1 Building Survey**

Currently there are no above ground structures present at Load Line 12. The Phase II RI sampling strategy is dependent on identifying the former structure footprints within an accuracy of several feet. To achieve this it will be necessary, at a minimum, to establish the corners of the former building locations prior to locating the Phase II sampling locations. Existing plat maps, topographic maps and aerial photographs will be used in conjunction with remaining control points (manholes, fire hydrants, fence lines, roadways, etc.) to locate the former buildings. A survey crew will establish corners to the extent possible based on these types of information.

#### **4.5.2 Sample Station Survey**

Following sampling and well installation activities, the horizontal coordinates of all sampling stations and monitoring wells will be determined to within 0.3 m (1 foot). The surface elevations of soil and sediment sampling stations will be determined to within 0.06 m (0.2 foot). For soil sampling stations, the ground elevations will be determined at the point of collection. For tributary surface water locations and sediment sampling stations that are not underwater (i.e., adjacent to the water edge), the ground elevation at the water's edge at the collection point will be determined. For surface water locations within a stream or pond and for sediment sampling stations underwater, the elevation of the water surface, depth to bottom, and elevation of

the bottom will be determined. For groundwater monitoring wells and piezometers, the horizontal and vertical coordinates will be determined in accordance with the current Facility-wide SAP, which requires 1.0 feet horizontally and 0.01 feet vertical accuracy.

All locations will be conveyed in Ohio State Plane Coordinates (NAD83). The vertical datum for all elevations will be 1929 National Geodetic Vertical Datum. All coordinates and elevations will be recorded on the boring logs upon receipt of quality assured survey results. In addition, electronic results will be provided to the USACE and RVAAP in ASCII format.

## **4.6 SEWER LINE SURVEY**

### **4.6.1 Rationale**

Migration of contaminants to surface water (by flushing during storm events) or groundwater (through leaking or breached sewer pipe) from the sanitary sewer system at Load Line 12 may represent a heretofore unquantified source release mechanism. Investigation of storm and sanitary sewer lines at other Army ammunition plants in load lines has shown that sewer lines are commonly contaminated with bulk explosives, particularly at load lines that were heavily used. Frequently, camera surveys of such lines reveal cracks or other breaches in the pipe.

In order to assess the existing sanitary sewer system for the presence of residual explosives compounds, to assess the integrity of the pipe and its potential of releasing contaminants to the environment, and to provide data for the evaluation of remedial alternatives, if any, a color video survey will be performed of the existing system at Load Line 12. The survey will evaluate approximately 4700 linear feet of main line and branch sections. The camera survey will be biased to the portions of the system located near the most contaminated areas of the load line, access permitting.

#### **4.6.1.1 Locations**

The suitability of sanitary sewer pipes and access points (such as outfalls and catch basins) for a camera survey is largely unknown. Therefore, the scope of the camera survey will be limited to the main lines that represent the collection points for sanitary effluent from the load line. The survey will begin at the first manhole (Manhole Cleanout #5) situated downflow of the former lift station that serviced Load Line 12 and continue upflow to the maximum extent practical or until an obstruction prevents further movement.

Figures 4-8 shows the planned sewer line sections for the camera surveys at Load Line 12. At this writing, it is not known whether all of the proposed entry points are still accessible. Final survey locations will be flagged and mapped in the field.

### **4.6.2 Procedures**

The camera survey of sanitary sewer lines at Load Line 12 will follow the standard operating procedures of the subcontracted video surveyor. A television camera and cable will be used for the survey that is specifically designed and constructed for sewer inspection. Lighting for the camera will allow a clear picture for the entire periphery of an 8-inch or 10-inch pipe. The following general procedures will apply.

- The camera shall be moved through the line in either direction at a uniformly slow rate. Precautions shall be taken to minimize the chances of the camera becoming stuck in the pipe.

- A suitable means of communication shall be established between the winches and the monitor control.
- Video operators shall advise the SAIC field manager of suitable locations (if any) for the collection of sediment and surface water samples within the sanitary sewer system, based upon their observations during the video survey.
- Television inspection of the sewer line shall be color videotaped or recorded on compact disk. When blockages, ruptures, or other significant features are noted, the camera shall be stopped to observe the condition, record the information, and if necessary, take photographs.
- Television logs shall be prepared and shall include identification of the section of pipe and pipe size. Records shall also include locations of reference points, points of entry, observed obstructions, ruptures, cracks, and other evidence of potential problems. These will be brought to the attention of the SAIC field manager while the survey is in progress.

The camera survey subcontractor shall prepare and submit a final report that will include, at a minimum, all field logbooks, a listing of identified or potential problem areas, and a sketch map showing the location of any identified or potential problem areas.

#### **4.6.3 OE screening**

Accumulated bulk explosive may be present in sewer pipes at Load Line 12. These compounds represent a substantial hazard to the field team conducting the camera survey and collecting samples of sediment. For this reason, OE support staff will oversee the camera survey. The OE Team Leader will train all field personnel to recognize and avoid contact with suspected bulk explosive in pipe. Safety briefings will also be provided by the OE support team to all site personnel and site visitors during the survey. The OE team will be authorized to stop the advance of the camera if OE is encountered in a given pipe segment. The OE support staff will clearly mark the area on the ground surface that corresponds to a significant obstruction in the pipeline caused by suspected OE.

#### **4.7 TEST PITS**

Six test pits are planned around the outer perimeter of the AOC in uncontaminated areas to generate stratigraphic data that would not ordinarily be obtained through conventional soil borings or Geoprobe sampling. Proposed locations are shown on [Figure 4-1](#). Test pits will be excavated using a backhoe or track hoe. The test pits will be approximately 45- to 60-cm (18- to 24-inches) wide and 4.3-m (15-feet) deep or extend to the saturated zone, whichever comes first. Material from the test pits will be logged using conventional geologic and geotechnical methods. Soil structures and any other geologic features observable in the side walls of the pits will also be noted. Samples for chemical analysis are not planned unless field observations indicate potential contamination concerns. Support for OE avoidance will be present during excavation activities, and magnetometer screening will be done at 0.6-m (2-foot) intervals. Soils will be stockpiled adjacent to the pit on plastic sheeting and covered with plastic if the pit is left open overnight or in the event of rainfall, unless visual observations or field screening for organic vapors indicate potential contamination, the soil will be returned to the excavation. Should potential contamination be observed, the soil will be managed in accordance with RVAAP investigation-derived waste management protocols described in Chapter 7.0.



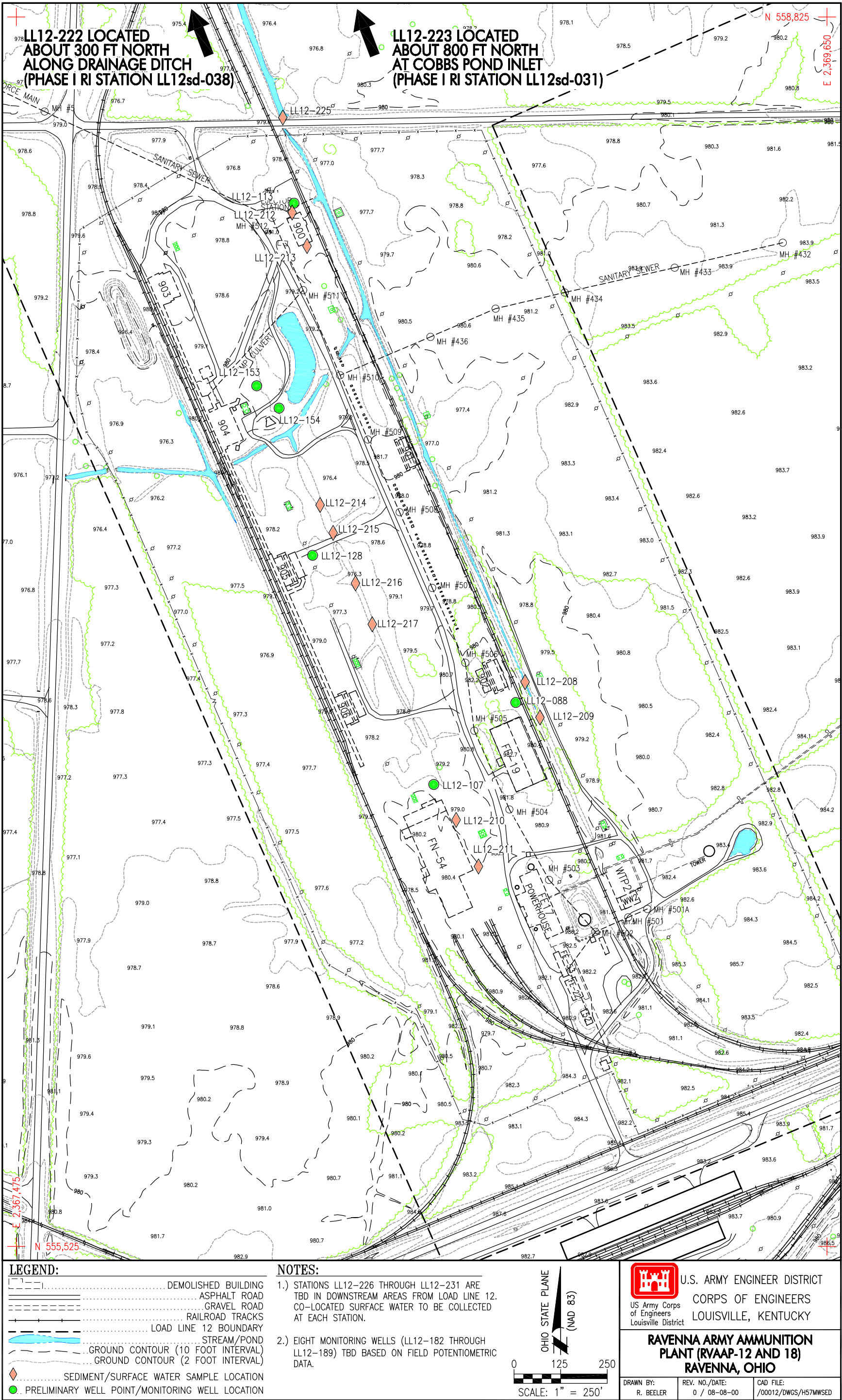


Figure 4-1. Proposed Monitoring Well and Surface Water/Sediment Sample Locations

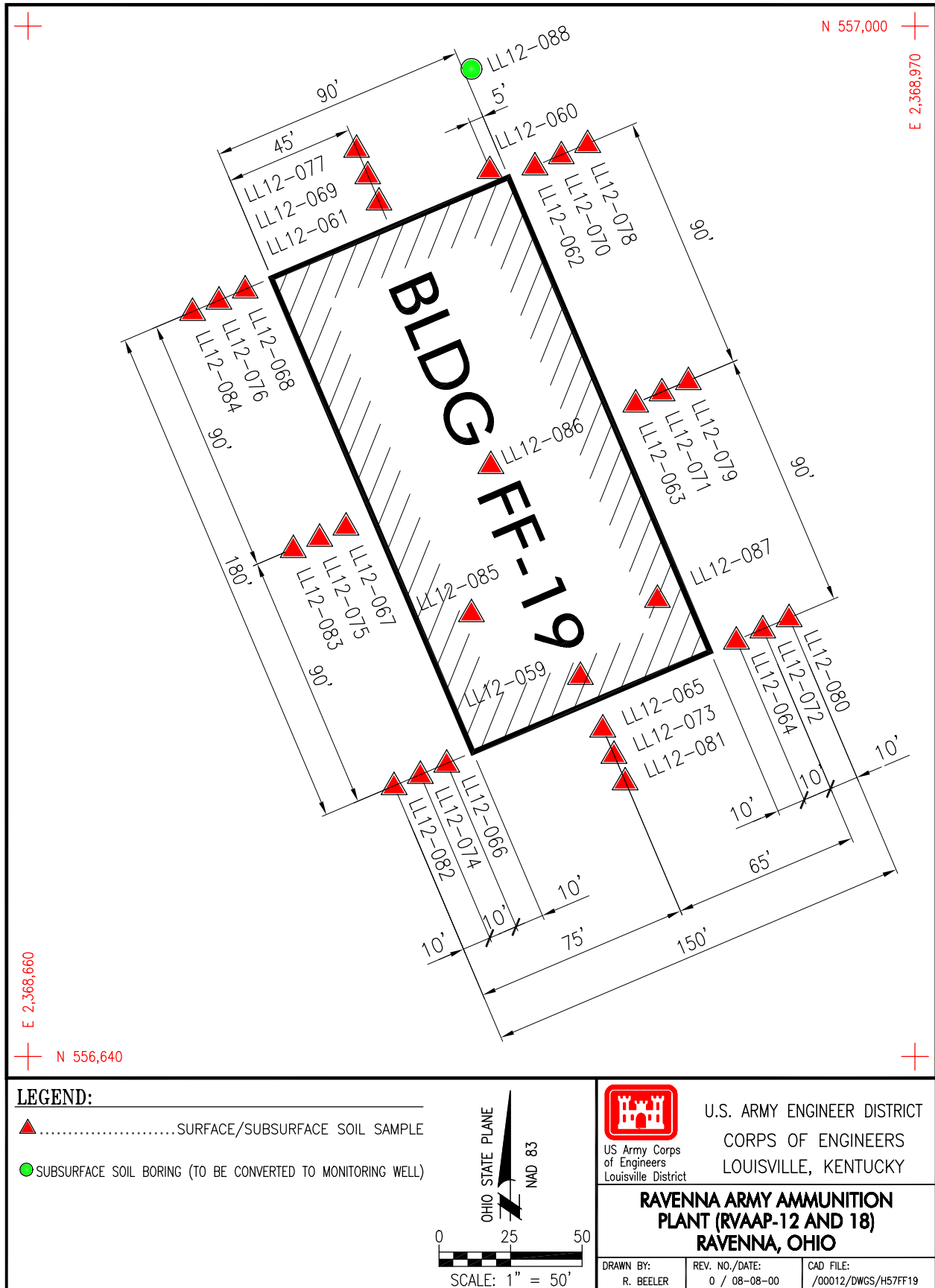


Figure 4-2. Building FF-19 Sample Locations



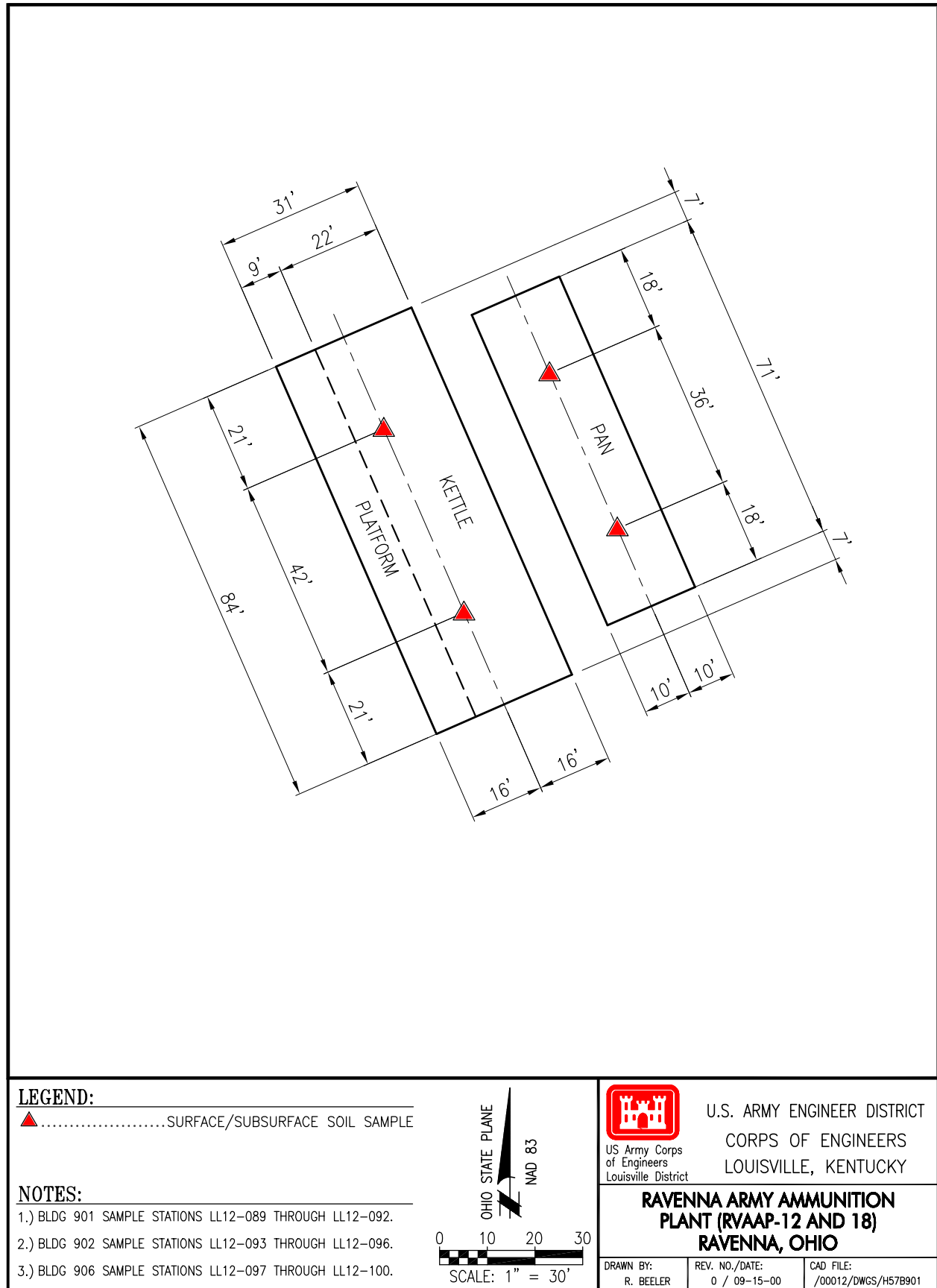


Figure 4.3. Buildings 901, 902, and 906 Sampling Locations

RVAAP Load Line 12 Phase II RI - Sampling and Analysis Plan Addendum No. 1

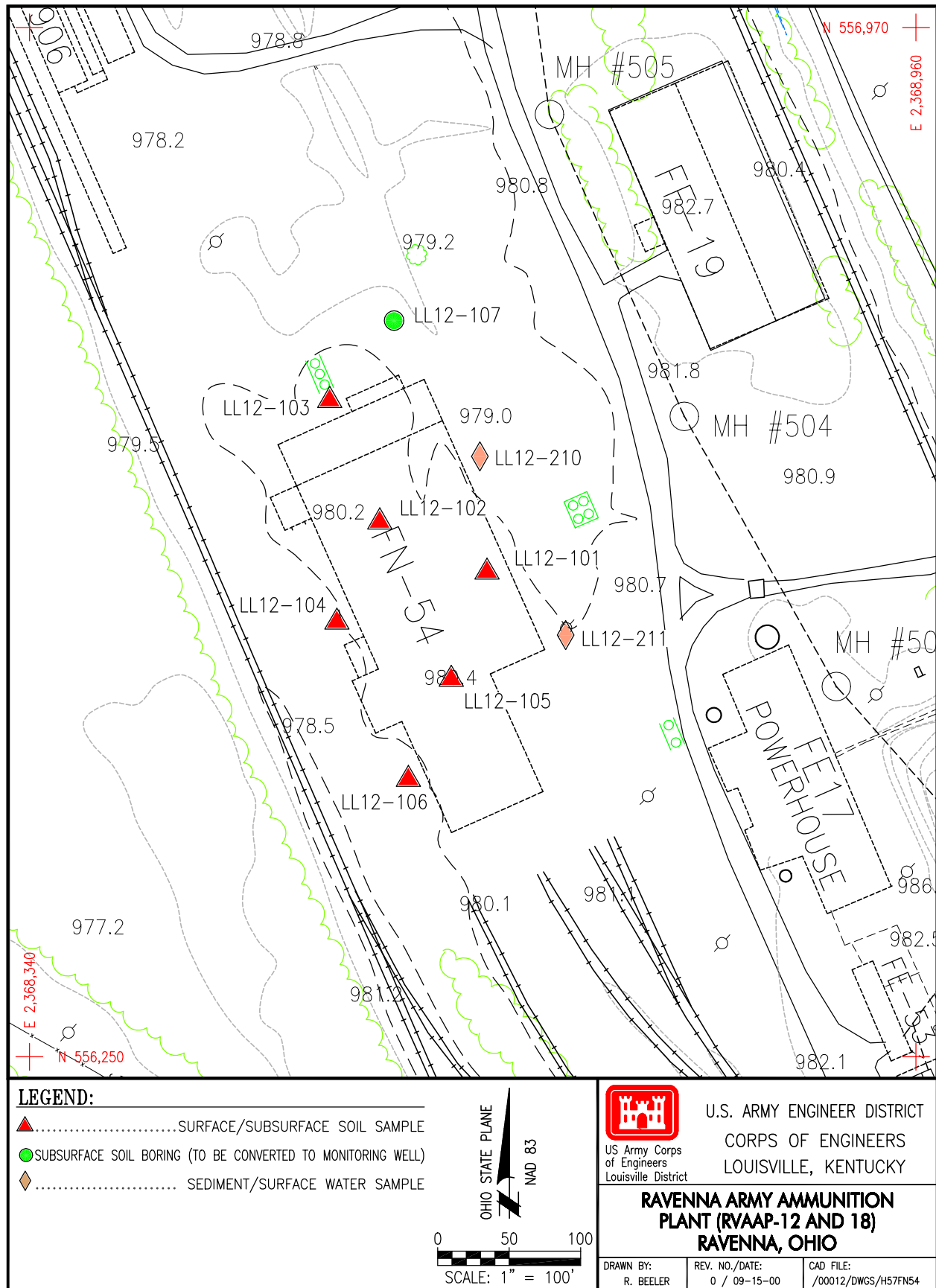


Figure 4.4. Building FN-54 Sampling Locations

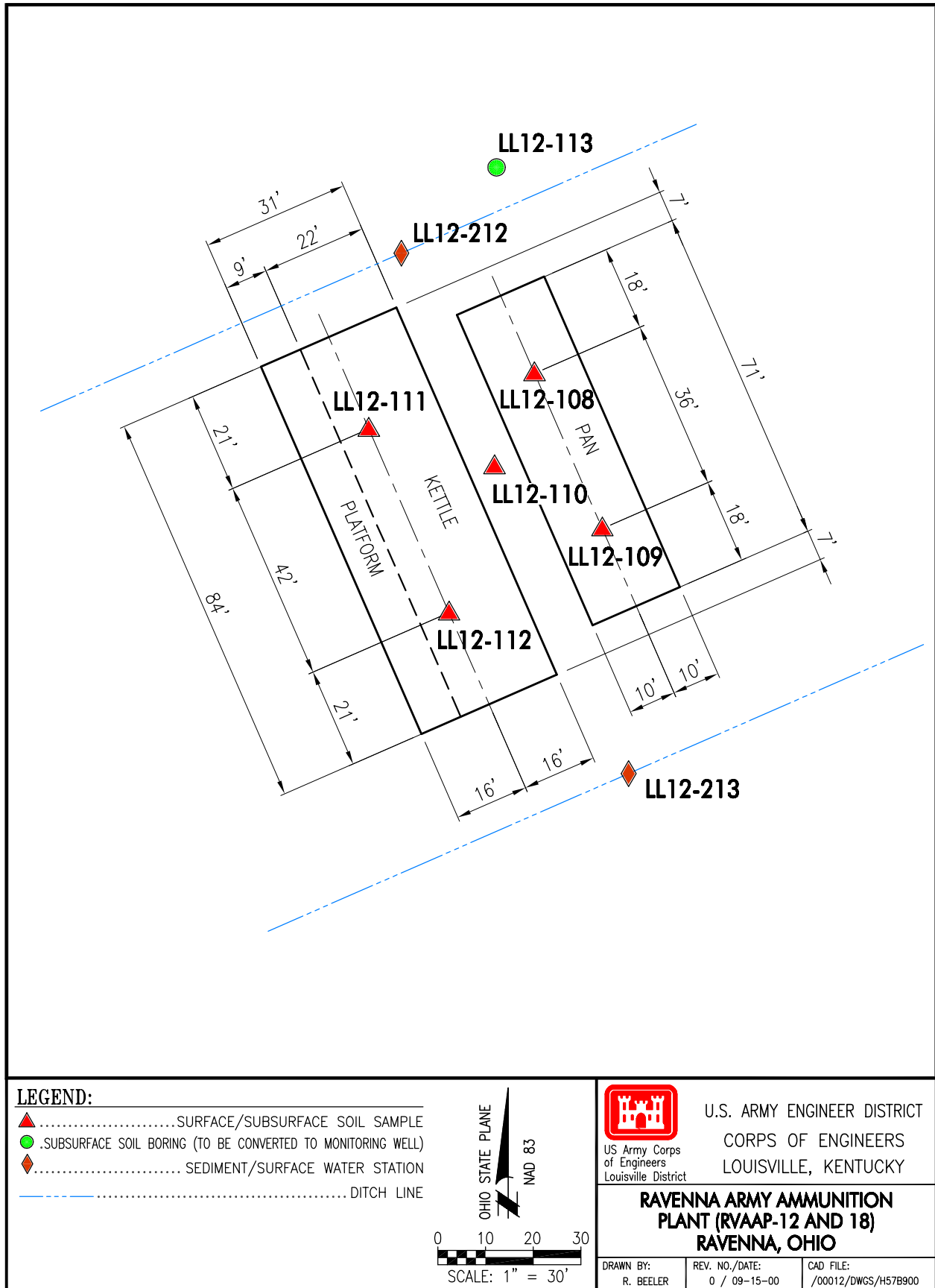


Figure 4.5. Building 900 Sampling Locations

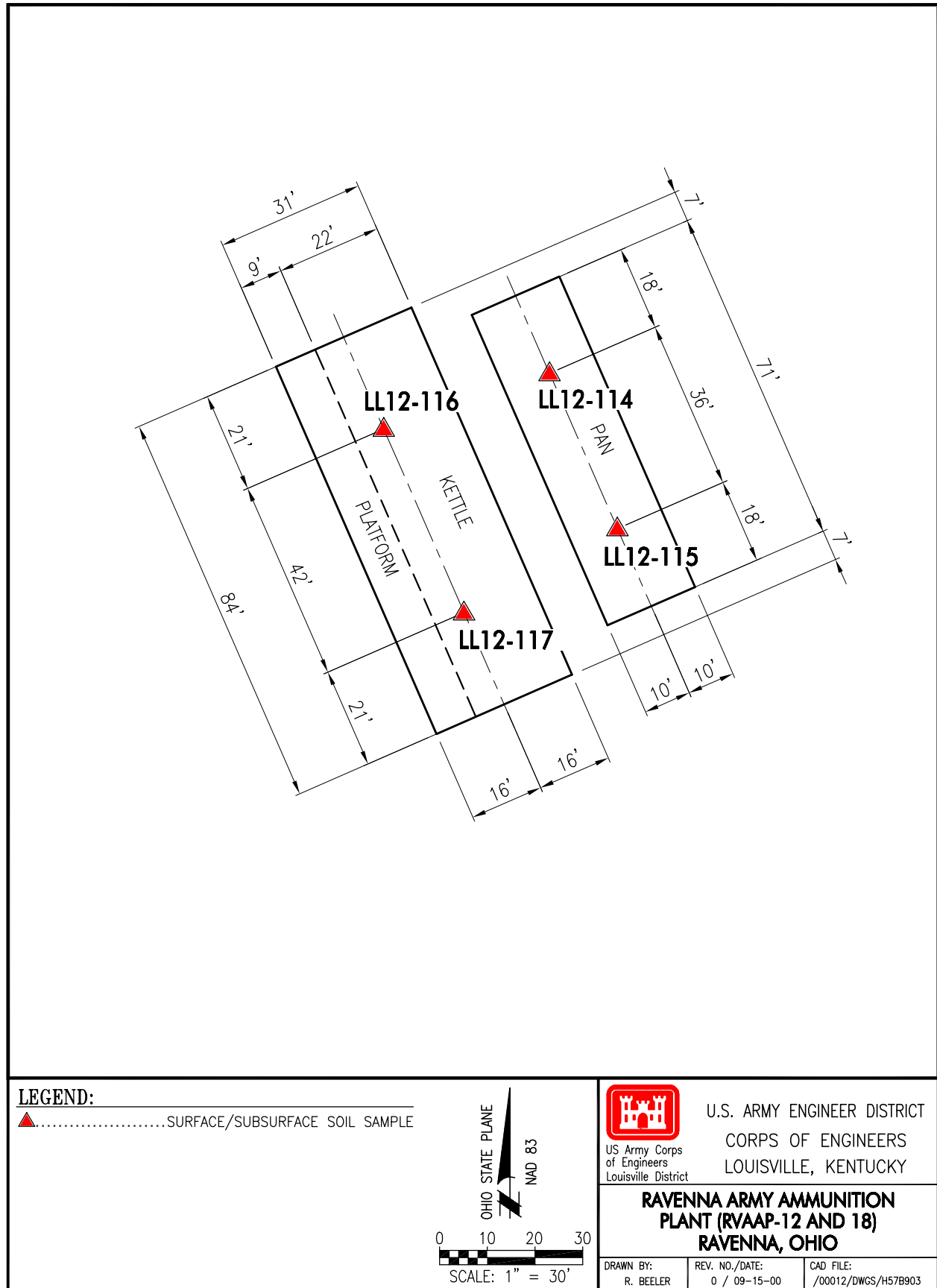


Figure 4.6. Building 903 Sampling Locations

RVAAP Load Line 12 Phase II RI - Sampling and Analysis Plan Addendum No. 1

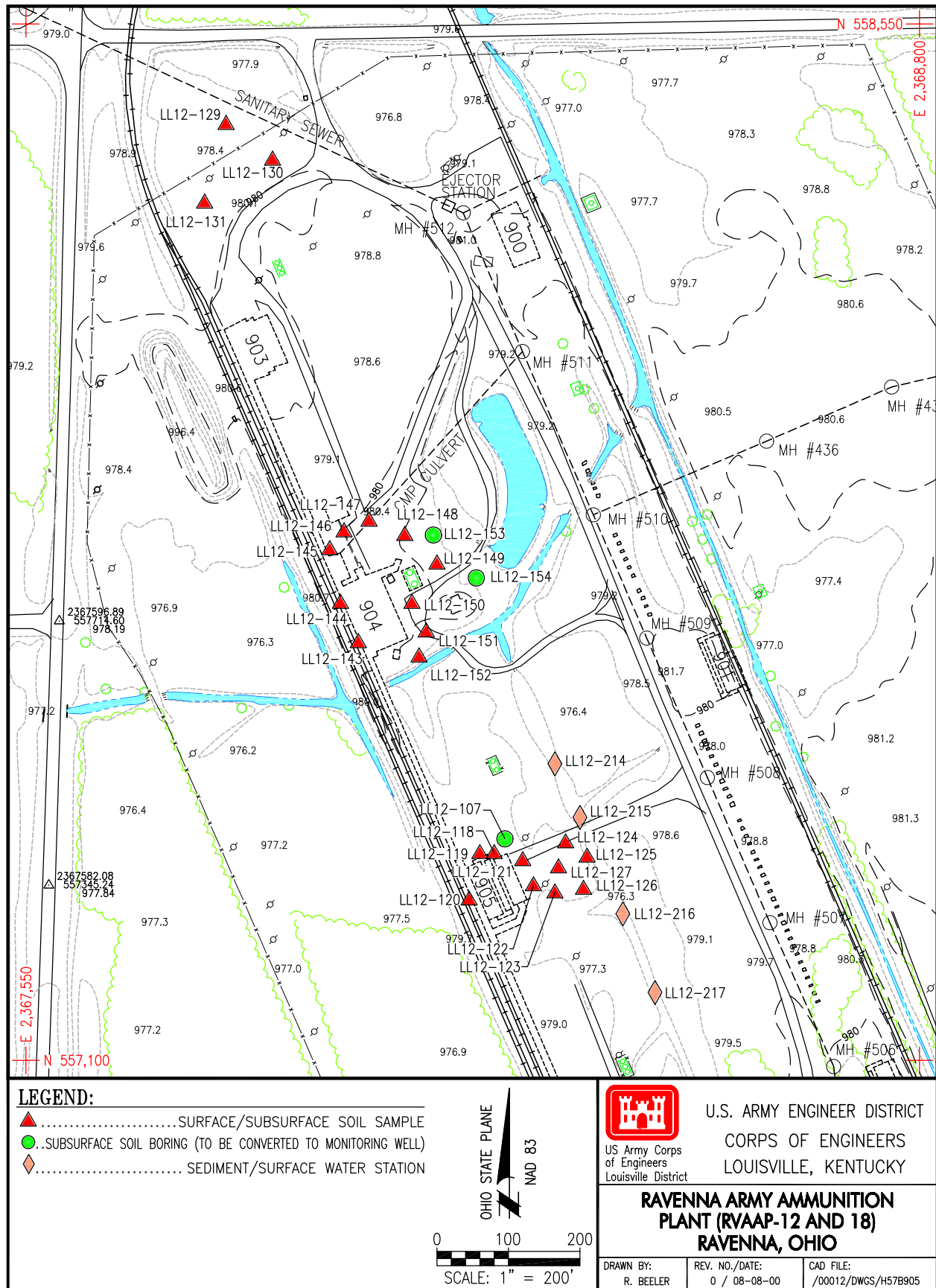


Figure 4.7. Load Line 12 Sample Locations for Building 905, Area Northwest of Building 903, and Building 904



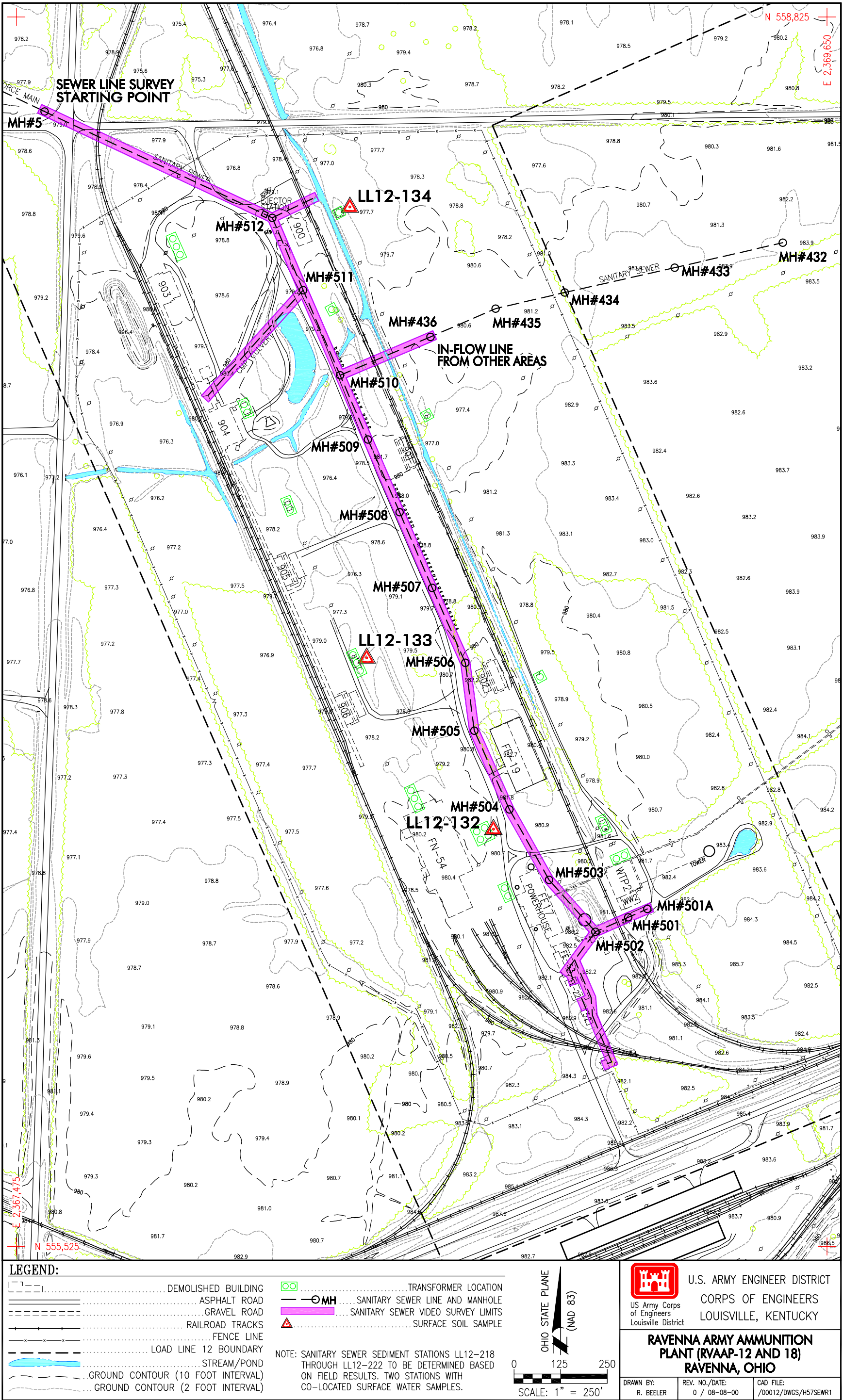


Figure 4.8. Transformer Pad Sampling Locations and Location of Load Line 12 Sanitary Sewer Line

RVAAP Load Line 12 Phase II RI - Sampling and Analysis Plan Addendum No. 1

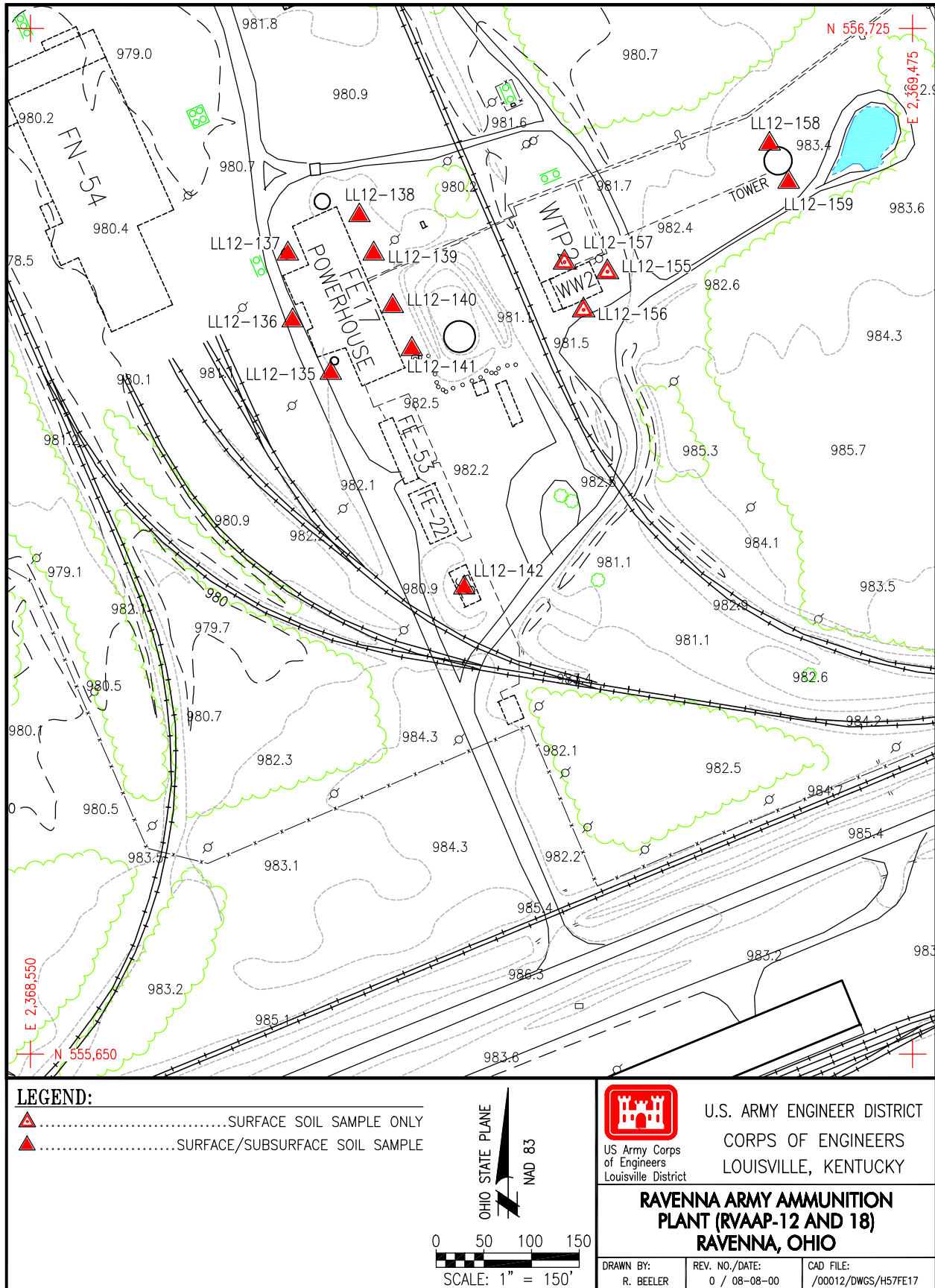
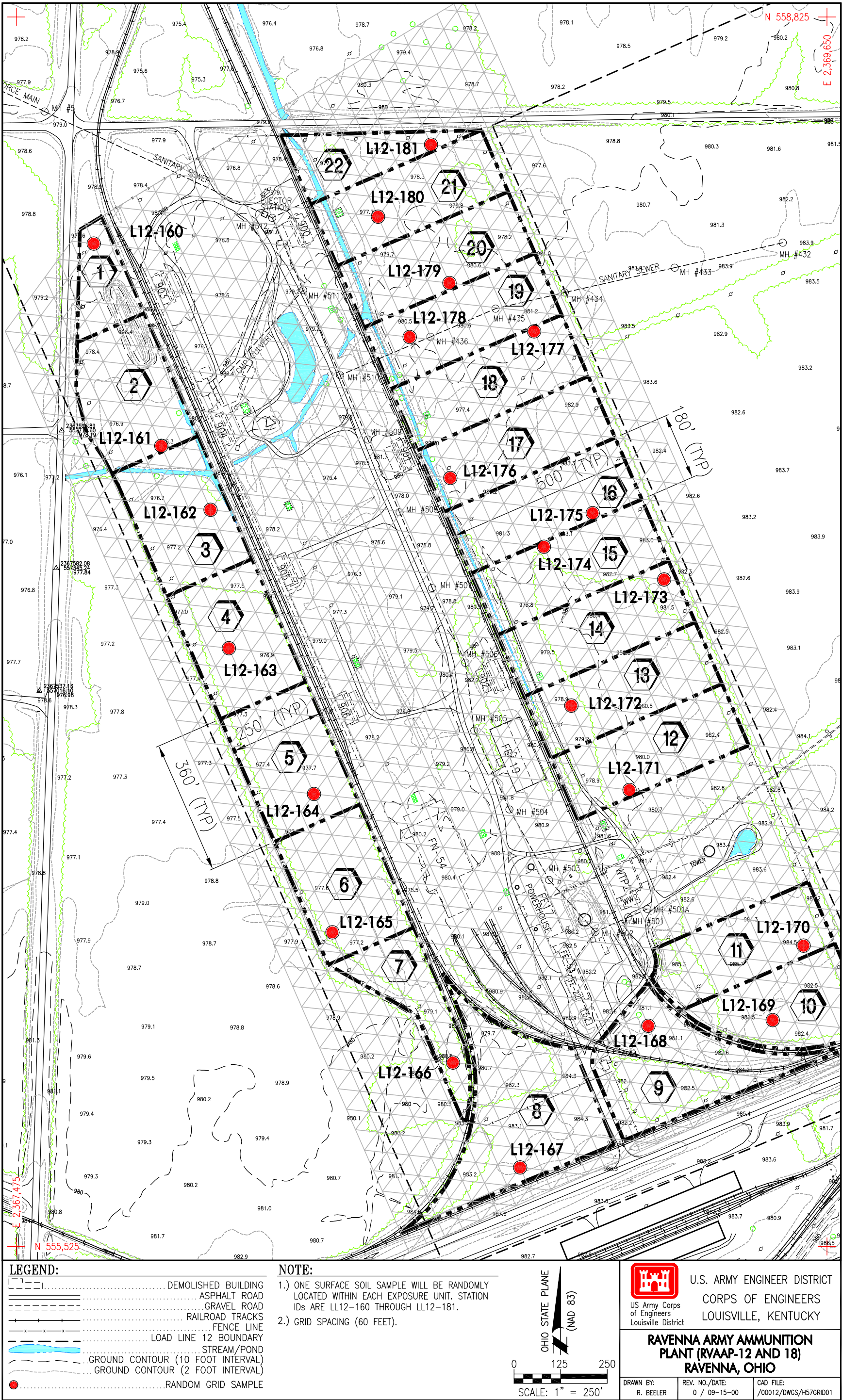


Figure 4.9. Load Line 12 Sample Locations for Building FE-17 (Powerhouse), Building 52, Water Works #2, and Water Tower





RVAAP Load Line 12 Phase II RI - Sampling and Analysis Plan Addendum No. 1

Figure 4-10. Load Line 12 Exposure Unit Sampling Grid for Surface Soil Samples



## **5.0 SAMPLE CHAIN OF CUSTODY/DOCUMENTATION**

### **5.1 FIELD LOGBOOK**

All field logbook information will follow structures identified in Section 5.1 of the Facility-wide SAP.

### **5.2 PHOTOGRAPHS**

Information regarding the documentation of photographs for the Load Line 12 Phase II RI is presented in Section 4.3.2.4.3 of the Facility-wide SAP. Representative photographs will be taken of the investigative measures during the Phase II RI and any significant observations that are made during the field effort. Photographs will be suitable for presentation in a public forum, as well as for documenting scientific information.

### **5.3 SAMPLE NUMBERING SYSTEM**

The sample numbering system that will be used to identify samples collected during the Phase II RI of Load Line 12 is explained in Section 5.3 of the Facility-wide SAP. The specific identifying information that will be used to implement this system during the Phase II RI is presented in [Figure 5-1](#). Samples have already been collected at Load Line 12 under the Phase I RI; therefore, sample numbering will continue the sequence established in the previous investigation. [Tables 5-1 through 5-3](#) present the baseline sample identification listing for the Phase II RI. Samples collected in addition to the baseline set will be identified sequentially by following the numbering system. If a sample in the baseline set is not collected or is reassigned to another location, a specific reason and notation will be given on the project field books.

### **5.4 SAMPLE DOCUMENTATION**

All sample label, logbook, field record, and field form information will follow structures identified

### **5.5 DOCUMENTATION PROCEDURES**

Documentation and tracking of samples and field information will follow the series of steps identified in Section 5.5 of the Facility-wide SAP.

### **5.6 CORRECTIONS TO DOCUMENTATION**

Any corrections to documentation will follow guidance established in Section 5.6 of the Facility-wide SAP.

**Sample Station Location Identification: XXXmm-NNN(n)**

XXX = Area Designator

Load Line 12= L12

mm = Sample Location Type

mw = Groundwater Monitoring Well  
so = Soil Boring/Subsurface Soil Sample Location  
sw = Surface Water Sample Location  
sd = Sediment Sample Location  
ss = Surface Soil Sample Location  
tr = Trench Sample Location  
sp = Seep or Spring Sample Location  
wp = Groundwater Well Point

NNN = Sequential Sample Location Number

Unique, sequential number for each sample location beginning with Phase I RI stations and extending into any subsequent investigative phases (i.e., 001 – 999).

(n) = Special Identifier

Optional use as needed to identify special sample matrices or sample location characteristics.

c = Stream or Drainage Channel Sample  
p = Pond Sample  
b = Railroad Ballast Sample  
d = Debris Sample  
s = Slag Sample

#### = Sequential Sample Identification Number

Unique, sequential number for each sample beginning with Phase I RI locations and extending into any subsequent investigative phases (i.e., 0001 – 9999).

tt = Sample Type

GW = Groundwater  
SO = Soil Sample  
SD = Sediment Sample  
SW = Surface Water Sample  
TB = Trip Blank  
FB = Field Blank  
ER = Equipment Rinsate

**Sample Identification: XXXmm-NNN(n)-####-tt**

**Figure 5-1. Load Line 12 Phase II RI Sample Identification System**

Table 5-1. Load Line 12 Phase II RI Baseline Soil Sample Identification List

AREA (No. Stations)	Sample Station ID	Depth (ft)	Sample ID	CHEMICAL ANALYSES										GEOTECHNICAL ANALYSES			
				Field Explosives	Explosives	Propellants	XRF Metals	TAL Metals	VOCs	SVOCs	Pest./ PCBs	Cyanide and Nitrate	TOC	Suite 1	Suite 2	Suite 3	Suite 4
Bldg FF-19 (30)	L12-059	0-1	L12ss-059-0372-SO	X	All samples > 1 mg/kg TNT and/or RDX + 15% of remaining samples for verification.	6 samples (10%) at locations with highest field explosives (TBD) will be submitted for analysis.	X	X	6 samples (10%) TBD will be submitted for analysis.	X	X	6 samples (10%) TBD will be submitted for analysis.	6 samples (10%) TBD will be submitted for analysis.				
		1-3	L12so-059-0373-SO	X			X	X									
		3-5	L12so-059-0374-SO	X			X	X									
	L12-060	0-1	L12ss-060-0375-SO	X			X	X									
		1-3	L12so-060-0376-SO	X			X	X									
		3-5	L12so-060-0377-SO	X			X	X									
	L12-061	0-1	L12ss-061-0378-SO	X			X	X									
		1-3	L12so-061-0379-SO	X			X	X									
		3-5	L12so-061-0380-SO	X			X	X									
	L12-062	0-1	L12ss-062-0381-SO	X			X	X									
		1-3	L12so-062-0382-SO	X			X	X									
		3-5	L12so-062-0383-SO	X			X	X									
	L12-063	0-1	L12ss-063-0384-SO	X			X	X									
		1-3	L12so-063-0385-SO	X			X	X									
		3-5	L12so-063-0386-SO	X			X	X									
	L12-064	0-1	L12ss-064-0387-SO	X			X	X									
		1-3	L12so-064-0388-SO	X			X	X									
		3-5	L12so-064-0389-SO	X			X	X									
	L12-065	0-1	L12ss-065-0390-SO	X			X	X									
		1-3	L12so-065-0391-SO	X			X	X									
		3-5	L12so-065-0392-SO	X			X	X									
	L12-066	0-1	L12ss-066-0393-SO	X			X	X									
		1-3	L12ss-066-0393-SO	X			X	X									
		3-5	L12so-066-0395-SO	X			X	X									
	L12-067	0-1	L12ss-067-0396-SO	X			X	X									
		1-3	L12so-067-0397-SO	X			X	X									
		3-5	L12so-067-0398-SO	X			X	X									
	L12-068	0-1	L12ss-068-0399-SO	X			X	X									
		1-3	L12so-068-0400-SO	X			X	X									
		3-5	L12so-068-0401-SO	X			X	X									
	L12-069	0-1	L12ss-069-0402-SO	X			X	X									
		1-3	L12so-069-0403-SO	X			X	X									
	L12-070	0-1	L12ss-070-0404-SO	X			X	X									
		1-3	L12so-070-0405-SO	X			X	X									
	L12-071	0-1	L12ss-071-0406-SO	X			X	X									
		1-3	L12so-071-0407-SO	X			X	X									
	L12-072	0-1	L12ss-072-0408-SO	X			X	X									
		1-3	L12so-072-0409-SO	X			X	X									
	L12-073	0-1	L12ss-073-0410-SO	X			X	X									
		1-3	L12so-073-0411-SO	X			X	X									

Table 5-1. Load Line 12 Phase II RI Baseline Soil Sample Identification List (continued)

AREA (No. Stations)	Sample Station ID	Depth (ft)	Sample ID	CHEMICAL ANALYSES											GEOTECHNICAL ANALYSES			
				Field Explosives	Explosives	Propellants	XRF Metals	TAL Metals	VOCs	SVOCs	Pest./PCBs	Cyanide and Nitrate	TOC	Suite 1	Suite 2	Suite 3	Suite 4	
Bldg. FF-19 (30) (cont)	L12-074	0-1	L12ss-074-0412-SO	X			X	X										
		1-3	L12so-074-0413-SO	X			X	X										
	L12-075	0-1	L12ss-075-0414-SO	X			X	X										
		1-3	L12so-075-0415-SO	X			X	X										
	L12-076	0-1	L12ss-076-0416-SO	X			X	X										
		1-3	L12so-076-0417-SO	X			X	X										
	L12-077	0-1	L12ss-077-0418-SO	X			X	X										
	L12-078	0-1	L12ss-078-0419-SO	X			X	X										
	L12-079	0-1	L12ss-079-0420-SO	X			X	X										
	L12-080	0-1	L12ss-080-0421-SO	X			X	X										
	L12-081	0-1	L12ss-081-0422-SO	X			X	X										
	L12-082	0-1	L12ss-082-0423-SO	X			X	X										
	L12-083	0 - 1	L12ss-083-0424-SO	X			X	X										
	L12-084	0 - 1	L12ss-084-0425-SO	X			X	X										
	L12-085	0 - 1	L12ss-085-0426-SO	X			X	X										
		1-3	L12so-085-0427-SO	X			X	X										
	L12-086	0 - 1	L12ss-086-0428-SO	X			X	X										
		1-3	L12so-086-0429-SO	X			X	X										
	L12-087	0 - 1	L12ss-087-0430-SO	X			X	X										
		1-3	L12so-087-0431-SO	X			X	X										
	L12-088	0-2	L12ss-088-0432-SO									X			Shelby Tube			
		24-26	L12so-088-0433-SO									X			Shelby Tube			
Bldg. 901 (4)	L12-089	0-1	L12ss-089-0434-SO	X	All samples > 1 mg/kg TNT and/or RDX + 15% of remaining samples for verification.	1 sample at location with highest field explosives.	X	X	1 sample (10%) TBD will be submitted for analysis.	X	1 sample (10%) TBD will be submitted for analysis.	1 sample (10%) TBD will be submitted for analysis.						
TBD - No more than two 1-3 ft subsurface soil samples will be analyzed for field explosives, XRF metals, TAL metals and SVOCs.		1-3	L12so-089-0435-SO	TBD			TBD	TBD										
	L12-090	0-1	L12ss-090-0436-SO	X			X	X										
		1-3	L12so-090-0437-SO	TBD			TBD	TBD										
	L12-091	0-1	L12ss-091-0438-SO	X			X	X										
		1-3	L12so-091-0439-SO	TBD			TBD	TBD										
	L12-092	0-1	L12ss-092-0440-SO	X			X	X										
		1-3	L12so-092-0441-SO	TBD	TBD	TBD												

Table 5-1. Load Line 12 Phase II RI Baseline Soil Sample Identification List (continued)

AREA (No. Stations)	Sample Station ID	Depth (ft)	Sample ID	CHEMICAL ANALYSES										GEOTECHNICAL ANALYSES			
				Field Explosives	Explosives	Propellants	XRF Metals	TAL Metals	VOCs	SVOCs	Pest./PCBs	Cyanide and Nitrate	TOC	Suite 1	Suite 2	Suite 3	Suite 4
<b>Bldg. 902 (4)</b>  TBD - No more than two 1-3 ft subsurface soil samples will be analyzed for field explosives, XRF metals, TAL metals and SVOCs.	L12-093	0-1	L12ss-093-0442-SO	X	All samples > 1 mg/kg TNT and/or RDX + 15% of remaining samples for verification.	1 sample at location with highest field explosives.	X	X	1 sample (10%) TBD will be submitted for analysis.	X	1 sample (10%) TBD will be submitted for analysis.	1 sample (10%) TBD will be submitted for analysis.					
		1-3	L12so-093-0443-SO	TBD			TBD	TBD		TBD							
	L12-094	0-1	L12ss-094-0444-SO	X			X	X		X							
		1-3	L12so-094-0445-SO	TBD			TBD	TBD		TBD							
	L12-095	0-1	L12ss-095-0446-SO	X			X	X		X							
		1-3	L12so-095-0447-SO	TBD			TBD	TBD		TBD							
	L12-096	0-1	L12ss-096-0448-SO	X			X	X		X							
		1-3	L12so-096-0449-SO	TBD			TBD	TBD		TBD							
<b>Bldg. 906 (4)</b>  TBD - No more than two 1-3 ft subsurface soil samples will be analyzed for field explosives, XRF metals, TAL metals and SVOCs.	L12-097	0-1	L12ss-097-0450-SO	X	All samples > 1 mg/kg TNT and/or RDX + 15% of remaining samples for verification.	1 sample at location with highest field explosives.	X	X	1 sample (10%) TBD will be submitted for analysis.	X	1 sample (10%) TBD will be submitted for analysis.	1 sample (10%) TBD will be submitted for analysis.					
		1-3	L12so-097-0451-SO	TBD			TBD	TBD		TBD							
	L12-098	0-1	L12ss-098-0452-SO	X			X	X		X							
		1-3	L12so-098-0453-SO	TBD			TBD	TBD		TBD							
	L12-099	0-1	L12ss-099-0454-SO	X			X	X		X							
		1-3	L12so-099-0455-SO	TBD			TBD	TBD		TBD							
	L12-100	0-1	L12ss-100-0456-SO	X			X	X		X							
		1-3	L12so-100-0457-SO	TBD			TBD	TBD		TBD							
<b>Bldg. FN-54 (6)</b>  TBD - No more than four, 1-3 ft subsurface soil samples and two, 3-5 ft subsurface soil samples will be analyzed for field explosives, XRF metals, and TAL metals.	L12-101	0-1	L12ss-101-0458-SO	X	All samples > 1 mg/kg TNT and/or RDX + 15% of remaining samples for verification.	1 sample at location with highest field explosives.	X	X	1 sample (10%) TBD will be submitted for analysis.	1 sample (10%) TBD will be submitted for analysis.	1 sample (10%) TBD will be submitted for analysis.	1 sample (10%) TBD will be submitted for analysis.					
		1-3	L12so-101-0459-SO	TBD			TBD	TBD									
		3-5	L12so-101-0460-SO	TBD			TBD	TBD									
	L12-102	0-1	L12ss-102-0461-SO	X			X	X									
		1-3	L12so-102-0462-SO	TBD			TBD	TBD									
		3-5	L12so-102-0463-SO	TBD			TBD	TBD									
	L12-103	0-1	L12ss-103-0464-SO	X			X	X									
		1-3	L12so-103-0465-SO	TBD			TBD	TBD									
		3-5	L12so-103-0466-SO	TBD			TBD	TBD									
	L12-104	0-1	L12ss-104-0467-SO	X			X	X									
		1-3	L12so-104-0468-SO	TBD			TBD	TBD									
		3-5	L12so-104-0469-SO	TBD			TBD	TBD									
	L12-105	0-1	L12ss-105-0470-SO	X			X	X									
		1-3	L12so-105-0471-SO	TBD			TBD	TBD									
		3-5	L12so-105-0472-SO	TBD			TBD	TBD									
	L12-106	0-1	L12ss-106-0473-SO	X			X	X									
		1-3	L12so-106-0474-SO	TBD			TBD	TBD									
		3-5	L12so-106-0475-SO	TBD			TBD	TBD									

Table 5-1. Load Line 12 Phase II RI Baseline Soil Sample Identification List (continued)

AREA (No. Stations)	Sample Station ID	Depth (ft)	Sample ID	CHEMICAL ANALYSES										GEOTECHNICAL ANALYSES			
				Field Explosives	Explosives	Propellants	XRF Metals	TAL Metals	VOCs	SVOCs	Pest./PCBs	Cyanide and Nitrate	TOC	Suite 1	Suite 2	Suite 3	Suite 4
Bldg. FN-54 (6) (cont.)	L12-107	0-2	L12ss-107-0476-SO										X			Shelby Tube	
		24-26	L12so-107-0477-SO										X			Shelby Tube	
Bldg. 900 (5)	L12-108	0-1	L12ss-108-0478-SO	X	All samples > 1 mg/kg TNT and/or RDX + 15% of remaining samples for verification.	1 sample at location with highest field explosives.	X	X	1 sample (10%) TBD will be submitted for analysis.	X	X	1 sample (10%) TBD will be submitted for analysis.					
TBD - No more than two, 1-3 ft subsurface soil samples will be analyzed for field explosives, XRF metals, and TAL metals.		1-3	L12so-108-0479-SO	X			X	X		X							
		3-5	L12so-108-0480-SO	X			X	X		X							
	L12-109	0-1	L12ss-109-0481-SO	X			X	X									
		1-3	L12so-109-0482-SO	TBD			TBD	TBD									
	L12-110	0-1	L12ss-110-0483-SO	X			X	X									
		1-3	L12so-110-0484-SO	TBD			TBD	TBD									
	L12-111	0-1	L12ss-111-0485-SO	X			X	X									
		1-3	L12so-111-0486-SO	TBD			TBD	TBD									
	L12-112	0-1	L12ss-112-0487-SO	X			X	X									
		1-3	L12so-112-0488-SO	TBD			TBD	TBD									
	L12-113	0-2	L12ss-113-0489-SO								X			Shelby Tube			
		24-26	L12so-113-0490-SO									X			Shelby Tube		
Bldg. 903 (4)	L12-114	0-1	L12ss-114-0491-SO	X	All samples > 1 mg/kg TNT and/or RDX + 15% of remaining samples for verification.	1 sample at location with highest field explosives.	X	X	1 sample (10%) TBD will be submitted for analysis.	1 sample (10%) TBD will be submitted for analysis.	1 sample (10%) TBD will be submitted for analysis.	1 sample (10%) TBD will be submitted for analysis.					
TBD - No more than two, 1-3 ft subsurface soil samples and one, 3-5 ft subsurface soil samples will be analyzed for field explosives, XRF metals, and TAL metals.		1-3	L12so-114-0492-SO	TBD			TBD	TBD									
		3-5	L12so-114-0493-SO	TBD			TBD	TBD									
	L12-115	0-1	L12ss-115-0494-SO	X			X	X									
		1-3	L12so-115-0495-SO	TBD			TBD	TBD									
		3-5	L12so-115-0496-SO	TBD			TBD	TBD									
	L12-116	0-1	L12ss-116-0497-SO	X			X	X									
		1-3	L12so-116-0498-SO	TBD			TBD	TBD									
		3-5	L12so-116-0499-SO	TBD			TBD	TBD									
	L12-117	0-1	L12ss-117-0500-SO	X			X	X									
		1-3	L12so-117-0501-SO	TBD			TBD	TBD									
		3-5	L12so-117-0502-SO	TBD			TBD	TBD									

Table 5-1. Load Line 12 Phase II RI Baseline Soil Sample Identification List (continued)

AREA (No. Stations)	Sample Station ID	Depth (ft)	Sample ID	CHEMICAL ANALYSES										GEOTECHNICAL ANALYSES			
				Field Explosives	Explosives	Propellants	XRF Metals	TAL Metals	VOCs	SVOCs	Pest./ PCBs	Cyanide and Nitrate	TOC	Suite 1	Suite 2	Suite 3	Suite 4
Bldg. 905 (11)	L12-118	0-1	L12ss-118-0503-SO	X	All samples > 1 mg/kg TNT and/or RDX + 15% of remaining samples for verification.	2 samples at locations with highest field explosives.	X	X	2 samples (10%) TBD will be submitted for analysis.	2 samples (10%) TBD will be submitted for analysis.	2 samples (10%) TBD will be submitted for analysis.	1 sample TBD will be submitted for analysis.					
TBD - No more than five, 1-3 ft subsurface soil samples and three, 3-5 ft subsurface soil samples will be analyzed for field explosives, XRF metals, and TAL metals.		1-3	L12so-118-0504-SO	TBD			TBD	TBD									
		3-5	L12so-118-0505-SO	TBD			TBD	TBD									
	L12-119	0-1	L12ss-119-0506-SO	X			X	X									
		1-3	L12so-119-0507-SO	TBD			TBD	TBD									
		3-5	L12so-119-0508-SO	TBD			TBD	TBD									
	L12-120	0-1	L12ss-120-0509-SO	X			X	X									
		1-3	L12so-120-0510-SO	TBD			TBD	TBD									
		3-5	L12so-120-0511-SO	TBD			TBD	TBD									
	L12-121	0-1	L12ss-121-0512-SO	X			X	X									
		1-3	L12so-121-0513-SO	TBD			TBD	TBD									
		3-5	L12so-121-0514-SO	TBD			TBD	TBD									
	L12-122	0-1	L12ss-122-0515-SO	X			X	X									
		1-3	L12so-122-0516-SO	TBD			TBD	TBD									
		3-5	L12so-122-0517-SO	TBD			TBD	TBD									
	L12-123	0-1	L12ss-123-0518-SO	X			X	X									
		1-3	L12so-123-0519-SO	TBD			TBD	TBD									
		3-5	L12so-123-0520-SO	TBD			TBD	TBD									
	L12-124	0-1	L12ss-124-0521-SO	X			X	X									
		1-3	L12so-124-0522-SO	TBD			TBD	TBD									
		3-5	L12so-124-0523-SO	TBD			TBD	TBD									
	L12-125	0-1	L12ss-125-0524-SO	X			X	X									
		1-3	L12so-125-0525-SO	TBD			TBD	TBD									
		3-5	L12so-125-0526-SO	TBD			TBD	TBD									
	L12-126	0-1	L12ss-126-0527-SO	X			X	X									
		1-3	L12so-126-0528-SO	TBD			TBD	TBD									
		3-5	L12so-126-0529-SO	TBD			TBD	TBD									
	L12-127	0-1	L12ss-127-0530-SO	X			X	X									
		1-3	L12so-127-0531-SO	TBD			TBD	TBD									
		3-5	L12so-127-0532-SO	TBD			TBD	TBD									
	L12-128	0-2	L12ss-128-0533-SO									X			Shelby Tube		
		24-26	L12so-128-0534-SO									X			Shelby Tube		

Table 5-1. Load Line 12 Phase II RI Baseline Soil Sample Identification List (continued)

AREA (No. Stations)	Sample Station ID	Depth (ft)	Sample ID	CHEMICAL ANALYSES										GEOTECHNICAL ANALYSES			
				Field Explosives	Explosives	Propellants	XRF Metals	TAL Metals	VOCs	SVOCs	Pest./PCBs	Cyanide and Nitrate	TOC	Suite 1	Suite 2	Suite 3	Suite 4
<b>Suspected OEW Area North of Bldg. 903 (3)</b>	L12-129	0-1	L12ss-129-0535-SO	X	All samples > 1 mg/kg TNT and/or RDX + 15% of remaining samples for verification.	1 sample at the location with highest field explosives.	X	X									
TBD - No more than one, 1-3 ft subsurface soil sample will be analyzed for field explosives, XRF metals, and TAL metals.		1-3	L12so-129-0536-SO	TBD			TBD	TBD									
	L12-130	0-1	L12ss-130-0537-SO	X			X	X									
		1-3	L12so-130-0538-SO	TBD			TBD	TBD									
	L12-131	0-1	L12ss-131-0539-SO	X			X	X									
		1-3	L12so-131-0540-SO	TBD			TBD	TBD									
<b>Transformer Pads</b>	L12-132	0-1	L12ss-132-0541-SO								PCBs only						
	L12-133	0-1	L12ss-133-0542-SO								PCBs only						
	L12-134	0-1	L12ss-134-0543-SO								PCBs only						
<b>Bldg. FE-17 Powerhouse (7)</b>	L12-135	1-3	L12so-135-0544-SO								PCBs only						
Metals for former coal pile location, VOCs and SVOCs at all former AST locations	L12-136	1-3	L12so-136-0545-SO								PCBs only						
	L12-137	1-3	L12so-137-0546-SO								PCBs only						
	L12-138	1-3	L12so-138-0547-SO				X	X	X	X	PCBs only						
	L12-139	1-3	L12so-139-0548-SO						X	X	PCBs only						
	L12-140	1-3	L12so-140-0549-SO						X	X	PCBs only						
	L12-141	1-3	L12so-141-0550-SO						X	X	PCBs only						
<b>Bldg. 52 (1)</b>	L12-142	0-1	L12ss-142-0551-SO	X	TBD		X	X	X	X	X	X					
		1-3	L12so-142-0552-SO	X	TBD		X	X	X	X	X	X					
<b>Bldg. 904 (12)</b>	L12-143	0-1	L12ss-143-0553-SO	X	All samples > 1 mg/kg TNT and/or RDX + 15% of remaining samples for verification.	3 samples at locations with highest field explosives.	X	X	3 samples (10%)	3 samples (10%)	3 samples (10%)	3 samples (10%)					
		1-3	L12so-143-0554-SO	X			X	X	TBD will be submitted for analysis	TBD will be submitted for analysis	TBD will be submitted for analysis	TBD will be submitted for analysis					
		3-5	L12so-143-0555-SO	X			X	X									
	L12-144	0-1	L12ss-144-0556-SO	X			X	X									
		1-3	L12so-144-0557-SO	X			X	X									
		3-5	L12so-144-0558-SO	X			X	X									
	L12-145	0-1	L12ss-145-0559-SO	X			X	X									
		1-3	L12so-145-0560-SO	X			X	X									
		3-5	L12so-145-0561-SO	X			X	X									
	L12-146	0-1	L12ss-146-0562-SO	X			X	X									
		1-3	L12so-146-0563-SO	X			X	X									
		3-5	L12so-146-0564-SO	X			X	X									



Table 5-1. Load Line 12 Phase II RI Baseline Soil Sample Identification List (continued)

AREA (No. Stations)	Sample Station ID	Depth (ft)	Sample ID	CHEMICAL ANALYSES										GEOTECHNICAL ANALYSES			
				Field Explosives	Explosives	Propellants	XRF Metals	TAL Metals	VOCs	SVOCs	Pest./ PCBs	Cyanide and Nitrate	TOC	Suite 1	Suite 2	Suite 3	Suite 4
Bldg. 904 (12) (cont.)	L12-147	0-1	L12ss-147-0565-SO	X			X	X									
		1-3	L12so-147-0566-SO	X			X	X									
		3-5	L12so-147-0567-SO	X			X	X									
	L12-148	0-1	L12ss-148-0568-SO	X			X	X									
		1-3	L12so-148-0569-SO	X			X	X									
		3-5	L12so-148-0570-SO	X			X	X									
	L12-149	0-1	L12ss-149-0571-SO	X			X	X									
		1-3	L12so-149-0572-SO	X			X	X									
		3-5	L12so-149-0573-SO	X			X	X									
	L12-150	0-1	L12ss-150-0574-SO	X			X	X									
		1-3	L12so-150-0575-SO	X			X	X									
		3-5	L12so-150-0576-SO	X			X	X									
	L12-151	0-1	L12ss-151-0577-SO	X			X	X									
		1-3	L12so-151-0578-SO	X			X	X									
		3-5	L12so-151-0579-SO	X			X	X									
	L12-152	0-1	L12ss-152-0580-SO	X			X	X									
		1-3	L12so-152-0581-SO	X			X	X									
		3-5	L12so-152-0582-SO	X			X	X									
	L12-153	0-2	L12ss-153-0583-SO										X			Shelby Tube	
		24-26	L12so-153-0584-SO										X			Shelby Tube	
	L12-154	0-2	L12ss-154-0585-SO														
		24-26	L12so-154-0586-SO										X			Shelby Tube	
Water Works # 2 (3)	L12-155	0-1	L12ss-155-0587-SO	X	All samples > 1 mg/kg TNT and/or RDX + 15% of remaining samples.		X	X			1 sample (10%) TBD will be submitted for analysis.						
		1-3	L12so-155-0588-SO	X			X	X									
	L12-156	0-1	L12ss-156-0589-SO	X			X	X									
		1-3	L12so-156-0590-SO	X			X	X									
	L12-157	0-1	L12ss-157-0591-SO	X			X	X									
		1-3	L12so-157-0592-SO	X			X	X									
Water Tower (2)	L12-158	0-1	L12ss-158-0593-SO				X	X									
	L12-159	0-1	L12ss-159-0594-SO				X	X									

Table 5-1. Load Line 12 Phase II RI Baseline Soil Sample Identification List (continued)

AREA (No. Stations)	Sample Station ID	Depth (ft)	Sample ID	CHEMICAL ANALYSES											GEOTECHNICAL ANALYSES			
				Field Explosives	Explosives	Propellants	XRF Metals	TAL Metals	VOCs	SVOCs	Pest./PCBs	Cyanide and Nitrate	TOC	Suite 1	Suite 2	Suite 3	Suite 4	
Random Grid in Non-Production Areas (22)	L12-160	0-1	L12ss-160-0595-SO	X	All samples > 1 mg/kg TNT and/or RDX + 15% of remaining samples for verification.	2 samples at locations with highest field explosives.	X	X	2 samples (10%) TBD will be submitted for analysis.	2 samples (10%) TBD will be submitted for analysis.	2 samples (10%) TBD will be submitted for analysis.	2 samples (10%) TBD will be submitted for analysis.						
	L12-161	0-1	L12ss-161-0596-SO	X			X	X										
	L12-162	0-1	L12ss-162-0597-SO	X			X	X										
	L12-163	0-1	L12ss-163-0598-SO	X			X	X										
	L12-164	0-1	L12ss-164-0599-SO	X			X	X										
	L12-165	0-1	L12ss-165-0600-SO	X			X	X										
	L12-166	0-1	L12ss-166-0601-SO	X			X	X										
	L12-167	0-1	L12ss-167-0602-SO	X			X	X										
	L12-168	0-1	L12ss-168-0603-SO	X			X	X										
	L12-169	0-1	L12ss-169-0604-SO	X			X	X										
	L12-170	0-1	L12ss-170-0605-SO	X			X	X										
	L12-171	0-1	L12ss-171-0606-SO	X			X	X										
	L12-172	0-1	L12ss-172-0607-SO	X			X	X										
	L12-173	0-1	L12ss-173-0608-SO	X			X	X										
	L12-174	0-1	L12ss-174-0609-SO	X			X	X										
	L12-175	0-1	L12ss-175-0610-SO	X			X	X										
	L12-176	0-1	L12ss-176-0611-SO	X			X	X										
	L12-177	0-1	L12ss-177-0612-SO	X			X	X										
	L12-178	0-1	L12ss-178-0613-SO	X			X	X										
	L12-179	0-1	L12ss-179-0614-SO	X			X	X										
	L12-180	0-1	L12ss-180-0615-SO	X			X	X										
	L12-181	0-1	L12ss-181-0616-SO	X			X	X										
TBD Monitoring Wells (8)	L12-182	0-2	L12ss-182-0617-SO										X			Shelby Tube		
		24-26	L12so-182-0618-SO										X			Shelby Tube		
	L12-183	0-2	L12ss-183-0619-SO										X			Shelby Tube		
		24-26	L12so-183-0620-SO										X			Shelby Tube		
	L12-184	24-26	L12so-184-0621-SO										X			Shelby Tube		
	L12-185	24-26	L12so-185-0622-SO										X			Shelby Tube		
	L12-186	24-26	L12so-186-0623-SO										X			Shelby Tube		

Table 5-1. Load Line 12 Phase II RI Baseline Soil Sample Identification List (continued)

AREA (No. Stations)	Sample Station ID	Depth (ft)	Sample ID	CHEMICAL ANALYSES										GEOTECHNICAL ANALYSES			
				Field Explosives	Explosives	Propellants	XRF Metals	TAL Metals	VOCs	SVOCs	Pest./ PCBs	Cyanide and Nitrate	TOC	Suite 1	Suite 2	Suite 3	Suite 4
TBD Monitoring Wells (8) (cont.)	L12-187	24-26	L12so-187-0624-SO										X			Shelby Tube	
	L12-188	24-26	L12so-188-0625-SO										X			Shelby Tube	
	L12-189	24-26	L12so-189-0626-SO										X			Shelby Tube	
Contingency (Bldg. 901, 902, 906)	L12-190	0-1	L12ss-190-0627-SO	X			X	X									
	L12-191	0-1	L12ss-191-0628-SO	X			X	X									
	L12-192	0-1	L12ss-192-0629-SO	X			X	X									
Contingency (Transformer Pads)	L12-193	0-1	L12ss-193-0630-SO								PCBs Only						
	L12-194	0-1	L12ss-194-0631-SO								PCBs Only						
	L12-195	0-1	L12ss-195-0632-SO								PCBs Only						
Test Pits and Piezometers  12 samples TBD from 6 test pits and 10 piezometers	L12-196	TBD	L12so-196-0633-SO												X		
	L12-197	TBD	L12so-197-0634-SO												X		
	L12-198	TBD	L12so-198-0635-SO												X		
	L12-199	TBD	L12so-199-0636-SO												X		
	L12-200	TBD	L12so-200-0637-SO												X		
	L12-201	TBD	L12so-201-0638-SO												X		
	L12-202	TBD	L12so-202-0639-SO												X		
	L12-203	TBD	L12so-203-0640-SO												X		
	L12-204	TBD	L12so-204-0641-SO												X		
	L12-205	TBD	L12so-205-0642-SO												X		
	L12-206	TBD	L12so-206-0643-SO												X		
	L12-207	TBD	L12so-207-0644-SO												X		
TOTALS	137 Stations		260 Samples	191	69 <sup>b</sup>	20	194	194	25	40	30 Pest./ 43 PCBs	19	21		12	21	

**Table 5-1. Load Line 12 Phase II RI Baseline Soil Sample Identification List (continued)**

AREA (No. Stations)	Sample Station ID	Depth (ft)	Sample ID	CHEMICAL ANALYSES										GEOTECHNICAL ANALYSES			
				Field Explosives	Explosives	Propellants	XRF Metals	TAL Metals	VOCs	SVOCs	Pest./ PCBs	Cyanide and Nitrate	TOC	Suite 1	Suite 2	Suite 3	Suite 4
FIELD DUPLICATES = 20 TOTAL				19	7	2	19	19	3	4	3 Pest./5 PCB	2	2				
USACE QA SPLIT SAMPLES = 20 TOTAL					7	2		19	3	4	3 Pest./5 PCB	2	2				
TRIP BLANKS = 0																	
FIELD BLANKS = 0																	
EQUIPMENT RINSATES = 0																	

<sup>a</sup> Suite 1 = Moisture content, grain size, USCS, and Atterberg Limits.

Suite 2 = Moisture content, grain size, USCS, Atterberg Limits, and hydrometer analysis.

Suite 3 = Moisture content, grain size (sieve only), USCS, Atterberg Limits, hydraulic conductivity, hydrometer, specific gravity, bulk density, porosity, pH, redox potential, and total organic carbon by chemical analysis.

Suite 4 = USCS, grain size (sieve only), and total organic carbon by chemical analysis.

<sup>b</sup> Maximum estimated number of explosives samples. Based on assumed 25 percent of field screening samples > 1 mg/kg TNT and/or RDX plus 15% of remaining samples submitted for confirmation analysis.

Table 5-2. Load Line 12 Phase II RI Sediment and Surface Water Baseline Sample Identification List

AREA (No. Stations)	Depth (ft)	Sample Station ID	Sample ID	CHEMICAL ANALYSES									GEOTECHNICAL ANALYSES <sup>a</sup>			
				Explosives	Propellants	TAL Metals	VOCs	SVOCs	Pest./ PCBs	Cyanide	Nitrate	TOC	Suite 1	Suite 2	Suite 3	Suite 4
Sediment Sample Stations																
Bldg. FF-19 (2)	0 to 0.5	L12-208	L12sd-208-0645-SD	X	Two propellant samples (10% of total) to be collected. Locations are TBD based on field observations.	X	X	X	X	X	X	X				X
	0 to 0.5	L12-209	L12sd-209-0646-SD	X		X	X	X	X	X	X	X				X
Bldg. FN-54 (2)	0 to 0.5	L12-210	L12sd-210-0647-SD	X		X	X	X	X	X	X	X				X
	0 to 0.5	L12-211	L12sd-211-0648-SD	X		X	X	X	X	X	X	X				X
Bldg. 900 (2)	0 to 0.5	L12-212	L12sd-212-0649-SD	X		X	X	X	X	X	X	X				X
	0 to 0.5	L12-213	L12sd-213-0650-SD	X		X	X	X	X	X	X	X				X
Bldg. 905 (4)	0 to 0.5	L12-214	L12sd-214-0651-SD	X		X	X	X	X	X	X	X				X
	0 to 0.5	L12-215	L12sd-215-0652-SD	X		X	X	X	X	X	X	X				X
	0 to 0.5	L12-216	L12sd-216-0653-SD	X		X	X	X	X	X	X	X				X
	0 to 0.5	L12-217	L12sd-217-0654-SD	X		X	X	X	X	X	X	X				X
Sanitary Sewer Lines (5 - TBD)	NA	L12-218	L12sd-218-0655-SD	X		X	X	X	X	X	X	X				X
	NA	L12-219	L12sd-219-0656-SD	X		X	X	X	X	X	X	X				X
	NA	L12-220	L12sd-220-0657-SD	X		X	X	X	X	X	X	X				X
	NA	L12-221	L12sd-221-0658-SD	X		X	X	X	X	X	X	X				X
	NA	L12-222	L12sd-222-0659-SD	X		X	X	X	X	X	X	X				X
Resample @ Phase I L12-031	0 to 0.5	L12-223	L12sd-223-0660-SD	X		X	X	X	X	X	X	X				X
Resample @ Phase I L12-038	0 to 0.5	L12-224	L12sd-224-0661-SD	X		X	X	X	X	X	X	X				X
Resample @ Phase I L12-039	0 to 0.5	L12-225	L12sd-225-0662-SD	X		X	X	X	X	X	X	X				X
Downstream Sediment (6 - TBD)	0 to 0.5	L12-226	L12sd-226-0663-SD	X		X	X	X	X	X	X	X				X
	0 to 0.5	L12-227	L12sd-227-0664-SD	X		X	X	X	X	X	X	X				X
	0 to 0.5	L12-228	L12sd-228-0665-SD	X		X	X	X	X	X	X	X				X
	0 to 0.5	L12-229	L12sd-229-0666-SD	X		X	X	X	X	X	X	X				X
	0 to 0.5	L12-230	L12sd-230-0667-SD	X		X	X	X	X	X	X	X				X
	0 to 0.5	L12-231	L12sd-231-0668-SD	X		X	X	X	X	X	X	X				X
TOTALS		24 Stations	24 Samples	24	2	24	24	24	24	24	24	24				24
FIELD DUPLICATES = 3 TOTAL				3	1	3	3	3	3	3	3	3				
USACE QA SPLIT SAMPLES = 3 TOTAL				3	1	3	3	3	3	3	3	3				
TRIP BLANKS = 0																
FIELD BLANKS = 0																
EQUIPMENT RINSATES = 0																

Table 5-2. Load Line 12 Phase II RI Sediment and Surface Water Baseline Sample Identification List

AREA (No. Stations)	Depth (ft)	Sample Station ID	Sample ID	CHEMICAL ANALYSES									GEOTECHNICAL ANALYSES <sup>a</sup>				
				Explosives	Propellants	TAL Metals	VOCs	SVOCs	Pest./PCBs	Cyanide	Nitrate	TOC	Suite 1	Suite 2	Suite 3	Suite 4	
Surface Water Stations																	
Bldg. FF-19	NA	L12-208	L12sw-208-0669-SW	X	Two propellant samples (10% of total) to be collected. Locations are TBD based on field observations. Surface water propellant samples will be co-located with the two sediment propellant samples.	X	X	X	X	X	X						
	NA	L12-209	L12sw-209-0670-SW	X		X	X	X	X	X	X						
Bldg. FN-54	NA	L12-210	L12sw-210-0671-SW	X		X	X	X	X	X	X						
	NA	L12-211	L12sw-211-0672-SW	X		X	X	X	X	X	X						
Bldg. 900	NA	L12-212	L12sw-212-0673-SW	X		X	X	X	X	X	X						
	NA	L12-213	L12sw-213-0674-SW	X		X	X	X	X	X	X						
Bldg. 905	NA	L12-214	L12sw-214-0675-SW	X		X	X	X	X	X	X						
	NA	L12-215	L12sw-215-0676-SW	X		X	X	X	X	X	X						
	NA	L12-216	L12sw-216-0677-SW	X		X	X	X	X	X	X						
	NA	L12-217	L12sw-217-0678-SW	X		X	X	X	X	X	X						
TBD Sanitary Sewer Lines (2) <sup>b</sup>	NA	TBD	L12sw-TBD-0679-SW	X		X	X	X	X	X	X						
	NA	TBD	L12sw-TBD-0680-SW	X		X	X	X	X	X	X						
Resample @ Phase I L12-031	0 to 0.5	L12-223	L12sw-223-0681-SW	X		X	X	X	X	X	X						
Resample @ Phase I L12-038	0 to 0.5	L12-224	L12sw-224-0682-SW	X		X	X	X	X	X	X						
Resample @ Phase I L12-039	0 to 0.5	L12-225	L12sw-225-0683-SW	X		X	X	X	X	X	X						
Downstream Sediment (TBD)	0 to 0.5	L12-226	L12sw-226-0684-SW	X		X	X	X	X	X	X						
	0 to 0.5	L12-227	L12sw-227-0685-SW	X	X	X	X	X	X	X							
	0 to 0.5	L12-228	L12sw-228-0686-SW	X	X	X	X	X	X	X							
	0 to 0.5	L12-229	L12sw-229-0687-SW	X	X	X	X	X	X	X							
	0 to 0.5	L12-230	L12sw-230-0688-SW	X	X	X	X	X	X	X							
	0 to 0.5	L12-231	L12sw-231-0689-SW	X	X	X	X	X	X	X							
TOTALS		21 Stations	21 Samples	21	2	21	21	21	21	21	21						
FIELD DUPLICATES = 2 TOTAL				2	0	2	2	2	2	2	2						
USACE QA SPLIT SAMPLES = 2 TOTAL				2	0	2	2	2	2	2	2						
TRIP BLANKS = 5																	
FIELD/SOURCE WATER BLANK = 1																	
EQUIPMENT RINSATES = 0																	

<sup>a</sup> Suite 1 = Moisture content, grain size, USCS, and Atterberg Limits.

Suite 2 = Moisture content, grain size, USCS, Atterberg Limits, and hydrometer analysis.

Suite 3 = Moisture content, grain size (sieve only), USCS, Atterberg Limits, hydraulic conductivity, hydrometer, specific gravity, bulk density, porosity, pH, redox potential, and total organic carbon by chemical analysis.

Suite 4 = USCS, grain size (sieve only), and total organic carbon by chemical analysis.

<sup>b</sup> To be co-located at two sewer line sediment sampling stations based on observed field conditions.

Table 5-3. Load Line 12 Phase II RI Groundwater Baseline Sample Identification List

AREA (No. Stations)	Depth (ft)	Sample Station ID	Sample ID	CHEMICAL ANALYSES							
				Explosives	Propellants	Filtered TAL Metals	VOCs	SVOCs	Pest./PCBs	Cyanide	Nitrate
Bldg. FF-19 (1)	NA	L12mw-088	L12mw-088-0690-GW	X	X		X	X	X	X	X
			L12mw-088-0691-GF			X					
Bldg. FN-54 (1)	NA	L12mw-107	L12mw-107-0692-GW	X	X		X	X	X	X	X
			L12mw-107-0693-GF			X					
Bldg. 900 (1)	NA	L12mw-113	L12mw-113-0694-GW	X	X		X	X	X	X	X
			L12mw-113-0695-GF			X					
Bldg. 905 (1)	NA	L12mw-128	L12mw-128-0696-GW	X	X		X	X	X	X	X
			L12mw-128-0697-GF			X					
Bldg. 904 (2)	NA	L12mw-153	L12mw-153-0698-GW	X	X		X	X	X	X	X
			L12mw-153-0699-GF			X					
	NA	L12mw-154	L12mw-154-0700-GW	X	X		X	X	X	X	X
			L12mw-154-0701-GF			X					
TBD Monitoring Wells (8)	NA	L12mw-182	L12mw-182-0702-GW	X	X		X	X	X	X	X
			L12mw-182-0703-GF			X					
	NA	L12mw-183	L12mw-183-0704-GW	X	X		X	X	X	X	X
			L12mw-183-0705-GF			X					
	NA	L12mw-184	L12mw-184-0706-GW	X	X		X	X	X	X	X
			L12mw-184-0707-GF			X					
	NA	L12mw-185	L12mw-185-0708-GW	X	X		X	X	X	X	X
			L12mw-185-0709-GF			X					
	NA	L12mw-186	L12mw-186-0710-GW	X	X		X	X	X	X	X
			L12mw-186-0711-GF			X					
	NA	L12mw-187	L12mw-187-0712-GW	X	X		X	X	X	X	X
			L12mw-187-0713-GF			X					
	NA	L12mw-188	L12mw-188-0714-GW	X	X		X	X	X	X	X
			L12mw-188-0715-GF			X					
	NA	L12mw-189	L12mw-189-0716-GW	X	X		X	X	X	X	X
			L12mw-189-0717-GF			X					
<b>TOTALS</b>		<b>14 Stations</b>	<b>28 Samples</b>	<b>14</b>	<b>14</b>	<b>14</b>	<b>14</b>	<b>14</b>	<b>14</b>	<b>14</b>	<b>14</b>
FIELD DUPLICATES = 2 TOTAL				2	2	2	2	2	2	2	2
USACE QA SPLIT SAMPLES = 2 TOTAL				2	2	2	2	2	2	2	2
TRIP BLANKS = 4							4				
FIELD/SOURCE WATER BLANK = 1				1	1	1	1	1	1	1	1
EQUIPMENT RINSATES = 1				1	1	1	1	1	1	1	1

## **5.7 MONTHLY REPORTS**

Monthly reports during implementation of the Phase II RI field investigation are not specified by contract. However, monthly reports for the Load Line 12 Phase II delivery order in general will be provided as a best management practice. The content of the reports will have content similar to that specified in Section 5.7 of the Facility-wide SAP.



## **6.0 SAMPLE PACKAGING AND SHIPPING REQUIREMENTS**

Sample packaging and shipping shall generally follow Chapter 6.0 of the Facility-wide SAP. Because the analytical laboratory is located less than 80 km (50 miles) from the site, the contract laboratory will provide same-day pickup of coolers containing samples. This will reduce the need for some of the packaging measures described in the Facility-wide SAP, which are intended for air-shipped coolers. Specifically:

- Chain-of-custody forms can be hand-carried by the courier to the laboratory.
- No airbills will be attached to couriered coolers.
- “THIS END UP” and “FRAGILE” stickers will not be required for containers transported by courier.

Coolers containing QA samples that are shipped to the USACE contract laboratory for independent analysis will be prepared and shipped in accordance with the Facility-wide SAP.

Geotechnical samples do not require refrigeration or other preservation, and will be shipped to the contract laboratory at the conclusion of the sampling effort by conventional methods.

## 7.0 INVESTIGATION-DERIVED WASTE

All IDW, including auger cuttings, personal protective equipment (PPE), disposable sampling equipment, and decontamination fluids, will be properly handled, labeled, characterized, and managed in accordance with Chapter 7.0 of the Facility-wide SAP. At the conclusion of field activities for the Load Line 12 Phase II RI, a letter report will be submitted to the USACE and RVAAP Environmental Coordinator documenting the characterization and classification of the wastes. Upon approval of the IDW classification report, all solid and liquid IDW, including solvent wastes from the field colorimetry laboratory, will be removed from the site and disposed of by a licensed waste disposal contractor. All shipments of IDW off site will be coordinated through the RVAAP Environmental Coordinator.

Five types of IDW are anticipated, which will be contained separately. The types and estimated quantities for each include:

- Soil and sediment, including residual surface and subsurface soil following sample homogenization and collection, drill cuttings, and residual sediment following sample homogenization and collection. An estimated 26, 55-gallon drums of soil and sediment IDW are anticipated.
- Development and purge water from monitoring wells. An estimated 16, 55-gallon drums of groundwater IDW are anticipated.
- Decontamination fluids, including those derived from decontamination of sampling equipment and drilling equipment. An estimated 1,500 gallons of decontamination fluid are anticipated.
- Field colorimetry laboratory liquid wastes, including spent reagents and decontamination water. One 55-gallon drum of this type of IDW is anticipated.
- Expendables/solid wastes, including PPE and disposable sampling equipment. Two 55-gallon drums of expendable IDW are anticipated.

Characterization and classification the different types of IDW will be based on the specific protocols described below. Expendable solid waste will be not sampled for characterization purposes.

- **Soils:** At locations where soil sampling is performed, any holes or borings below the ground surface will be filled with bentonite granules to ground surface to prevent vertical migration of any potential contamination. Drill cutting and any excess soil not used for samples will be placed in 55-gallon drums. Disposition of the drummed soil will be based on analytical results of environmental samples. Toxicity characteristic leaching procedure (TCLP) samples will be collected if analytical data indicate that the contents of a drum are potentially hazardous.
- **Sediment:** At locations where sediment sampling results in a hole that remains open, bentonite granules will be placed in the hole to ground surface. If the hole collapses or is under water, no additional measures will be taken with the hole. Any excess sediment not used for samples will be placed in 55-gallon drums. Disposition of the drummed sediment will be based on analytical results of environmental samples. A TCLP sample will be collected if analytical data indicate that the contents of the drum containing residual sediment are potentially hazardous.

- **IDW Water:** Development water from newly installed wells, purge water, and excess water not used for environmental samples will be placed in 55-gallon drums. Disposition will be based on the analytical results of the environmental samples. If results indicate that IDW water is potentially hazardous, TCLP samples will be collected.
- **Decontamination Fluids:** Decontamination fluids will be placed in drums or a polytank up to 1,500 gallons in size as needed. Disposition of decontamination liquid will be based on the collection and analysis of TCLP liquid sample(s).
- **Field Colorimetry Laboratory Liquid Wastes:** These fluids will be managed and characterized as noted above for decontamination fluids. In addition, process knowledge will be used to also characterize and classify the waste (i.e., notation of any RCRA-listed hazardous spent reagents added to the IDW container).

Drummed soil, sediment, and IDW water will be transported to Building 1036, where it will be staged on wooden pallets. Decontamination fluids and field laboratory wastes will also be staged at Building 1036 within secondary containment structures. To avoid potential drum rupture due to freezing conditions, Building 1036 will be weather-proofed to the extent possible. Also, drums containing liquid IDW will be filled only 75% capacity.

## 8.0 REFERENCES

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**APPENDIX A**

**SELECTED RESULTS FROM**

**PREVIOUS ENVIRONMENTAL INVESTIGATIONS**

**AT**

**LOAD LINE 12**

**[PHASE I REMEDIAL INVESTIGATION (1998)]**

Table A-1. Load Line 12 Analytical Results (Surface Soil and Sediment)

Analyte	Units	Frequency of Detects	Background Criteria	Detects > Background	Minimum Detect	Maximum Detect	USGS Value	Site Related?	Justification
<i>Surface Soil</i>									
Cyanide	mg/kg	6/ 8	.		0.15	1.6		Yes	No Background Data Available
1,3,5-Trinitrobenzene	µg/kg	3/ 30	.		250	4600		Yes	No Background Data Available
2,4,6-Trinitrotoluene	µg/kg	18/ 30	.		450	19000000		Yes	Detected > 5% of Samples
2,4-Dinitrotoluene	µg/kg	1/ 30	.		13000	13000		Yes	Detected > 5% of Samples
HMX	µg/kg	6/ 30	.		1300	180000		Yes	No Background Data Available
RDX	µg/kg	8/ 30	.		2800	6800000		Yes	No Background Data Available
Aluminum	mg/kg	30/ 30	15600	3/ 30	2190	105000	20000 - 100000	Yes	> 5% Detect Above Background
Antimony	mg/kg	2/ 8	.		0.86	5.9		Yes	No Background Data Available
Arsenic	mg/kg	30/ 30	19.6	0/ 30	4	17.4	5.2 - 27.0	No	Below Background
Barium	mg/kg	30/ 30	75	16/ 30	20.2	274	300 - 700	Yes	> 5% Detect Above Background
Beryllium	mg/kg	8/ 8	.		0.27	1.5	1.5 - 2.0	Yes	No Background Data Available
Cadmium	mg/kg	27/ 30	0.29	16/ 30	0.09	6.6	1 - 2	Yes	> 5% Detect Above Background
Calcium	mg/kg	8/ 8	.		2390	171000	1100 - 31000	No	Essential Nutrient
Chromium	mg/kg	30/ 30	18.7	7/ 30	7	163	15.0 - 100.0	Yes	> 5% Detect Above Background
Cobalt	mg/kg	8/ 8	.		3.6	13.8	7 - 20	Yes	No Background Data Available
Copper	mg/kg	8/ 8	.		14.8	3610	7.0 - 70.0	Yes	No Background Data Available
Iron	mg/kg	8/ 8	.		13700	26700	15000 - 50000	No	Essential Nutrient

Table A-1. Load Line 12 Analytical Results (Surface Soil and Sediment) (continued)

Analyte	Units	Frequency of Detects	Background Criteria	Detects > Background	Minimum Detect	Maximum Detect	USGS Value	Site Related?	Justification
Lead	mg/kg	30/ 30	17.9	25/ 30	13.2	589	15 - 30	Yes	> 5% Detect Above Background
Magnesium	mg/kg	8/ 8	.		937	22500	3000 - 15000	No	Essential Nutrient
Manganese	mg/kg	30/ 30	728	3/ 30	42.7	1760	150 - 1000	Yes	> 5% Detect Above Background
Mercury	mg/kg	13/ 30	0.08	2/ 30	0.04	0.32	0.03 - 0.22	Yes	> 5% Detect Above Background
Nickel	mg/kg	8/ 8	.		10.2	199	15 - 50	Yes	No Background Data Available
Potassium	mg/kg	8/ 8	.		404	1130	11800 - 25100	No	Essential Nutrient
Selenium	mg/kg	28/ 30	2.6	0/ 30	0.34	2.2	<0.1 - 1.2	No	Below Background
Silver	mg/kg	3/ 30	0.24	3/ 30	0.5	4.7	0.7	Yes	> 5% Detect Above Background
Sodium	mg/kg	8/ 8	.		167	370	5000 - 7000	No	Essential Nutrient
Thallium	mg/kg	7/ 8	.		0.91	4.3		Yes	No Background Data Available
Vanadium	mg/kg	8/ 8	.		5.7	26.9	20 - 150	Yes	No Background Data Available
Zinc	mg/kg	30/ 30	72.1	18/ 30	33.9	1030	25 - 110	Yes	> 5% Detect Above Background
4,4'-DDE	µg/kg	2/ 8	.		4.9	39		Yes	No Background Data Available
4,4'-DDT	µg/kg	3/ 8	.		3.5	25		Yes	No Background Data Available
Alpha chlordane	µg/kg	2/ 8	.		20	38		Yes	No Background Data Available
Aroclor-1254	µg/kg	2/ 8	.		760	1700		Yes	No Background Data Available
Aroclor-1260	µg/kg	1/ 8	.		2600	2600		Yes	No Background Data Available
Endosulfan II	µg/kg	1/ 8	.		3.3	3.3		Yes	No Background Data Available
Endrin	µg/kg	6/ 8	.		4.7	110		Yes	No Background Data Available



**Table A-1. Load Line 12 Analytical Results (Surface Soil and Sediment) (continued)**

<b>Analyte</b>	<b>Units</b>	<b>Frequency of Detects</b>	<b>Background Criteria</b>	<b>Detects &gt; Background</b>	<b>Minimum Detect</b>	<b>Maximum Detect</b>	<b>USGS Value</b>	<b>Site Related?</b>	<b>Justification</b>
Endrin aldehyde	µg/kg	1/ 8	.		31	31		Yes	No Background Data Available
Endrin ketone	µg/kg	1/ 8	.		38	38		Yes	No Background Data Available
Gamma chlordane	µg/kg	2/ 8	.		7.2	38		Yes	No Background Data Available
Gamma-BHC (lindane)	µg/kg	1/ 8	.		15	15		Yes	No Background Data Available
Heptachlor	µg/kg	2/ 8	.		1.9	8.1		Yes	No Background Data Available
Heptachlor epoxide	µg/kg	1/ 8	.		2.8	2.8		Yes	No Background Data Available
Methoxychlor	µg/kg	1/ 8	.		47	47		Yes	No Background Data Available
1,2,4-Trichlorobenzene	µg/kg	1/ 8	.		85	85		Yes	No Background Data Available
2-Methylnaphthalene	µg/kg	4/ 8	.		81	260		Yes	No Background Data Available
Acenaphthene	µg/kg	5/ 8	.		44	2700		Yes	No Background Data Available
Acenaphthylene	µg/kg	2/ 8	.		81	280		Yes	No Background Data Available
Anthracene	µg/kg	5/ 8	.		120	8700		Yes	No Background Data Available
Benzo(a)anthracene	µg/kg	6/ 8	.		240	14000		Yes	No Background Data Available
Benzo(a)pyrene	µg/kg	6/ 8	.		240	12000		Yes	No Background Data Available
Benzo(b)fluoranthene	µg/kg	5/ 8	.		290	11000		Yes	No Background Data Available
Benzo(g,h,i)perylene	µg/kg	6/ 8	.		160	8500		Yes	No Background Data Available
Benzo(k)fluoranthene	µg/kg	6/ 8	.		170	14000		Yes	No Background Data Available

Table A-1. Load Line 12 Analytical Results (Surface Soil and Sediment) (continued)

Analyte	Units	Frequency of Detects	Background Criteria	Detects > Background	Minimum Detect	Maximum Detect	USGS Value	Site Related?	Justification
Bis(2-ethylhexyl)phthalate	µg/kg	4/ 8	.		40	220		Yes	Detected > 5% of Samples
Carbazole	µg/kg	5/ 8	.		110	3800		Yes	No Background Data Available
Chrysene	µg/kg	6/ 8	.		240	13000		Yes	No Background Data Available
Dibenzo(a,h)anthracene	µg/kg	6/ 8	.		66	4400		Yes	No Background Data Available
Dibenzofuran	µg/kg	4/ 8	.		280	1900		Yes	No Background Data Available
Fluoranthene	µg/kg	7/ 8	.		73	30000		Yes	No Background Data Available
Fluorene	µg/kg	5/ 8	.		42	3200		Yes	No Background Data Available
Indeno(1,2,3-cd)pyrene	µg/kg	6/ 8	.		130	9200		Yes	No Background Data Available
Naphthalene	µg/kg	3/ 8	.		130	270		Yes	No Background Data Available
Phenanthrene	µg/kg	6/ 8	.		140	23000		Yes	No Background Data Available
Pyrene	µg/kg	6/ 8	.		380	25000		Yes	No Background Data Available
Acetone	µg/kg	2/ 6	.		55	99		Yes	No Background Data Available
Toluene	µg/kg	2/ 7	.		7	16		Yes	Detected > 5% of Samples
<i>Sediment</i>									
Cyanide	mg/kg	1/ 3	.		1.4	1.4		Yes	No Background Data Available
1,3,5-Trinitrobenzene	µg/kg	1/ 19	.		660	660		Yes	No Background Data Available
2,4,6-Trinitrotoluene	µg/kg	5/ 19	.		160	170000		Yes	Detected > 5% of Samples
Aluminum	mg/kg	19/ 19	15600	1/ 19	6870	18500	20000 - 100000	Yes	> 5% Detect Above Background

**Table A-1. Load Line 12 Analytical Results (Surface Soil and Sediment) (continued)**

Analyte	Units	Frequency of Detects	Background Criteria	Detects > Background	Minimum Detect	Maximum Detect	USGS Value	Site Related?	Justification
Antimony	mg/kg	1/ 3	.		2.6	2.6		Yes	No Background Data Available
Arsenic	mg/kg	19/ 19	19.6	3/ 19	4	217	5.2 - 27.0	Yes	> 5% Detect Above Background
Barium	mg/kg	19/ 19	75	5/ 19	26.7	170	300 - 700	Yes	> 5% Detect Above Background
Beryllium	mg/kg	3/ 3	.		0.66	2.5	1.5 - 2.0	Yes	No Background Data Available
Cadmium	mg/kg	18/ 19	0.29	11/ 19	0.09	2	1 - 2	Yes	> 5% Detect Above Background
Calcium	mg/kg	3/ 3	.		2710	4510	1100 - 31000	No	Essential Nutrient
Chromium	mg/kg	19/ 19	18.7	5/ 19	8.2	27.7	15.0 - 100.0	Yes	> 5% Detect Above Background
Cobalt	mg/kg	3/ 3	.		8	27.7	7 - 20	Yes	No Background Data Available
Copper	mg/kg	3/ 3	.		28.9	399	7.0 - 70.0	Yes	No Background Data Available
Iron	mg/kg	3/ 3	.		19400	48800	15000 - 50000	No	Essential Nutrient
Lead	mg/kg	19/ 19	17.9	12/ 19	10.3	88.7	15 - 30	Yes	> 5% Detect Above Background
Magnesium	mg/kg	3/ 3	.		2160	2420	3000 - 15000	No	Essential Nutrient
Manganese	mg/kg	19/ 19	728	1/ 19	53.7	1170	150 - 1000	Yes	> 5% Detect Above Background
Mercury	mg/kg	8/ 19	0.08	6/ 19	0.06	1.2	0.03 - 0.22	Yes	> 5% Detect Above Background
Nickel	mg/kg	3/ 3	.		19	59.7	15 - 50	Yes	No Background Data Available
Potassium	mg/kg	3/ 3	.		800	1050	11800 - 25100	No	Essential Nutrient
Selenium	mg/kg	16/ 19	2.6	0/ 19	0.41	2.4	<0.1 - 1.2	No	Below Background
Silver	mg/kg	2/ 19	0.24	2/ 19	0.47	58	0.7	Yes	> 5% Detect Above Background
Sodium	mg/kg	3/ 3	.		287	654	5000 - 7000	No	Essential Nutrient
Thallium	mg/kg	3/ 3	.		0.74	2.4		Yes	No Background Data Available

**Table A-1. Load Line 12 Analytical Results (Surface Soil and Sediment) (continued)**

<b>Analyte</b>	<b>Units</b>	<b>Frequency of Detects</b>	<b>Background Criteria</b>	<b>Detects &gt; Background</b>	<b>Minimum Detect</b>	<b>Maximum Detect</b>	<b>USGS Value</b>	<b>Site Related?</b>	<b>Justification</b>
Vanadium	mg/kg	3/ 3	.		16.1	22.7	20 - 150	Yes	No Background Data Available
Zinc	mg/kg	19/ 19	72.1	16/ 19	57.3	794	25 - 110	Yes	> 5% Detect Above Background
Aroclor-1254	µg/kg	1/ 3	.		310	310		Yes	No Background Data Available
Heptachlor	µg/kg	1/ 3	.		1.9	1.9		Yes	No Background Data Available
Anthracene	µg/kg	1/ 3	.		350	350		Yes	No Background Data Available
Benzo(a)anthracene	µg/kg	1/ 3	.		460	460		Yes	No Background Data Available
Benzo(a)pyrene	µg/kg	1/ 3	.		340	340		Yes	No Background Data Available
Benzo(b)fluoranthene	µg/kg	1/ 3	.		320	320		Yes	No Background Data Available
Benzo(g,h,i)perylene	µg/kg	1/ 3	.		240	240		Yes	No Background Data Available
Benzo(k)fluoranthene	µg/kg	1/ 3	.		350	350		Yes	No Background Data Available
Chrysene	µg/kg	1/ 3	.		620	620		Yes	No Background Data Available
Fluoranthene	µg/kg	1/ 3	.		1600	1600		Yes	No Background Data Available
Indeno(1,2,3-cd)pyrene	µg/kg	1/ 3	.		280	280		Yes	No Background Data Available
N-nitrosodiphenylamine	µg/kg	1/ 3	.		2000	2000		Yes	No Background Data Available
Phenanthrene	µg/kg	1/ 3	.		540	540		Yes	No Background Data Available
Pyrene	µg/kg	1/ 3	.		980	980		Yes	No Background Data Available
2-Butanone	µg/kg	1/ 3	.		440	440		Yes	No Background Data Available

**Table A-1. Load Line 12 Analytical Results (Surface Soil and Sediment) (continued)**

<b>Analyte</b>	<b>Units</b>	<b>Frequency of Detects</b>	<b>Background Criteria</b>	<b>Detects &gt; Background</b>	<b>Minimum Detect</b>	<b>Maximum Detect</b>	<b>USGS Value</b>	<b>Site Related?</b>	<b>Justification</b>
Acetone	µg/kg	2/ 3	.		150	870		Yes	No Background Data Available
Carbon disulfide	µg/kg	1/ 3	.		180	180		Yes	No Background Data Available

## **APPENDIX B**

### **FIELD COLORIMETRIC ANALYTICAL PROCEDURE**

## STANDARD OPERATING PROCEDURE FOR FIELD COLORIMETRIC ANALYSIS OF EXPLOSIVES FOR RAVENNA ARMY AMMUNITION PLANT, RAVENNA, OHIO

### 1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to provide directions for in the field chemical determination of the presence of 2,4,6-trinitrotoluene (TNT) and hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX) in soil and sediment. This procedure will allow the quantification of these two compounds using a battery operated spectrophotometer by experienced analytical personnel.

The resulting data is intended to provide information that meets DQOs for field screening for the purpose of expedient field operation decisions. The resulting data will not meet DQOs necessary for risk assessment nor be stand-alone for feasibility studies.

### 2.0 METHOD SUMMARY

A 20 gram aliquot of undried sample is placed in an appropriate size container and extracted with 100 ml of acetone. After filtration and color development the background and developed color is measured at the appropriate wavelength on the spectrophotometer. After subtraction of the background color the concentration of the target compound is determined based on the absorbance measurement from the spectrophotometer.

Two separate color developments and absorbance measurements are required for the determination of TNT and RDX by this procedure. TNT detection and quantification is based on the spectrophotometric measurement at 540 nm of the red color complex resulting from the addition of potassium hydroxide (KOH) and sodium sulfite ( $\text{Na}_2\text{SO}_3$ ) to the filtered acetone extract. RDX detection and quantification is based on the spectrophotometric measurement at 507 nm the red color complex resulting from the derivitization of the acetone extract with acetic acid and zinc and subsequent color development with commercially available HACH NitroVer 3 reagent.

The method concentration range for the compounds is typically 1 – 30 ppm for TNT and 2.5 – 35 ppm for RDX, wet weight. The actual range found will be dependent on the individual instrumentation and the cuvet diameter. The actual reportable concentration range needs to be determined on a project by project basis.

### 3.0 REFERENCES

- 3.1 Jenkins, T.F. (1990), “Development of a Simplified Field Method for the Determination of TNT in Soil”, U.S. Cold Regions Research and Engineering Laboratory, Special Report 90-30.
- 3.2 RVAAP Site Wide SAP, July 2000
- 3.3 RVAAP Site Wide QAPP, July 2000  
Science Applications International Corporation Quality Assurance Administrative Procedures (SAIC QAAPs).
- 3.4 Environmental Compliance Branch Standard Operating Procedures and Quality Assurance Manual, U.S. EPA, Region IV Environmental Services Division, February, 1991.

Science Applications International Corporation Field Technical Procedure (SAIC TFP) May 5, 1995.

- 3.5 Jenkins, T.F., and Walsh, M.E. (1993). “Determination of TNT/RDX in Soils Using Colorimetry”, U.S. Cold Regions Research and Engineering Laboratory.

#### **4.0 RESPONSIBILITIES**

##### **4.1 Contractor Program Manager**

The Program Manager is responsible for approving this procedure.

##### **4.2 Contractor Quality Assurance/Quality Control (QA/QC) Officer**

The QA/QC Officer is responsible for approving this procedure and verifying that this procedure is being implemented.

##### **4.3 Contractor Health and Safety (H&S) Officer**

The H&S Officer is responsible for ensuring that appropriate and contractual H&S policies and procedures are in effect and verify enforcement of same by line management.

##### **4.4 Contractor Program or Project Manager**

The Program or Project Manager is responsible for:

- designating a qualified person to train personnel who will be using this procedure
- ensuring that this and all appropriate procedures are followed
- the interpretation of these operating instructions
- verifying that the appropriate training records are submitted to the Central Records Facility

##### **4.5 Contractor Field Sampling Team Leader**

The Field Sampling Team Leader is responsible for:

- assigning field sampling team members
- coordinating and preparing for field sampling and field analytical activities by ensuring compliance with the SAP and field procedures (including operating instructions)
- ensuring that the field sampling team members and the field analysts are appropriately trained and the training is properly documented
- overall management of field activities.

##### **4.6 Contractor Field Sampling Team Members**

The field sampling team members are responsible for:

- assisting the field sampling team leader in selecting locations and intervals for sampling as identified in the SAP



- collecting the required field samples, appropriately documenting sample collection activities, properly labeling samples, and delivering samples to the field analysts

#### **4.7 Contractor Field Analysts**

The field analysts are responsible for:

- implementation of and adherence to this field analytical procedure
- performing appropriate calibrations
- analyzing samples
- performing QC analysis
- maintaining analytical equipment
- documenting information according to the steps defined in this procedure.

### **5.0 GENERAL INFORMATION**

- 5.1** Any deviation from this procedure's requirements will be justified to and authorized by the Contractor Project Manager or Program Manager.
- 5.2** Deviations from this procedure's requirements must be sufficiently documented to allow re-creation of the modified process.
- 5.3** Refer to and implement the site- or project-specific H&S Plan for relevant H&S requirements.
- 5.4** Refer to and implement the project-specific SAP for relevant sampling and analysis requirements.
- 5.5** It is RVAAP policy to maintain an effective program to control employee exposure to chemical, radiological, and physical stress which is consistent with U.S. Occupational Safety and Health Administration (OSHA) established standards and requirements.
- 5.6** Refer to and implement the site- or project-specific Waste Management Plan for relevant waste and waste disposal requirements.
- 5.7** Subcontractor personnel who implement this procedure must provide documented evidence of having been trained in the procedure to the Program Manager of Project Manager in accordance with subsection 4.5.
- 5.8** Data Quality Objectives (DQOs) for field analyses should be identified in project-specific documents (i.e., SAP, QAPP). As presented, this procedure provides appropriate guidance to produce quantitative screening data. QC includes multi-level calibration, method blank information, and control sample analysis. Duplicate analytical information is optional.
- 5.9** Sample analytical reports and QC information will be provided to the Sampling Team Leader daily. In addition, sample results may be requested as determined by the Sampling Team Leader.
- 5.10** Upon completion of a project, final data packages will be assembled including but not limited to; analytical results, QC data, calibration information, and a written summary of each day's activities.

- 5.11** For additional information regarding instrument calibration, adjustment, maintenance, or replacement components, consult the manufacturer's instruction and operational manuals.
- 5.12** Sampling equipment needed for the collection of soils and sediments will vary depending on project requirements and will be identified in the project-specific SAP.
- 5.13** The analyst must be capable of making judgment calls and technical decisions based upon a clear understanding of Beer Lambert's Law, dilutions; along with the ability to execute proper analytical measurement techniques.

## **6.0 INTERFERENCES**

- 6.1** Several other nitroaromatic compounds have been investigated which develop a visible color when processed through the procedure and measured at 540 nm; Tetryl (orange), TNB (red), DNB (purple) and 2,4,6-DNT (pink). These compounds, if present, may contribute to the sample absorbance and be calculated as TNT.
- 6.2** Similar color development was not observed for other nitroaromatics, e.g., RDX, HMX, nitrobenzene o-nitrotoluene, m-nitrotoluene, p-nitrotoluene, nitroglycerine, 4-amino-2,6-dinitrotoluene or 2-amino-4,6-dinitrotoluene, with the TNT method. These compounds, if present, would not contribute to the color intensity at 540 nm.
- 6.3** Humic organic matter in soil is extracted to some degree with the TNT method and yields a yellow color that becomes darker upon addition of the procedure's reagents. The contribution of this interference is estimated and accounted for with the background correction step outlined in this procedure.
- 6.4** Percentage of H<sub>2</sub>O (ice and water) in soil samples can alter the color development time. In addition, results should be noted as wet weight.
- 6.5** The Griess Reaction that produces the red azo dye in the RDX determination will also produce similarly-colored products if HMX, nitroglycerine, nitrocellulose, PETN, or nitroguanidine are present in the soil. This reaction keys on the presence of organo-nitrates and may give false positive results for RDX in samples from areas where destruction of explosives has occurred as a result of detonation or burning.
- 6.6** Humic substances that produce a background yellow color in the acetone extract are removed when the extract is acidified with acetic acid and filtered prior to RDX determination. Therefore, there is no requirement to obtain and subtract an initial absorbance from the final absorbance after color development.

## **7.0 SAFETY INFORMATION**

- 7.1** Normal safety precautions associated with laboratory use of a flammable organic solvent should be employed.
- 7.2** Acetone and acetone solutions spilled on skin should be rapidly rinsed off with water.

- 7.3** Organic solvents and solvent wastes must be stored separately from strong oxidizers (e.g., nitric acid) and never mixed with them.
- 7.4** Flammable materials must be stored in approved containers and locations.
- 7.5** Eye protection must be worn at all times and by all individuals entering the field laboratory area.

## **8.0 INSTRUMENTS AND SUPPLIES**

### **8.1 Instrumentation**

Spectrophotometer – Fixed wavelength, battery-operated (e.g., HACH DR 2000) or for standard 110 v electrical if available at the project. Need a measurement path width of 25 mm (1 in.) for maximum sensitivity.

- 8.1.2** Balance – Accurate to 0.1 gram or better. Electrical (e.g., 110 v plug in) or battery-operated preferred. Mechanical is acceptable, but calibration check needs to be performed more frequently.

### **8.2 Chemicals and Reagents**

- 8.2.1** TNT – Traceable to a known quality SARM, provided commercially as a certified grade neat material, or standard of known concentration in a known solvent. (Typically from commercial standards preparation as 1,000 ppm in acetone or methanol. Prefer 5,000 to 10,000 ppm if available.)

- 8.2.2** RDX – Traceable to a known quality SARM, provided commercially as a certified grade neat material, or standard of known concentration in a known compatible solvent. (Typically available as 1,000 ppm in acetonitrile; prefer as 5,000 or 10,000 ppm in acetone or methanol.)

- 8.2.3** Acetone – Commercially available as reagent grade from chemical suppliers. Also available off-the-shelf from local hardware or paint stores.

Caution – Acetone is a volatile solvent and must be used only in a well ventilated temperature controlled environment.

Caution – Acetone is often a site contaminant of concern. As such, both analyst and sampling personnel must be aware of its presence and potential impact for cross contamination of samples destined for volatile organic analyses.

- 8.2.4** Glacial Acetic Acid – Reagent grade from chemical supplier.
- 8.2.5** Potassium Hydroxide – Reagent grade pellets
- 8.2.6** Sodium Sulfite – Granular, reagent grade.
- 8.2.7** Zinc – Metal powder, reagent grade. Note: Must be kept dry in a dessicator.
- 8.2.8** Clean Sand – Sand being used for well construction or commercially available play sand that has been acetone washed.

**8.2.9** Water Deionized – Commercially available from chemical supplier or off-the-shelf from local drug or food stores.

**8.2.10** HACH NitroVer 3 Powder Pillow.

### **8.3 Supplies**

Caution – Acetone is a strong solvent that readily dissolves a majority of plastics. If substitutions are made to the following items, be sure they are compatible with acetone (i.e., polypropylene, nylon, glass, or Teflon) and do not attribute any color, turbidity or organo-nitrate materials.

#### **8.3.1** Bottles

- 250-ml polypropylene bottles with screw top caps.
- 30-ml polypropylene bottle and screw cap.

#### **8.3.2** Squeeze wash bottles with hazard label:

- 1 liter deionized water
- 1 liter acetone

#### **8.3.3** Serological Pipettes

- 2 ml
- 10 ml

#### **8.3.4** Pipette Bulbs – Safety pipette filters

#### **8.3.5** Transfer Pipettes and Tips

- 10 ml repipet sampling pipettes
- 10 ml repipet sampling Pipettes Tip pkg 100

#### **8.3.6** Volumetric Flasks

- 50 ml polypropylene
- 100 ml polypropylene
- 25 ml glass

#### **8.3.7** Graduated Cylinders

- 10 ml polypropylene
- 50 ml polypropylene
- 100 ml polypropylene

#### **8.3.8** Syringes

- 0.250 ml Hamilton Gastight fixed needle
- 2.50 ml Hamilton Gastight fixed needed
- 60 ml; Luer-Lock disposable syringes

#### **8.3.9** Syringe Filters

- 25 mm; 0.45 nm nylon filters in polypropylene housing; Luer Lock fitting (Milex SR; Whatman GD/X or equivalent)

#### **8.3.10** Spectrophotometer Cuvetts

- 3 – matched pairs; 25 mm path length compatible with spectrophotometer

### 8.3.11 Tongue Depressors

- 1 box

### 8.3.12 Desiccant system

- 1 small desiccator cabinet
- 2 silica gel desiccant cans

### 8.3.13 Alumina A Cartridge

- Alumina A ion exchange cartridge, 6 ml capacity

### 8.3.14 1000 ml Polypropylene beaker

## 9.0 METHOD CALIBRATION

### 9.1 Standards Preparation

Four types of standards are prepared for each of the two analytical parameters. Actual concentrations and transfer volumes will be dependent on the stock solution concentration being used. The four standards to be prepared are the: working stock, calibration, Laboratory Control Sample (LCS) spiking, and Continuous Calibration Verification (CCV).

#### 9.1.1 Working Stock Standards

##### SARM Source

Dry to a consistent weight over night in a desiccator. Weigh ~0.5 g on a 4 place balance, transfer and dilute to volume in a 100 ml volumetric flask with acetone. This gives ~5,000 ppm stock solution. Store in either a sealed serum vial or tightly capped 20 ml polypropylene or glass bottle with minimal headspace that has been blackened to keep light out.

##### Working Stock Solution 40 ppm

Source Concentration (ppm)	Transfer Volume <sup>1</sup> (ml)	Final Volume (ml acetone)	Final Concentration (ppm)
10,000 <sup>2</sup>	0.20	50	40
5,000 <sup>2,3</sup>	0.40	50	40
1,000 <sup>2</sup>	1.00	25	40

<sup>1</sup>Transfer using the 2.5 ml gastight syringe.

<sup>2</sup>Commercially prepared standard source.

<sup>3</sup>Prepared source from either a SARM or available solid material source of known purity.

## 9.1.2 Calibration Standards

### TNT Calibration Standards

Working Stock (ppm)	Transfer <sup>1</sup> Volume (ml)	Final <sup>2</sup> Volume (ml acetone)	Water <sup>3</sup> Volume (ml)	Final Conc. (ppm)
40	0.5	100	3	0.2
40	1.0	100	3	0.4
40	2.0	100	3	0.8
40	5.0	50	1.5	4.0
40	10.0	50	1.5	8.0

<sup>1</sup>Transfer using to deliver serological pipettes.

<sup>2</sup>Bring up to final volume in volumetric flask with Acetone.

<sup>3</sup>Add defined water to volumetric flask after bringing to volume and prior to mixing, essentially giving a final volume of 103 & 51.5 ml.

### RDX Calibration Standards

Working Stock (ppm)	Transfer <sup>1</sup> Volume (ml)	Final <sup>2</sup> Volume (ml acetone)	Water <sup>3</sup> Volume (ml)	Final Conc. (ppm)
40	1.2	100	3	0.48
40	2.5	100	3	1.0
40	2.5	50	1.5	2.0
40	5	50	1.5	4.0
40	9	50	1.5	7.2

<sup>1</sup>Transfer using to deliver serological pipettes.

<sup>2</sup>Bring up to final volume in volumetric flask with Acetone.

<sup>3</sup>Add defined water to volumetric flask after bringing to volume and prior to mixing, essentially giving a final volume of 103 & 51.5 ml.

## 9.1.3 Continuing Calibration Verification Standards

### TNT 0.8 ppm

Working Stock (ppm)	Transfer <sup>1</sup> Volume (ml)	Final <sup>2</sup> Volume (ml acetone)	Water <sup>3</sup> Volume (ml)	Final Conc. (ppm)
40	2.0	100	3	0.8

<sup>1</sup>Transfer using serological pipettes.

<sup>2</sup>Bring up to final volume in volumetric flask with Acetone.

<sup>3</sup>Add defined water to volumetric flask after bringing to volume and prior to mixing, essentially giving a final volume of 103 ml.

### RDX 2.0 ppm

Working Stock (ppm)	Transfer <sup>1</sup> Volume (ml)	Final <sup>2</sup> Volume (ml acetone)	Water <sup>3</sup> Volume (ml)	Final Conc. (ppm)
40	5.0	100	3	2.0

<sup>1</sup>Transfer using serological pipettes.

<sup>2</sup>Bring up to final volume in volumetric flask with Acetone.

<sup>3</sup>Add defined water to volumetric flask after bringing to volume and prior to mixing, essentially giving a final volume of 103 ml.

### 9.1.4 Laboratory Control Standards

The RDX and TNT LCS are prepared at the same time on the same aliquot of clean sand.

Sand Weight (g)	RDX Transfer Volume/Conc. (ml/ppm)	TNT Transfer Volume/Conc. (ml/ppm)	Water Volume (ml)	Acetone Volume (ml)	Final TNT/RDX Conc. PRM
20	5.0/40	2.0/40	3	93	0.8/2.0

Note: Typically the LCS is allowed to stand 1 hour after standard spiking and prior to water and solvent addition to allow the solvent to evaporate and the compound to come into contact with the soil. However, this is not done in this procedure due to large volume of spiking solutions being added.

## 9.2 Calibration

### 9.2.1 TNT Calibration

1. Zero spectrophotometer reading with an acetone blank.
2. Place a 25 ml aliquot of each prepared standard in a 30-ml bottle.
3. Add 4-5 KOH pellets and 0.5 g (excess) of  $\text{Na}_2\text{SO}_3$  to each standard.
4. Cap bottle, shake, and allow a minimum of 10 minutes for color development.
5. Filter through syringe filter into cuvet and read absorbance at 540 nm.

### 9.2.2 RDX

1. To a measured 20 ml aliquot of each prepared standard in a 30 ml bottle, add 2 ml of acetic acid (using 10 ml sampling pipetor set to 2ml), mix and transfer to a prepared 60 ml syringe and filter unit containing ~0.3g of zinc powder.
2. Twelve seconds after pouring the standard solution into the syringe, insert the plunger and begin filtering the derivitized extract through the filter back into the original 30 ml container. Filtration must be continuous once initiated and at a rate that does not allow the extract to be in contact with the zinc for more than 25 seconds total.
3. Measure and transfer 5 ml of the filtered extract (using a 10 ml sampling pipetor set to 5ml) to a second 30 ml bottle containing 20 ml of DI water (measure and transfer using a 10 ml sampling pipetor).
4. Add content of one NitroVer 3 powder pillow.
5. Cap, shake, and allow a minimum of 15 minutes for color development.
6. Zero the spectrophotometer with DI water.
7. Measure absorbance of each standard at 507 nm.

### 9.3 Calculations and Acceptance Criteria

#### 9.3.1 Response Factor

$$RF = \frac{CONC_{STD}}{ASB_{STD}}$$

where

RF = Response factor for a given standard as mg/l compound per absorbance unit,

CONC<sub>STD</sub> = Concentration of measured standard as mg/l,

ASBSTD = Absorbance reading of spectrophotometer for measured standard.

#### 9.3.2 Relative Standard Deviation (% RSD)

$$\%RSD = \frac{RF_{SO}}{RF_{AVG}} \times 100$$

where

%RSD = Relative standard deviation as a percentage,

RF<sub>SO</sub> = The standard deviation of all the RFs used in the calibration curve, (N is equal to 5 if all points are used or 4 if one point is eliminated)

RF<sub>AVG</sub> = Average response factor for all the RFs used in the calibration curve.

#### 9.3.3 Calibration Criteria

The calibration curve is acceptable if the % RSD is < 25%. Note the use of all 5 points is preferable; however, the elimination of one point and use of 4 points is acceptable.

### 9.4 Continuing Calibration Verification (CCV)

#### 9.4.1 A CCV needs to be analyzed under the following circumstances:

- Start and end of each days work for each compound
- At the completion of a compound's analytical sequence prior to changing the spectrophotometer wavelength setting
- Prior to the start of the compound's analysis sequence after changing the spectrophotometer wavelength setting.

#### 9.4.2 CCV Analysis

The CCV standard will be prepared as defined in Section 9.1.3 for the applicable compound. The CCV standard will be developed according to the steps defined in Section 9.2.1 for TNT and 9.2.2 for RDX.



### 9.4.3 CCV Calculations and Acceptance Criteria

Acceptance that the derivitization, color development, and spectrophotometric system is in control is based on the comparability of the found CCV concentration to the expected CCV concentration, (i.e., percent recovery; %R).

$$\%R = \frac{CCV_{MES}}{CCV_{EXP}} \times 100$$

where

%R = Percent recovered,

CCV<sub>MES</sub> = Measured concentration of CCV using the RF from the applicable, calibration curve,

CCV<sub>RXP</sub> = Concentration of the prepared standard used for the CCV.

A %R of 75-125% is acceptable and the system has been demonstrated to be in control. Recoveries outside this range will require appropriate corrective action and evaluation of results for affected samples.

## 10.0 SAMPLE PREPARATION AND ANALYSIS

### 10.1 Expendable Materials

The following expendable materials are needed for the analysis of a sample for both TNT and RDX.

- 1 – 250 ml polypropylene bottle with screw cap
- 3 – 60 ml syringes with fitted filters
- 3 – syringe filters
- 3 – 30 ml polypropylene bottles with screw cap
- KOH pellets
- Sodium sulfite
- Zinc powder
- 1-HACH NitroVer 3 powder pillow

### 10.2 Sample Extraction

#### 10.2.1 LCS and Method Blank

Weigh two 20 g aliquots of clean sand into two separate 250 ml bottles. Mark one bottle as the method blank and leave unspiked adding only 3 ml water and 100 ml acetone. Mark the second bottle as the LCS and prepare as defined in Section 9.1.4.

#### 10.2.2 Sample Preparation

To an appropriate marked 250 ml bottle, weigh 20 g  $\pm$  0.5 g of soil/sediment sample and record to the nearest 0.1 g. Measure and add 100 ml of acetone to the soil cap and shake for a minimum of 3 minutes. Allow the bottle to set a reasonable amount of time and let the soil/sediment settle out.

For the TNT background color measurement and RDX analysis, pull 40 ml of acetone from above the sediment up through the filter into Syringe 1.

### **10.3 TNT Analysis**

#### **10.3.1 Color Development**

For TNT analysis, remove the syringe plunger from Syringe 2 and place 4 to 5 KOH pellets and ~ 0.5 g of Na<sub>2</sub>SO<sub>3</sub> into the syringe barrel and replace the plunger. Place the tip of the syringe filter into the acetone extract above the sediment and pull 25 ml of extract into the syringe. Shake and allow a minimum of 10 minutes for color development. (Note: color development rate can be temperature dependent; therefore, it may be necessary to allow more development time during cold weather.)

#### **10.3.2 Background Measurement**

Remove the filter from Syringe 1 (Section 10.2.2), and fill the 10 ml cuvet  $\frac{3}{4}$  full. Measure the absorbance of the sample's background color at 540 nm on the spectrophotometer. Record the absorbance in the appropriate logbook form column.

#### **10.3.3 TNT Color Measurement**

After the color development time has elapsed, change the filter on the TNT color syringe (Syringe 2). Filter the colored extract into the 10 ml cuvet until it is  $\frac{3}{4}$  full. Measure the absorbance of the sample at 540 nm on the spectrophotometer. Record the absorbance in the logbook.

Calculate the TNT concentration based on the formula in Section 11.1 and the applicable Average Response Factor from the applicable calibration curve.

### **10.4 RDX Analysis**

#### **10.4.1 Ion Exchange**

Remove the filter from Syringe 1 (Section 10.2.2) and use the extract to fill the reservoir above the solid phase in the Supeleo Alumina-A ion exchange tube. (Note: Flow of the extract through the ion column should not exceed 5 ml/min. For the defined tubes, the acetone extract typically has a flow rate of 2 to 3 mls/min (an occasional check of the flow rate is recommended).)

Discard the first 2 to 3 ml that passed through the column. Collect the next 20 ml of extract that passes through the column. Pour a measured 20 ml of the ion exchanged extract into a 30 ml bottle.

#### **10.4.2 Derivitization**

Add 2 ml of glacial acetic acid to the 20 mls of ion exchanged extract, using a preset and dedicated 10 ml sampling pipetor. (Note: In cold weather temperature <40°F arrangements need to be made to keep the acetic acid warm to keep it from crystallizing.) Transfer the entire contents of the 30 ml bottle to a prepared syringe containing ~0.3 g of dry zinc powder. Pour it into the barrel through the top with the plunger removed. After 12 seconds, replace the syringe plunger and begin to filter the derivitized extract back into the 30 ml bottle. The filtration needs to be consistent in starting at 12 seconds and not taking more than 10 to 15 seconds to complete.

#### **10.4.3 RDX Color Development and Measurement**

Measure and transfer 5 ml of the derivitized extract, using a dedicated preset sampling pipetor, to a second 30 ml bottle with 20 ml of DI water. Add the contents of one NitroVer 3 powder pillow, cap, mix,

and allow 15 minutes for color development. (Note: set the remaining derivatized sample aside for re-analysis or dilutions, if necessary.)

After the color has developed, measure the absorbance at 507 nm on the spectrophotometer. Calculate the RDX concentration based on the Average Response Factor for the applicable calibration curve using the calculations found in Section 11.2.

## 11.0 CALCULATIONS

### 11.1 TNT Concentration

$$TNT_{CONC} = \frac{(ABS_{SMP} - 2XABS_{BKG}) \times RF_{AVG} \times DF}{WGT_{SMP}}$$

Where

TNT<sub>CONC</sub> = Concentration of TNT in sample as ppm wet weight  
 ASB<sub>SMP</sub> = Absorbance reading for the color developed sample extract  
 ASB<sub>BKG</sub> = Absorbance reading for the background or non-color developed sample extract  
 RF<sub>AVG</sub> = Average response factor for applicable calibration curve  
 DF = Dilution factor (when applicable)  
 WGT<sub>SMP</sub> = Weight of sample aliquot used for extraction and analysis.

### 11.2 RDX Concentration

$$RDX_{CONC} = \frac{ASB_{SMP} \times RF_{AVG} \times DF}{WGT_{SMP}}$$

Where

RDX<sub>CONC</sub> = Concentration of RDX in the sample as ppm wet weight  
 ASB<sub>SMP</sub> = Absorbance reading for the color developed sample extract  
 RF<sub>AVG</sub> = Average response factor for applicable calibration curve  
 DF = Dilution factor (when applicable)  
 WGT<sub>SMP</sub> = Weight of sample aliquot used for extraction and analysis.

## 12.0 Quality Control

### 12.1 Method Blank (MB)

Prepared as defined in Section 10.2.1. A MB is analyzed daily with first batch of samples processed and at a frequency of 1 per 20 samples, thereafter. The method blank is acceptable when the calculated concentration does not exceed 1.0 ppm for TNT or 2.0 ppm for RDX.

### 12.2 Laboratory Control Sample (LCS)

Prepared as defined in Section 10.2.2. The LCS is analyzed daily with first batch of samples processed and at a frequency of 1 per 20 samples thereafter. Acceptable if %R is 60-140%.

### 12.3 Duplicate Analysis (DUP)

One laboratory duplicate analysis is performed for every 20 field samples analyzed. Samples for duplicate analysis can be selected at a later time based on samples having a positive result. Acceptable if RPD values are <50% for samples with concentrations >10 ppm and <90% for sample concentrations <10 ppm. (Note: Method resolution needs to be taken into consideration before accepting or rejecting duplicate analysis.)

### 12.4 Reporting Limit

The lower reporting limit is calculated based on the concentration of the lowest standard used in the applicable calibration curve adjusted for the extraction volume and sample weight.

### 12.5 QC Summary

QC Parameter	Frequency	Acceptance criteria
Calibration curve	Start of project; major change to instrument or procedure; failure of CCV	% RSD < 25%
CCV	Start of day End of day Before and after changing spectrophotometer wavelength	%R 75 ± 125%
Method blank	1 per day and as needed to achieve 1 per 20 ratio	< 1 ppm TNT < 2 ppm RDX
LCS	1 per day and as needed to achieve 1 per 20 ratio	%R 60-140%
Analytical duplicate	1 per 20 samples; preferable on samples with positive hits	Concentrations > 10 ppm RPD < 50% Concentrations < 10 ppm RPD < 90%

## 13.0 ANALYTICAL WASTE

The major waste generated during the implementation of this procedure will be extract solutions and colored complex solutions. These solutions are caustic flammable solvent wastes and should be handled as such. These wastes must be properly containerized and labeled. Coordination must be established with the site waste manager, and disposal must be in accordance with the site Waste Management Plan.

Other general waste generated during the analysis should not represent a chemical or biological hazard, however, proper site handling and disposal procedures should be implemented.

## 14.0 EQUIPMENT AND SUPPLIES

### 14.1 NONEXPENDABLE

Item	Supplier	Catalog No.	Units	Order
DR2010 Spectrophotometer	HACH	DR2010	ea	1
10 ml DR2010 matched cuvetts	HACH	24954-02	pair	3
Top-loading balance	Cole Palmer	E11300-06	ea	1
10 ml Polypropylene serological pipets	Fisher	13-662-12D	ea	2
Pipet safety bulb	Fisher	13-681-51	ea	3
10 ml Sampling respirator	Fisher	13-689-26	ea	3
10 ml Polypropylene graduated cylinder	Fisher	08-572A	ea	8
50 ml Polypropylene graduated cylinder	Fisher	08-572C	ea	3
100 ml Polypropylene graduated cylinder	Fisher	08-572D	ea	3
Dessicator Cabinet	Fisher	08-647-20	ea	1
Desiccant Cans	Fisher	01-952-5	ea	2
50 ml Propylene volumetric flask	Fisher	10-198-50A	ea	5
100 ml Propylene volumetric flask	Fisher	10-198-50B	ea	5
25 ml glass volumetric flask	Fisher	10-200A	ea	3
Acetone washbottle	Fisher	03-409-23A	pkg/6	1
Water washbottle	Fisher	03-409-23G	pkg/6	1
0.250 ml Hamilton gastight syringe	Fisher	13-684-102	ea	2
2.5 ml Hamilton gastight syringe	Fisher	13-684-110	ea	3

### 14.2 EXPENDABLE

Item	Supplier	Catalog No.	Units	Order
60 ml disposable syringe Luer lock	Fisher	14-823-2D	Case/120	3
25 mm; 0.45 nylon; polypropylene housing syringe filters	Fisher	09-740-35Q	case/300	2
Acetone	local paint or hardware supplier		gal.	3
Zinc powder technical grade	Fisher	25-500	500g	1
DI water	Fisher	W2-4	Ll	2
Sodium sulfide technical; granular	Fisher	5447-500	500 g	1
Potassium hydroxide technical; pellets	Fisher	P250-500	500 g	1
Acetic acid glacial	Fisher	A385-500	500 ml	1
Polypropylene bottles 250 ml	Fisher	03-083-52	case/72	1
Polypropylene bottles 30 ml	Fisher	03-083-49	case/72	1
Alumina A SPME column	Supeko	5-70834	30/pkg	4
25 ml NitroVer3 powder pillow	HACH	14034-99	100/pkg	2
Sampling respirator tips	Fisher	D7-101	100/pkg	2
RDX standard 1,000 ppm in acetonitrile	Accustandard		ea	4
TNT standard 1,000 ppm in methanol	Accustandard		ea	4
Tongue depressors	Fisher	01-346	1200/box	1
100 ml Tripour polypropylene beaker	Fisher	02-593-50F	pkg/100	1

## **APPENDIX C**

### **HUMAN HEALTH RISK ASSESSMENT ALGORITHMS**

## APPENDIX C

### HUMAN HEALTH RISK ASSESSMENT ALGORITHMS

Appendix C contains the equations used to estimate risk to human receptor populations. Risk estimation is conducted in several steps including estimation of exposure concentration, calculation of intake and dose, toxicity assessment, and risk characterization. The methods and equations used in each step are described in the sections below.

#### C.1 ESTIMATION OF EXPOSURE CONCENTRATION

Exposure concentrations are medium-specific contaminant concentrations a potential receptor is expected to encounter. Exposure concentrations from direct contact with environmental media (soils, sediment, groundwater, surface water) are based on the sampling results of the media. Exposure concentrations for contaminants that have migrated into secondary media (beef, milk, venison, fish, and vegetables) are modeled from the equations presented in the following sections.

**Chemical Concentration in Beef.** Concentrations in beef cattle are calculated from the concentration in the cattle's food sources due to soil and water contamination. The contaminant levels in pasture are estimated by the equation:

$$C_p = C_s \times (R_{upp} + R_{es}),$$

where:

- $C_p$  = concentration of contaminant in pasture (mg/kg, calculated),
- $C_s$  = concentration of contaminant in soil (mg/kg),
- $R_{upp}$  = multiplier for dry root uptake for pasture (unitless),
- $R_{es}$  = resuspension multiplier (unitless).

The multiplier for dry root uptake for pasture,  $R_{upp}$ , is estimated as:

$$R_{upp} = Bv_{dry},$$

where:

- $R_{upp}$  = multiplier for dry root uptake for pasture (unitless),
- $Bv_{dry}$  = soil-to-plant uptake, dry weight (kg/kg, chemical-specific, or  $38 \times K_{ow}^{-0.58}$ ),
- $K_{ow}$  = octanol-water partitioning coefficient (unitless, chemical-specific).

The resuspension multiplier is estimated as:

$$R_{es} = MLF,$$

where:

- $R_{es}$  = resuspension multiplier (unitless),
- $MLF$  = plant mass loading factor (unitless, 0.25 for pasture).

The concentration of contaminants in beef cattle from ingestion of contaminated pasture, soil, and water is estimated using the following equation:

$$C_b = BTF_{\text{beef}} \times [(C_p \times Q_{pb} \times f_{pb} \times f_{sb}) + (C_s \times Q_{sb} \times f_{pb}) + (C_w \times Q_{wb})],$$

where:

$C_b$	=	concentration of contaminant in beef (mg/kg dry weight),
$BTF_{\text{beef}}$	=	beef transfer coefficient (day/kg, chemical-specific, or $2.5 \times 10^{-8} \times K_{ow}$ ),
$K_{ow}$	=	octanol-water partitioning coefficient (unitless, chemical-specific),
$C_p$	=	concentration of contaminant in pasture (mg/kg, calculated),
$Q_{pb}$	=	quantity of pasture ingested by beef cattle (kg/day),
$f_{pb}$	=	fraction of year beef cattle is on-site (kg/day),
$f_{sb}$	=	fraction of beef cattle's food that is from the site (kg/day),
$C_s$	=	concentration of contaminant in soil (mg/kg),
$Q_{sb}$	=	quantity of soil ingested by beef cattle (kg/day),
$C_w$	=	concentration of contaminant in water (mg/L),
$Q_{wb}$	=	quantity of water ingested by beef cattle (L/day).

**Chemical Concentration in Milk.** Milk concentrations from dairy cattle are calculated from the concentration in the cattle's food sources due to soil and water contamination. The contaminant levels in pasture are estimated in the same fashion as for beef cattle (see above).

The concentration of contaminants in dairy cattle's milk, from ingestion of contaminated pasture, soil, and water is estimated using the following equation:

$$C_m = BTF_{\text{milk}} \times [(C_p \times Q_{pd} \times f_{pd} \times f_{sd}) + (C_s \times Q_{sd} \times f_{pd}) + (C_w \times Q_{wd})],$$

where:

$C_m$	=	concentration of contaminant in milk (mg/kg),
$BTF_{\text{milk}}$	=	milk transfer coefficient (day/kg, chemical-specific, or $7.9 \times 10^{-9} \times K_{ow}$ ),
$K_{ow}$	=	octanol-water partitioning coefficient (unitless, chemical-specific),
$C_p$	=	concentration of contaminant in pasture (mg/kg, calculated),
$Q_{pd}$	=	quantity of pasture ingested by dairy cattle (kg/day),
$f_{pd}$	=	fraction of year dairy cattle is on-site (kg/day),
$f_{sd}$	=	fraction of dairy cattle's food that is from the site (kg/day),
$C_s$	=	concentration of contaminant in soil (mg/kg),
$Q_{sd}$	=	quantity of soil ingested by dairy cattle (kg/day),
$C_w$	=	concentration of contaminant in water (mg/L),
$Q_{wd}$	=	quantity of water ingested by dairy cattle (L/day).

**Chemical Concentration in Venison.** Concentrations in venison are estimated by calculating the concentration in venison food sources due to soil contamination. The contaminant levels in forage are estimated by the following:

$$C_p = (CF)(C_s)(B_p),$$

where:



- $C_p$  = concentration of contaminant in forage (mg/kg dry weight),  
 $CF$  = conversion factor to adjust for soil containing 20 percent moisture (1.25 unitless),  
 $C_s$  = concentration of contaminant in soil (mg/kg),  
 $B_p$  = soil-to-forage biotransfer factor (mg chemical per kg of dry plant/mg of chemical per kg or dry soil)(chemical specific).

The  $B_p$  for metals is taken from the available literature. The  $B_p$  for semivolatile organics are calculated using the following formulas:

$$\log B_p = 1.588 - 0.578 \log K_{ow},$$

where:

- $\log B_p$  = soil-to-forage biotransfer factor (mg chemical per kg of dry plant/mg of chemical per kg or dry soil)(chemical-specific),  
 $K_{ow}$  = octanol-water partitioning coefficient (unitless, chemical-specific).

A  $B_p$  is not estimated for VOCs, because these chemicals are expected to volatilize rapidly from soils and plants and thus are insignificant in food chain pathways.

The concentration of contaminants in venison from ingestion of contaminated forage is estimated using the following equation:

$$C_v = (Q_p)(C_p)(FI_e)(B_v),$$

where:

- $C_v$  = contaminant concentration in venison (mg/kg),  
 $Q_p$  = browse ingestion rate (0.87 kg dry weight/day),  
 $C_p$  = contaminant concentration in browse (mg/kg dry weight),  
 $FI_e$  = fraction browse ingested from the contaminated site (site area/home range),  
 $B_v$  = biotransfer factor for venison (days/kg).

The  $B_v$  for beef is used for deer due to a lack of available literature values for deer. Both of these animals are ruminants; therefore, the uptake and bioaccumulation of contaminants is likely to be similar. The meat of deer contains less fat than commercial beef, 14.4 percent fat for beef as compared to 2.9 percent for venison. Organic chemicals have a greater affinity to fat and thus would not accumulate as much in venison. Therefore, the beef biotransfer factors for organics are adjusted by 2.9/14.4 (0.20) to reflect this lower accumulation rate.

The  $B_v$  values for metals are taken from the published literature. The  $B_v$  values for organics are calculated as follows:

$$B_v = R_f \times 10^{-7.6 + \log K_{ow}},$$

where:

- $B_v$  = biotransfer factor for venison (days/kg),  
 $R_f$  = ratio of the fat content in venison to the fat content of beef (0.20),  
 $K_{ow}$  = octanol-water partitioning coefficient (unitless, chemical-specific)

**Chemical Concentrations in Fish.** Fish may bioconcentrate contaminants from water and sediment. The contaminant concentration in fish due to bioconcentrating contaminants from surface water is estimated using the following equation:

$$C_{fw} = (C_w)(BCF),$$

where:

- $C_{fw}$  = contaminant concentration in fish from surface water (mg/kg),  
 $C_w$  = contaminant concentration in water (mg/L),  
 $BCF$  = fish bioconcentration factor (L/kg).

Many BCF factors for fish are available from the literature. In the absence of a BCF literature value for an organic, the value is estimated using the following equation:

$$\log BCF = 0.76 \times K_{ow} - 0.23,$$

where:

- $BCF$  = fish bioconcentration factor (L/kg),  
 $K_{ow}$  = octanol-water partitioning coefficient (unitless, chemical-specific).

**Ingestion of Homegrown Vegetables.** The model to estimate the chemical concentration in homegrown vegetables is comprised of contributions from irrigation and soil resuspension.

The root uptake from irrigation component is estimated by the equation:

$$Irr_{rup} = (Ir \times F \times Bv_{wet} \times [1 - e^{(-\lambda_B \times t_b)}] / (P \times \lambda_B),$$

where:

- $Irr_{rup}$  = multiplier in vegetable equation for root uptake from irrigation (L/kg),  
 $Ir$  = irrigation rate (L/m<sup>2</sup>-day),  
 $F$  = irrigation period as a fraction (unitless),  
 $Bv_{wet}$  = soil-to-plant uptake factor, wet weight (kg/kg),  
 $\lambda_B$  = effective rate for removal (1/day, calculated as  $\lambda_i + \lambda_{HL}$ ),  
 $\lambda_i$  = decay rate (1/day, assume 0 for chemicals),  
 $\lambda_{HL}$  = soil leaching rate (1/day),  
 $t_b$  = long-term deposition and buildup (days),  
 $P$  = area density for root zone (kg/m<sup>2</sup>).

The resuspension from irrigation component is estimated by the equation:

$$Irr_{res} = (Ir \times F \times MLF \times [1 - e^{(-\lambda_B \times t_b)}] / (P \times \lambda_B),$$

where:

$Irr_{res}$	=	multiplier in vegetable equation for resuspension from irrigation (L/kg),
$Ir$	=	irrigation rate (L/m <sup>2</sup> -day),
$F$	=	irrigation period as a fraction (unitless),
$MLF$	=	plant mass loading factor (unitless, 0.26 for vegetables),
$\lambda_B$	=	effective rate for removal (1/day, calculated as $\lambda_i + \lambda_{HL}$ ),
$\lambda_i$	=	decay rate (1/day, assume 0 for chemicals),
$\lambda_{HL}$	=	soil leaching rate (1/day),
$t_b$	=	long-term deposition and buildup (days),
$P$	=	area density for root zone (kg/m <sup>2</sup> ).

The aerial deposition from irrigation component is estimated by the equation:

$$Irr_{dep} = (Ir \times F \times I_f \times T \times [1 - e^{(-\lambda_E \times t_v)}] / (Y_v \times \lambda_E),$$

where:

$Irr_{dep}$	=	multiplier in vegetable equation for aerial deposition from irrigation (L/kg),
$Ir$	=	irrigation rate (L/m <sup>2</sup> -day),
$F$	=	irrigation period as a fraction (unitless),
$I_f$	=	interception fraction (unitless),
$T$	=	translocation factor (unitless),
$\lambda_E$	=	decay for removal on produce (1/day, calculated as $\lambda_i + 0.693/t_w$ ),
$\lambda_i$	=	decay rate (1/day, assume 0 for chemicals),
$t_w$	=	weathering half-life (days),
$t_v$	=	above ground exposure time (days),
$Y_v$	=	plant yield (wet) (kg/m <sup>2</sup> ).

The chemical concentration in homegrown vegetables is estimated with the equation:

$$C_{veg} = C_w \times (Irr_{rup} + Irr_{res} + Irr_{dep}) + C_s \times (Bv_{wet} + MLF),$$

where:

$C_w$	=	concentration of contaminant in water (mg/L),
$Irr_{rup}$	=	multiplier in vegetable equation for root uptake from irrigation (L/kg),
$Irr_{res}$	=	multiplier in vegetable equation for resuspension from irrigation (L/kg),
$Irr_{dep}$	=	multiplier in vegetable equation for aerial deposition from irrigation (L/kg),
$C_s$	=	concentration of contaminant in soil (mg/kg),
$Bv_{wet}$	=	soil-to-plant uptake, wet weight (kg/kg, chemical-specific, or $7.7 \times K_{ow}^{-0.58}$ ),
$K_{ow}$	=	octanol-water partitioning coefficient (unitless, chemical-specific),
$MLF$	=	plant mass loading factor (unitless, 0.26 for vegetables).

## C.2 ESTIMATION OF INTAKE AND DOSE

The quantification of exposure to receptors from contact with chemicals in different media involves estimating the amount of contaminant that is taken into the body via various routes of exposures. This section describes the models used to quantify doses or intakes of contaminants by exposure pathways identified for a site. The intake of contaminants from environmental media (soils, groundwater, and

surface water) and secondary sources (deer, fish, beef, milk, and vegetables) are discussed below. Exposure parameters used for evaluating each receptor are provided in Table C-1.

### Estimated Intakes and Doses from Soils and Sediment.

Potential exposure pathways for soils include incidental ingestion, inhalation of fugitive dust and VOCs, and dermal contact with soils. The equations used to estimate potential intakes and doses from these exposure pathways are discussed below.

**Incidental Ingestion.** The intake of chemicals from incidental ingestion of soils and sediments is estimated using the following equation:

$$I_s = (C_s)(IR_s)(FI_s)EF_T(ED) / [(BW)(AT)],$$

where:

$I_s$	=	ingested soil or sediment intake (mg/kg-day, calculated),
$C_s$	=	concentration in soil or sediment (mg/kg),
$IR_s$	=	ingestion rate of soil or sediment (kg/day),
$FI_s$	=	fraction of exposure attributed to site soil (unitless),
$EF_T$	=	exposure frequency (days/year),
$ED$	=	exposure duration (years),
$BW$	=	body weight (kg),
$AT$	=	averaging time (days).

**Inhalation of VOCs and Dust.** The following equation is used to estimate the inhalation intake of contaminants in air from airborne dust and VOCs:

$$I_a = (C_s)(IR_a)(PEF^{-1} + VF^{-1})(FI_a)(Et_a)(EF_T)(ED) / [(BW)(AT)],$$

where:

$I_a$	=	inhaled intake of COPC (mg/kg-day, calculated),
$C_s$	=	concentration of COPC in soil (mg/kg),
$IR_a$	=	inhalation rate (m <sup>3</sup> /hour),
$PEF$	=	particulate emission factor (9.24E+08 m <sup>3</sup> /kg, site-specific),
$VF$	=	chemical-from-soil volatilization factor (m <sup>3</sup> /kg, chemical-specific),
$FI_a$	=	fraction of exposure attributed to the media (unitless),
$ET_a$	=	exposure time (hours/day),
$EF_T$	=	exposure frequency (days/year),
$ED$	=	exposure duration (years),
$BW$	=	body weight (kg),
$AT$	=	averaging time (days).

The particulate emission factor (PEF) is used to evaluate the fugitive dust contribution to the inhalation of soils pathway, while the volatilization factor (VF) is used to evaluate chemicals that volatilize from soils (volatile organic compounds only). The PEF and VF factors are calculated per EPA's Soil Screening Guidance (EPA 1996), using site specific factors for Cleveland Ohio, the city nearest Ravenna for which EPA has provided parameters to estimate PEF and VF values. Specific equations for PEF and VF are provided below. For the National Guard receptor, whose activities generate more dust than activities of

other receptors, a dust-loading factor of 600 µg/m<sup>3</sup> is applied, resulting in a PEF of 1.67E+06 m<sup>3</sup>/kg for this receptor.

The PEF for non-National Guard receptors is calculated by the following equation:

$$PEF = \frac{LS \times V \times DH \times 3600s/hr}{A} \times \frac{1000g/kg}{0.036 \times (1 - G) \times (U_m / U_t)^3 \times F(x)},$$

where:

PEF	=	particulate emission factor (m <sup>3</sup> /kg),
LS	=	width of contaminated area (m),
V	=	wind speed in mixing zone (m/s),
DH	=	diffusion height (m),
A	=	area of contamination (m <sup>2</sup> ),
0.036	=	respirable fraction (g/m <sup>2</sup> -hr),
G	=	fraction of surface covered with vegetation (unitless),
U <sub>m</sub>	=	mean annual wind speed (m/sec),
U <sub>t</sub>	=	equivalent threshold value of wind speed at 10 m (m/sec),
F(x)	=	function dependent on U <sub>m</sub> /U <sub>t</sub> (unitless).

The chemical-from-soil volatilization factor is calculated as follows:

$$VF = \frac{(LS \times V \times DH)}{A} \times \frac{(3.14 \times \alpha T)^{1/2}}{(2 \times D_{ei} \times E \times K_{as} \times 10^{-3} kg/g)},$$

where:

VF	=	chemical-from-soil volatilization factor (m <sup>3</sup> /kg, chemical-specific),
LS	=	width of contaminated area (m),
V	=	wind speed in mixing zone (m/s),
DH	=	diffusion height (m),
A	=	area of contamination (m <sup>2</sup> ),
D <sub>ei</sub>	=	effective diffusivity (cm <sup>2</sup> /s), calculated from D <sub>i</sub> x E <sup>0.33</sup> ,
D <sub>i</sub>	=	molecular diffusivity (cm <sup>2</sup> /s),
E	=	true soil porosity (unitless),
K <sub>as</sub>	=	soil/air partitioning coefficient (g soil/cm <sup>3</sup> air), calculated from H/K <sub>d</sub> ,
H	=	Henry's law constant (atm-m <sup>3</sup> /mol),
K <sub>d</sub>	=	soil/water partitioning coefficient (cm <sup>3</sup> /g),
T	=	exposure interval (seconds),
α	=	is defined by the equation:

$$\alpha = (D_{ei} \times E) / [E + (\rho_s)(1 - E) / K_{as}]$$

where:

ρ <sub>s</sub>	=	true soil density or particulate density (g/cm <sup>3</sup> ).
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Dermal Contact with COPCs in Soil. The dermal dose of a contaminant is estimated from the equation:

$$DAD = (C_s)(FI_s)(CF)(AF)(ABS)(SAS)(EF_T)(ED) / [(BW)(AT)],$$

where:

DAD	=	average dermally absorbed dose of the COPC (mg/kg-day, calculated),
C <sub>s</sub>	=	concentration of COPC in soil (mg/kg),
FI <sub>s</sub>	=	fraction of exposure attributed to site soil or sediment (unitless),
CF	=	conversion factor (10 <sup>-6</sup> kg/mg x 10 <sup>4</sup> cm <sup>2</sup> /m <sup>2</sup> ),
AF	=	soil-to-skin adherence factor (mg/cm <sup>2</sup> ),
ABS	=	absorption fraction (unitless, chemical-specific)
SAS	=	surface area of the skin available for contact with contaminated medium (m <sup>2</sup> /day),
EF <sub>T</sub>	=	exposure frequency (days/year),
ED	=	exposure duration (years),
BW	=	body weight (kg),
AT	=	averaging time (days).

ABS values have been empirically determined for very few chemicals. EPA (1992) discussed the available empirical data, as well as several predictive approaches for estimating ABS, but refrains from recommending any single approach. EPA (1995) recommends reasonable default values of 0.1% for inorganic chemicals and 1% for organic chemicals, to reflect the matrix effect (i.e., binding to organic matter in soil). Chemical-specific ABS values available from EPA Region V will be used whenever possible. When chemical-specific values are not available, EPA Region V recommends a default ABS of 0.1 for SVOCs (USACE 2000b). For LL12, default values of 0.1% for inorganics (EPA 1995), 10% for SVOCs (USACE 2000b), and 1% for other organics (i.e., VOCs) (EPA 1995) will be used when chemical-specific data are not available.

### Estimated Intakes and Doses from Groundwater and Surface Water

Potential exposure pathways for groundwater and surface water include ingestion, inhalation of VOCs, and dermal contact. The equations used to estimate potential intakes and doses from these exposure pathways are described below.

**Ingestion Drinking Water.** Ingestion of groundwater or surface water used as a potable water source is quantified with the following equation:

$$I_w = (C_w)(IR_w)(FI_w)(EF_T)(ED) / [(BW)(AT)],$$

where:

I <sub>w</sub>	=	ingested intake of COPC in drinking water (mg/kg-day),
C <sub>w</sub>	=	concentration of COPC in drinking water (mg/L),
IR <sub>w</sub>	=	drinking water ingestion rate (L/day),
FI <sub>w</sub>	=	fraction of exposure attributed to site medium (unitless),
EF <sub>T</sub>	=	exposure frequency (days/year),
ED	=	exposure duration (years),
BW	=	body weight (kg),
AT	=	averaging time (days).

**Incidental Ingestion while Swimming.** Incidental ingestion of surface water while swimming is quantified with the following equation:

$$I_{\text{swim}} = (C_w)(IR_w)(ET_w)(EF_T)(ED) / [(BW)(AT)],$$

where:

$I_{\text{swim}}$	=	incidental ingestion intake (mg/kg-day),
$C_w$	=	concentration in surface water (mg/L),
$IR_w$	=	incidental ingestion rate while swimming (L/hour),
$ET_w$	=	exposure time (hours/day)
$EF_T$	=	exposure frequency (days/year),
$ED$	=	exposure duration (years),
$BW$	=	body weight (kg),
$AT$	=	averaging time (days).

**Inhalation of VOCs in Groundwater or Surface Water.** The daily intake from the inhalation of VOCs for water use (e.g., showering) may be evaluated using the following equation (EPA 1991b):

$$I_s = (C_w)(IR)(ET)(K)(EF_T)(ED) / [(BW)(AT)],$$

where:

$I_s$	=	estimated inhalation exposure during water use (mg/day),
$C_w$	=	concentration in groundwater or surface water (chemical-specific; mg/L),
$IR$	=	inhalation rate (m <sup>3</sup> /hour),
$ET$	=	exposure time to water (hour/day),
$K$	=	volatilization factor (0.0005 x 1000 L/m <sup>3</sup> ),
$EF_T$	=	exposure frequency (days/year),
$ED$	=	exposure duration (years),
$BW$	=	body weight (kg),
$AT$	=	averaging time (days).

**Dermal Contact.** The dermal dose is estimated as the dose that crosses the skin and is systematically absorbed. The dermal dose is estimated from the equation:

$$DAD = (C_w)(PC)(ET_w)(CF)(SAS)(EF_T)(ED) / [(BW)(AT)],$$

where:

$DAD$	=	average dermally absorbed dose of the COPC (mg/kg-day, calculated),
$C_w$	=	concentration of chemicals of concern (COC) in water (mg/L),
$PC$	=	permeability coefficient (cm/hour, chemical-specific),
$ET_w$	=	time of exposure (hours/event),
$CF$	=	conversion factor (0.01 m/cm x 1000 L/m <sup>3</sup> )
$SAS$	=	surface area of the skin available for contact with contaminated medium (m <sup>2</sup> ),
$EF_T$	=	exposure frequency (events/year),
$ED$	=	exposure duration (years),
$BW$	=	body weight (kg),
$AT$	=	averaging time (days).

The permeability coefficient (PC) describes the rate of movement of a constituent from water across the dermal barrier to the systemic circulation. The PC has been determined for very few inorganic

compounds. For those inorganic compounds for which empirical data are not available, EPA (1992) recommends a default of  $10^{-3}$  cm/hour.

The PC for organic chemicals varies by several orders of magnitude (EPA 1992). The PC for organic chemicals is highly dependent on lipophilicity, expressed as a function of the octanol/water partition coefficient ( $K_{ow}$ ). Because the stratum corneum (the outer skin layer) is rich in lipid content, it may act as a sink, initially reducing the transport of chemical to the systemic circulation. When possible, values for PC are taken from EPA (1992). If PC values are not available, they may be calculated from the formula:

$$\log(PC) = 2.72 + 0.71 \log(K_{ow}) - 0.0061 MW,$$

where:

PC = permeability coefficient (cm/hour, calculated),  
 $K_{ow}$  = octanol/water partition coefficient (unitless),  
 MW = molecular weight.

### Estimation of Intakes from Consumption of Game

The intake from ingestion of venison and fish by the sportsman is estimated from the equation:

$$I_g = [(C_v)(IR_v)(FI_v) + (C_f)(IR_f)(FI_f)] \frac{(EF_G)(ED)}{(BW)(AT)},$$

where:

$I_g$  = ingested intake in game (venison and fish) (mg/kg-day, calculated),  
 $C_v$  = concentration in venison (mg/kg),  
 $IR_v$  = ingestion rate of venison (kg/day),  
 $FI_v$  = fraction of daily intake of venison from contaminated sources (unitless),  
 $C_f$  = concentration in fish (mg/kg),  
 $IR_f$  = ingestion rate of fish (kg/day),  
 $FI_f$  = fraction of daily intake of fish from contaminated sources (unitless),  
 $EF_G$  = exposure frequency (days/year),  
 $ED$  = exposure duration (years),  
 $BW$  = body weight (kg),  
 $AT$  = averaging time (days).

### Estimation of Intakes from Consumption of Beef

The intake from ingestion of beef by the residential farmer is estimated from the equation:

$$I_b = (C_b)(IR_b)(FI_b)(EF_B)(ED) / [(BW)(AT)],$$

where:

$I_b$  = ingested intake of beef (mg/kg-day, calculated),  
 $C_b$  = concentration in beef (mg/kg),  
 $IR_b$  = ingestion rate of beef (kg/day),  
 $FI_b$  = fraction of daily intake of beef from contaminated sources (unitless),



EF <sub>B</sub>	=	exposure frequency (days/year),
ED	=	exposure duration (years),
BW	=	body weight (kg),
AT	=	averaging time (days).

### Estimation of Intakes from Consumption of Milk

The intake from ingestion of milk by the residential farmer is estimated from the equation:

$$I_m = (C_m)(IR_m)(FI_m)(EF_M)(ED) / [(BW)(AT)],$$

where:

I <sub>m</sub>	=	ingested intake of milk (mg/kg-day, calculated),
C <sub>m</sub>	=	concentration in milk (mg/kg),
IR <sub>m</sub>	=	ingestion rate of milk (kg/day),
FI <sub>m</sub>	=	fraction of daily intake of milk from contaminated sources (unitless),
EF <sub>M</sub>	=	exposure frequency (days/year),
ED	=	exposure duration (years),
BW	=	body weight (kg),
AT	=	averaging time (days).

### Estimation of Intakes from Consumption of Homegrown Vegetables

The intake from ingestion of homegrown vegetables by the residential farmer is estimated from the equation:

$$I_{veg} = (C_{veg})(IR_{veg})(FI_{veg})(EF_{VEG})(ED) / [(BW)(AT)],$$

where:

I <sub>veg</sub>	=	ingested intake of vegetables (mg/kg-day, calculated),
C <sub>veg</sub>	=	concentration in vegetables (mg/kg),
IR <sub>veg</sub>	=	ingestion rate of vegetables (kg/day),
FI <sub>veg</sub>	=	fraction of daily intake of vegetables from contaminated sources (unitless),
EF <sub>VEG</sub>	=	exposure frequency (days/year),
ED	=	exposure duration (years),
BW	=	body weight (kg),
AT	=	averaging time (days).

## C.3 TOXICITY ASSESSMENT

To understand the potential health risk associated with a potentially hazardous chemical, information on chemical-specific toxicity is required. Toxicity information is used in conjunction with the results of the exposure assessment to characterize potential health risks. The toxic mechanisms for chemicals are divided into two categories, carcinogenicity and systemic toxicity (noncancer effects).

### Assessment of Chemical Carcinogens

Although few chemicals are known human carcinogens, many chemicals are suspected to be human carcinogens based on the results of animal studies. The evaluation of the potential carcinogenicity of a

chemical includes both a qualitative and a quantitative aspect (EPA 1989). The qualitative aspect is a weight-of-evidence evaluation of likelihood that a chemical might induce cancer in humans. The EPA recognizes six weight-of-evidence group classifications for carcinogenicity:

**Group A – Human Carcinogen.** Data for humans are sufficient to identify the chemical as a human carcinogen.

**Group B1 – Probable Human Carcinogen.** Human data indicate a causal association is credible, but alternative explanations cannot be dismissed.

**Group B2 – Probable Human Carcinogen.** Human data are insufficient to support a causal association, but testing data support a causal association in animals.

**Group C – Possible Human Carcinogen.** Human data are inadequate or lacking, but animal data suggest a causal association, although the studies have deficiencies that limit interpretation.

**Group D – Not Classifiable as to Human Carcinogenicity.** Human and animal data are lacking or inadequate.

**Group E – Evidence of Noncarcinogenicity to Humans.** Data for humans show negative results or are lacking, and adequate animal data indicate no association with cancer.

The quantitative evaluation is an estimate of carcinogenic potency. Potency estimates are developed only for chemicals in Groups A, B1, B2, and C. The potency estimates are statistically derived from the dose-response curve from the best human or animal study or studies available for a given chemical. In the case of animal studies, pharmacokinetic data or principles are used to estimate an equivalent human dose. The potency estimates are referred to as the cancer slope factor (CSF), and are expressed as risk per unit dose (per mg/kg-day). In order to be appropriately conservative, the CSF is usually the 95 percent upper bound on the slope of the dose-response curve extrapolated from high (experimental) doses to the low-dose range expected in environmental exposure scenarios. It is assumed that there is no threshold for carcinogens (e.g., a dose below which exposure is safe), and, therefore, any exposure represents some quantifiable risk. The discussion of chemical carcinogenicity includes the EPA's classification of carcinogenicity and the CSF recommended by the EPA. The CSF used in evaluating the carcinogenic risks associated with exposure to each COPC will be obtained from the Integrated Risk Information Service (IRIS) computer database or the most recent Health Effects Assessment Summary Tables (HEAST). Separate CSFs are available for oral and inhalation exposures.

Toxicity values for inhalation are presented as unit risk factors [i.e., risk per ( $\mu\text{g}/\text{m}^3$ )]. This value is converted to a CSF [i.e., risk per (mg/kg-day)] by dividing the unit risk factor by the average respiration rate of an adult (20  $\text{m}^3/\text{day}$ ) and multiplying it by the average body weight (70 kg) and by 1,000 to convert micrograms to milligrams.

**Evaluation of Polycyclic Aromatic Hydrocarbons (PAHs).** Seven PAHs [benzo(a)pyrene, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenz(a,h)anthracene, indeno(1,2,3-cd)pyrene] are considered to be potentially carcinogenic. Adequate toxicity data are available to determine a CSF only for benzo(a)pyrene, therefore, risks from the other potentially carcinogenic PAHs will be estimated using a toxicity equivalency approach. This approach assigns a relative toxicity, reported as a relative potency factors (RPFs) to each of the seven potentially carcinogenic PAHs. Exposure concentrations are converted to equivalent concentrations of benzo(a)pyrene by multiplying the concentration by the appropriate RPF. This results in Benzo(a)pyrene

equivalent concentration for each of the other PAHs. The CSF for benzo(a)pyrene is used to evaluate risk from the total benzo(a)pyrene equivalent concentration. RPFs developed by EPA (1993) are listed below:

Compound	RPF
Benzo(a)pyrene	1.0
Benzo(a)anthracene	0.1
Benzo(b)fluoranthene	0.1
Benzo(k)fluoranthene	0.01
Chrysene	0.001
Dibenz(a,h) anthracene	1.0
Indeno(1,2,3-cd)pyrene	0.1

### Noncancer Effects

Many chemicals pose a potential health effect other than cancer. The range of potential noncancer effects is great (e.g., ranging from liver damage to dental fluorosis). The evaluation of noncancer effects (EPA 1989) involves:

- Identification of the critical effect (or threshold effect) for each duration of exposure [i.e., the adverse effect that occurs at the lowest dose (e.g., if liver damage occurs at 20 mg/kg-day, and mortality occurs at 100 mg/kg-day, liver damage is the critical effect].
- Quantification of the threshold dose for the critical effect for each duration of exposure (i.e., the dose at or above which the effect occurs, and below which the effect does not occur).
- Development of an uncertainty factor (i.e., quantification of the uncertainty associated with interspecies extrapolation, intraspecies variation in sensitivity, severity of the critical effect and slope of the dose-response curve, and deficiencies in the database) in regard to developing a reference dose (RfD) for human exposure.
- Identification of the target organ(s) for the critical effect for each route of exposure.

The information described above is used to derive reference doses (RfDs), expressed as mg/kg-day, which is considered to be the dose to humans at which adverse effects are not expected to occur. Because it is assumed that there is a threshold (e.g., a safe dose for noncarcinogens), the RfD is a non-probabilistic expression of the likelihood that an adverse effect might occur. RfDs are derived separately for oral and inhalation exposure pathways because of possible differences in the rate of absorption, target organs, and mechanisms of toxicity.

The inhalation toxicity is generally expressed as the reference concentration (i.e., that concentration of a chemical in air that is not likely to have an adverse effect upon human receptors). The reference concentration is converted to an RfD by multiplying the reference concentration ( $\mu\text{g}/\text{m}^3$ ) by the average respiration rate of an adult (20  $\text{m}^3/\text{day}$ ) and dividing by the average body weight (70 kg). The final RfD value is converted from micrograms to milligrams by dividing by 1,000.

Chronic exposure is generally defined as an exposure equal to or greater than 7 years. Some receptors (i.e., construction workers and on-site child residents) have a subchronic exposure. As a conservative measure, chronic RfDs, may be used to evaluate the potential adverse health effects associated with subchronic exposure to chemicals.

**Evaluation of Lead.** No suitable dose-response values exist for assessing the risks associated with exposure to lead. The EPA has developed an Adult lead model for evaluating lead exposure. This model will be used if necessary to evaluate lead at Load Line 1.

**Evaluation of Copper.** No RfD is available for elemental copper. However, EPA established an action level of 1300 µg/L for drinking water. This is converted to an RfD of 0.037 mg/kg-day by multiplying by a standard drinking water ingestion rate of 2 L/day and dividing by an average adult body weight of 70 kg and a conversion factor of 1000 µg/mg.

### **Dermal Evaluation of Chemicals**

Methodologies for estimating inhaled or ingested intake of a chemical account for the amount of chemical presented to the barrier membrane of the pulmonary or gastrointestinal mucosa, respectively. However, the dermal dose is estimated as the dose that crosses the skin and is systematically absorbed. For this reason, dermal toxicity values must be based on absorbed dose.

Dermal RfD and CSF values may be derived from the corresponding oral values. In the derivation of a dermal RfD, the oral RfD is multiplied by a gastrointestinal absorption factor (GAF), expressed as a unitless fraction. The resulting dermal RfD is an RfD based on absorbed dose, which is the appropriate value with which to compare dermal doses because dermal doses are expressed as absorbed rather than exposure doses. In a similar manner, and for the same reasons, a dermal CSF is derived by dividing the oral cancer slope factor by the GAF.

Not all COPCs have specific GAF values. When quantitative data are insufficient, a default GAF is used. Default values of 0.9 for organic chemicals and 0.05 for inorganic chemicals will be used (USACE 2000 personal communication between D. Brancato, USACE, and S. Robers, SAIC).

## **C.4 RISK CHARACTERIZATION**

Risk characterization is the final step during which exposure and toxicity information are integrated to qualitatively or quantitatively evaluate the potential health risks associated with exposure to contaminants. Quantitative estimates of both carcinogenic and noncarcinogenic risks are calculated for each contaminant and each potentially complete exposure pathway.

### **Methodology for Carcinogens**

The risk attributed to exposure to chemical carcinogens is estimated as the probability of an individual developing cancer over a lifetime as a result of exposure to a potential carcinogen. At low doses, the risk of developing cancer is determined as follows (EPA 1989):

$$Risk = (CDI)(SF),$$

where:

- Risk = risk of cancer incidence, expressed as a unitless probability,
- CDI = chronic daily intake averaged over 70 years (mg/kg-day),
- SF = slope factor (mg/kg-day)<sup>-1</sup>.

For a given pathway with simultaneous exposure of a receptor to several carcinogens, the following equation is used to sum cancer risks:

$$Risk_{total} = Risk(chem_1) + Risk(chem_2) + \dots + Risk(chem_i),$$

where:

Risk = total risk of cancer incidence,  
 $chem_i$  = individual carcinogenic chemical.

Contaminants contributing significantly to the total risk associated with a site are identified as contaminants of concern (COC).

### Methodology for Noncarcinogens

The risks associated with the effects of noncarcinogenic hazardous chemicals are evaluated by comparing an exposure level or intake to a reference dose. The ratio of intake over the reference dose is termed the Hazard Quotient (HQ) (EPA 1989) and is defined as:

$$HQ = I/RfD,$$

where:

HQ = hazard quotient (unitless),  
 I = intake of a chemical (mg/kg-day),  
 RfD = reference dose (mg/kg-day).

When using this equation to estimate potential risk, both the intake and the RfD must refer to exposures of equivalent duration (i.e., sub-chronic, chronic, or less than two weeks). Chemical exposures are evaluated in all cases on a chronic basis, using chronic RfD values.

This approach is different from the probabilistic approach used to evaluate carcinogens. An HQ of 0.01 does not imply a 1 in 100 chance of an adverse effect, but indicates only that the estimated intake is 100 times less than the reference dose. An HQ of unity (1) indicates that the exposure intake is equal to the RfD. If the HQ is greater than 1, or above unity, there may be concern for potential health effects.

In the case of simultaneous exposure of a receptor to several chemicals, a Hazard Index (HI) is calculated as the sum of the Hazard Quotients by:

$$HI = I_1/RfD_1 + I_2/RfD_2 + \dots I_i/RfD_i,$$

where:

$I_i$  = intake for the  $i^{th}$  toxicant, where  $i = 1, 2, 3$   
 $RfD_i$  = reference dose for the  $i^{th}$  toxicant, where  $i = 1, 2, 3$

Hazard indices are determined by assuming dose additivity for those chemicals acting by the same mechanism and inducing the same effects (EPA 1989). Initially all of the chemicals are assumed to have the same mechanism of toxicity. If the HI is below 1, then the target organ specific HIs will also be below 1.0. If the HI exceeds 1.0, then HIs are calculated for each target organ. This provides a more accurate estimation of the potential systemic toxicity associated with exposure to a chemical mixture.

### Uncertainty

There are uncertainties associated with all phases of the Human Health Risk Assessment (HHRA), including collection and laboratory analysis of the samples, exposure assessment, toxicity assessment, and risk characterization. Site-specific uncertainties will be discussed as part of the risk assessment and the impact of the uncertainties will be qualitatively addressed.

### **Uncertainty in Exposure Assessment**

Three major types of uncertainties should be considered when reviewing the results of the exposure assessment: (1) uncertainties associated with predicting future land use, (2) uncertainties associated with estimating chemical concentrations at receptor locations, and (3) uncertainties associated with assumptions used in the exposure models.

Physiological values (e.g., body weight, inhalation rates) and behavioral values (e.g., average time spent in one place, amount of soil ingested) used to model the RME are a combination of average and upper-bound levels taken from reliable sources. The use of upper-bound estimates will tend to overestimate exposure for the RME. Therefore, the predicted risks are likely to be greater than the actual risks. This provides a conservative, health-protective approach for the risk assessment.

### **Uncertainty in Toxicity Assessment**

The toxicological parameters used to quantify potential risk to a receptor include CSFs and RfDs. These values are often derived from laboratory animal studies. The following overriding uncertainties associated with the use of laboratory animal studies are:

- The extrapolation of toxic effects observed at the high dose necessary to conduct animal studies to effects that might occur at the much lower, environmentally relevant doses.
- The extrapolation from toxic effects in animals to toxic effects in man (i.e., the potential for animal responses to differ from responses of man).

The EPA has derived CSFs using a weight-of-evidence approach from studies in the scientific literature. The CSFs represent the upper 95% confidence limits on the slope of the dose response curve for carcinogenic responses. Because CSFs represent the near upper limits of the slope of the line, the use of the CSF is more likely to overestimate the actual risk than under estimate it.

Uncertainties also arise in the development of the RfDs used to characterize noncarcinogenic effects. These reference values are derived using studies in humans or animals by identifying the lowest-observed-adverse-effect level (LOAEL) or no-observed-adverse-effect level (NOAEL). Two basic types of uncertainty arise. The first is related to the extrapolation from toxic effects seen at high dose to predict effects at the low dose usually encountered in the environment. The second involves extrapolation from effects in animals to effects in man. Each of these is offset by an uncertainty factor that is actually a product of as many as five separate factors, each intended to account for one type of uncertainty (EPA 1989). The LOAEL and NOAEL are divided by this composite uncertainty factor. The uncertainty factors usually range from 10 to 10,000. The five types of uncertainty (each representing an uncertainty factor of 5 to 10) included in the assignment of the uncertainty factor are:

- sensitive subpopulations in the general population,
- extrapolation from animals to humans,
- extrapolation from a subchronic study to a chronic estimate,

- extrapolation from a LOAEL to a NOAEL, and
- additional uncertainties in the critical study used in setting the RfD or reference concentration.

In addition, the absence of established toxicity criteria for some COPCs may result in an underestimation of risks.

### Uncertainty in Risk Characterization

The risk characterization evaluates the potential risks associated with exposure to numerous chemicals via multiple pathways. There is uncertainty associated with exposure to chemical mixtures because chemicals may have synergistic or antagonistic effects on other chemicals. It is assumed that all chemicals have additive toxicity and that the potential health effects would be equal to the sum of each of the individual chemical actions for chemicals that act upon the same target organ. This may result in the overestimation or underestimation of certain risks.

In general, sources of uncertainty may be categorized into site-specific factors (e.g., variability in analytical data, modeling results, and exposure parameter assumptions) and toxicity factors. The use of conservative assumptions in the risk assessment is believed to result in an overestimate of risk. Actual site risks are likely to be lower.

## C.5 REFERENCES

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Table C-1. Parameters Used to Quantify Exposures for Each Medium and Receptor

Parameter	Units	Security Guard/ Maintenance Worker (1)	Hunter/ Trapper (2)	Child Trespasser (3)	National Guard Trainee (4)	Open Recreator (5)	Open Industrial Worker (6)	Resident Farmer (child/adult) (7)
<b>Pathway</b>								
<i>Surface Soil</i>								
<b>Incidental ingestion</b>								
Soil ingestion rate (Adult)	kg/day	0.000 <sup>a</sup>	0.0001 <sup>a</sup>	NA	0.0001 <sup>a</sup>	0.0001 <sup>a</sup>	0.0001 <sup>a</sup>	0.0001 <sup>a</sup>
Soil ingestion rate (Child)	kg/day	NA	NA	0.0002 <sup>a</sup>	NA	NA	NA	0.0002 <sup>a</sup>
Exposure time	hours/day	1 <sup>b</sup>	2 <sup>b</sup>	2 <sup>q</sup>	8 <sup>b</sup>	1 <sup>b</sup>	NA	NA
Exposure frequency	days/year	250 <sup>a</sup>	90 <sup>b</sup>	50 <sup>q</sup>	180 <sup>b</sup>	75 <sup>b</sup>	250 <sup>a</sup>	350 <sup>a</sup>
Exposure duration (Adult)	years	25 <sup>a</sup>	30 <sup>b</sup>	NA	25 <sup>b</sup>	30 <sup>a</sup>	25 <sup>a</sup>	24 <sup>a</sup>
Exposure duration (Child)	years	NA	NA	10 <sup>q</sup>	NA	NA	NA	6 <sup>a</sup>
Body weight (Adult)	kg	70 <sup>a</sup>	70 <sup>a</sup>	NA	70 <sup>a</sup>	70 <sup>a</sup>	70 <sup>a</sup>	70 <sup>a</sup>
Body weight (Child)	kg	NA	NA	45 <sup>r</sup>	NA	NA	NA	15 <sup>a</sup>
Carcinogen averaging time	days	25550 <sup>a</sup>	25550 <sup>a</sup>	25550 <sup>a</sup>	25550 <sup>a</sup>	25550 <sup>a</sup>	25550 <sup>a</sup>	25550 <sup>a</sup>
Noncarcinogen averaging time (Adult)	days	9125 <sup>a</sup>	10950 <sup>a</sup>	NA	9125 <sup>a</sup>	10950 <sup>a</sup>	9125 <sup>a</sup>	8760 <sup>a</sup>
Noncarcinogen averaging time (Child)	days	NA	NA	3650 <sup>a</sup>	NA	NA	NA	2190 <sup>a</sup>
Fraction Ingested	unitless	1 <sup>b</sup>	1 <sup>b</sup>	1 <sup>b</sup>	1 <sup>b</sup>	1 <sup>b</sup>	1 <sup>b</sup>	1 <sup>b</sup>
Conversion Factor	days/hour	0.042	0.042	0.042	0.042	0.042	NA	NA
<b>Dermal contact</b>								
Skin area	m <sup>2</sup> /event	0.33 <sup>d</sup>	0.57 <sup>d</sup>	0.815 <sup>c</sup>	0.33 <sup>d</sup>	0.57 <sup>d</sup>	0.33 <sup>d</sup>	0.57 <sup>d</sup>
Adherence factor	mg/cm <sup>2</sup>	0.7 <sup>c</sup>	0.07 <sup>c</sup>	0.2 <sup>c</sup>	0.3 <sup>c</sup>	0.07 <sup>c</sup>	0.2 <sup>c</sup>	0.4 <sup>c</sup>
Exposure frequency	events/year	250 <sup>a</sup>	90 <sup>b</sup>	50 <sup>q</sup>	180 <sup>b</sup>	75 <sup>c</sup>	250 <sup>a</sup>	350 <sup>a</sup>
Exposure duration	years	25 <sup>a</sup>	30 <sup>b</sup>	10 <sup>q</sup>	25 <sup>b</sup>	30 <sup>a</sup>	25 <sup>a</sup>	30 <sup>a</sup>
Body weight	kg	70 <sup>a</sup>	70 <sup>a</sup>	45 <sup>r</sup>	70 <sup>a</sup>	70 <sup>a</sup>	70 <sup>a</sup>	70 <sup>a</sup>
Carcinogen averaging time	days	25550 <sup>a</sup>	25550 <sup>a</sup>	25550 <sup>a</sup>	25550 <sup>a</sup>	25550 <sup>a</sup>	25550 <sup>a</sup>	25550 <sup>a</sup>
Noncarcinogen averaging time	days	9125 <sup>a</sup>	10950 <sup>a</sup>	3650 <sup>a</sup>	9125 <sup>a</sup>	10950 <sup>a</sup>	9125 <sup>a</sup>	10950 <sup>a</sup>
Conversion Factor	(kg-cm <sup>2</sup> )/(mg-m <sup>2</sup> )	0.01	0.01	0.01	0.01	0.01	0.01	0.01
<b>Inhalation of VOCs and dust</b>								
Inhalation rate	m <sup>3</sup> /day	20 <sup>a</sup>	20 <sup>a</sup>	20 <sup>a</sup>	20 <sup>a</sup>	20 <sup>a</sup>	20 <sup>a</sup>	20 <sup>a</sup>
Exposure time	hours/day	1 <sup>b</sup>	2 <sup>b</sup>	2 <sup>q</sup>	8 <sup>b</sup>	1 <sup>b</sup>	NA	NA
Exposure frequency	days/year	250 <sup>a</sup>	90 <sup>b</sup>	50 <sup>q</sup>	180 <sup>b</sup>	75 <sup>c</sup>	250 <sup>a</sup>	350 <sup>a</sup>
Exposure duration	years	25 <sup>a</sup>	30 <sup>b</sup>	10 <sup>q</sup>	25 <sup>b</sup>	30 <sup>a</sup>	25 <sup>a</sup>	30 <sup>a</sup>

Table C-1. Parameters Used to Quantify Exposures for Each Medium and Receptor (continued)

Parameter	Units	Security Guard/ Maintenance Worker (1)	Hunter/ Trapper (2)	Child Trespasser (3)	National Guard Trainee (4)	Open Recreator (5)	Open Industrial Worker (6)	Resident Farmer (7)
Body weight	kg	70 <sup>a</sup>	70 <sup>a</sup>	45 <sup>f</sup>	70 <sup>a</sup>	70 <sup>a</sup>	70 <sup>a</sup>	70 <sup>a</sup>
Carcinogen averaging time	days	25550 <sup>a</sup>	25550 <sup>a</sup>	25550 <sup>a</sup>	25550 <sup>a</sup>	25550 <sup>a</sup>	25550 <sup>a</sup>	25550 <sup>a</sup>
Noncarcinogen averaging time	days	9125 <sup>a</sup>	10950 <sup>a</sup>	3650 <sup>a</sup>	9125 <sup>a</sup>	10950 <sup>a</sup>	9125 <sup>a</sup>	10950 <sup>a</sup>
Conversion Factor	days/hour	0.042	0.042	0.042	0.042	0.042	NA	NA
<i>Subsurface Soil</i>								
<b>Incidental ingestion</b>								
Soil ingestion rate (Adult)	kg/day	NA	NA	NA	0.0001 <sup>a</sup>	NA	0.0001 <sup>a</sup>	0.0001 <sup>a</sup>
Soil ingestion rate (Child)	kg/day	NA	NA	NA	NA	NA	NA	0.0002 <sup>a</sup>
Exposure time	hours/day	NA	NA	NA	8 <sup>b</sup>	NA	NA	NA
Exposure frequency	days/year	NA	NA	NA	28 <sup>b</sup>	NA	250 <sup>a</sup>	350 <sup>a</sup>
Exposure duration (Adult)	years	NA	NA	NA	25 <sup>b</sup>	NA	25 <sup>a</sup>	24 <sup>a</sup>
Exposure duration (Child)	years	NA	NA	NA	NA	NA	NA	6 <sup>a</sup>
Body weight (Adult)	kg	NA	NA	NA	70 <sup>a</sup>	NA	70 <sup>a</sup>	70 <sup>a</sup>
Body weight (Child)	kg	NA	NA	NA	NA	NA	NA	15 <sup>a</sup>
Carcinogen averaging time	days	NA	NA	NA	25550 <sup>a</sup>	NA	25550 <sup>a</sup>	25550 <sup>a</sup>
Noncarcinogen averaging time (Adult)	days	NA	NA	NA	9125 <sup>a</sup>	NA	9125 <sup>a</sup>	8760 <sup>a</sup>
Noncarcinogen averaging time (Child)	days	NA	NA	NA	NA	NA	NA	2190 <sup>a</sup>
Fraction Ingested	unitless	NA	NA	NA	1 <sup>b</sup>	NA	1 <sup>b</sup>	1 <sup>b</sup>
Conversion Factor	days/hour	NA	NA	NA	0.042	NA	NA	NA
<b>Dermal contact</b>								
Skin area	m <sup>2</sup> /event	NA	NA	NA	0.316 <sup>d</sup>	NA	0.316 <sup>d</sup>	0.53 <sup>e</sup>
Adherence factor	mg/cm <sup>2</sup>	NA	NA	NA	1 <sup>c</sup>	NA	1 <sup>c</sup>	1 <sup>c</sup>
Exposure frequency	events/year	NA	NA	NA	28 <sup>b</sup>	NA	250 <sup>a</sup>	350 <sup>a</sup>
Exposure duration	years	NA	NA	NA	25 <sup>b</sup>	NA	25 <sup>a</sup>	30 <sup>a</sup>
Body weight	kg	NA	NA	NA	70 <sup>a</sup>	NA	70 <sup>a</sup>	70 <sup>a</sup>
Carcinogen averaging time	days	NA	NA	NA	25550 <sup>a</sup>	NA	25550 <sup>a</sup>	25550 <sup>a</sup>
Noncarcinogen averaging time	days	NA	NA	NA	9125 <sup>a</sup>	NA	9125 <sup>a</sup>	10950 <sup>a</sup>
Conversion Factor	(kg-cm <sup>2</sup> )/(mg-m <sup>2</sup> )	NA	NA	NA	0.01	NA	0.01	0.01

Table C-1. Parameters Used to Quantify Exposures for Each Medium and Receptor (continued)

Parameter	Units	Security Guard/ Maintenance Worker (1)	Hunter/ Trapper (2)	Child Trespasser (3)	National Guard Trainee (4)	Open Recreator (5)	Open Industrial Worker (6)	Resident Farmer (7)
<b>Inhalation of VOCs and dust</b>								
Inhalation rate	m <sup>3</sup> /day	NA	NA	NA	20 <sup>a</sup>	NA	20 <sup>a</sup>	20 <sup>a</sup>
Exposure time	hours/day	NA	NA	NA	8 <sup>b</sup>	NA	NA	NA
Exposure frequency	days/year	NA	NA	NA	28 <sup>b</sup>	NA	250 <sup>a</sup>	350 <sup>a</sup>
Exposure duration	years	NA	NA	NA	25 <sup>b</sup>	NA	25 <sup>a</sup>	30 <sup>a</sup>
Body weight	kg	NA	NA	NA	70 <sup>a</sup>	NA	70 <sup>a</sup>	70 <sup>a</sup>
Carcinogen averaging time	days	NA	NA	NA	25550 <sup>a</sup>	NA	25550 <sup>a</sup>	25550 <sup>a</sup>
Noncarcinogen averaging time	days	NA	NA	NA	9125 <sup>a</sup>	NA	9125 <sup>a</sup>	10950 <sup>a</sup>
Conversion Factor	days/hour	NA	NA	NA	0.042	NA	NA	NA
<i>Sediment</i>								
<b>Incidental ingestion</b>								
Soil ingestion rate (Adult)	kg/day	NA	0.0001 <sup>a</sup>	NA	0.0001 <sup>a</sup>	0.0001 <sup>a</sup>	NA	0.0001 <sup>a</sup>
Soil ingestion rate (Child)	kg/day	NA	NA	0.0002 <sup>a</sup>	NA	NA	NA	0.0002 <sup>a</sup>
Exposure time	hours/day	NA	2 <sup>b</sup>	2 <sup>q</sup>	8 <sup>b</sup>	1 <sup>b</sup>	NA	NA
Exposure frequency	days/year	NA	90 <sup>b</sup>	50 <sup>q</sup>	28 <sup>b</sup>	75 <sup>c</sup>	NA	350 <sup>a</sup>
Exposure duration (Adult)	years	NA	30 <sup>b</sup>	NA	25 <sup>b</sup>	30 <sup>a</sup>	NA	24 <sup>a</sup>
Exposure duration (Child)	years	NA	NA	10 <sup>q</sup>	NA	NA	NA	6 <sup>a</sup>
Body weight (Adult)	kg	NA	70 <sup>a</sup>	NA	70 <sup>a</sup>	70 <sup>a</sup>	NA	70 <sup>a</sup>
Body weight (Child)	kg	NA	NA	45 <sup>r</sup>	NA	NA	NA	15 <sup>a</sup>
Carcinogen averaging time	days	NA	25550 <sup>a</sup>	25550 <sup>a</sup>	25550 <sup>a</sup>	25550 <sup>a</sup>	NA	25550 <sup>a</sup>
Noncarcinogen averaging time (Adult)	days	NA	10950 <sup>a</sup>	NA	9125 <sup>a</sup>	10950 <sup>a</sup>	NA	8760 <sup>a</sup>
Noncarcinogen averaging time (Child)	days	NA	NA	3650 <sup>a</sup>	NA	NA	NA	2190 <sup>a</sup>
Fraction Ingested	unitless	NA	1 <sup>b</sup>	1 <sup>b</sup>	1 <sup>b</sup>	1 <sup>b</sup>	NA	1 <sup>b</sup>
Conversion Factor	days/hour	NA	0.042	0.042	0.042	0.042	NA	NA
<b>Dermal contact</b>								
Skin area	m <sup>2</sup> /event	NA	0.53 <sup>e</sup>	0.815 <sup>f</sup>	0.316 <sup>d</sup>	0.53 <sup>e</sup>	NA	0.53 <sup>e</sup>
Adherence factor	mg/cm <sup>2</sup>	NA	1 <sup>c</sup>	0.2 <sup>c</sup>	1 <sup>c</sup>	1 <sup>c</sup>	NA	1 <sup>c</sup>
Exposure frequency	events/year	NA	90 <sup>b</sup>	50 <sup>q</sup>	28 <sup>b</sup>	75 <sup>c</sup>	NA	350 <sup>a</sup>
Exposure duration	years	NA	30 <sup>b</sup>	10 <sup>q</sup>	25 <sup>b</sup>	30 <sup>a</sup>	NA	30 <sup>a</sup>
Body weight	kg	NA	70 <sup>a</sup>	45 <sup>r</sup>	70 <sup>a</sup>	70 <sup>a</sup>	NA	70 <sup>a</sup>

Table C-1. Parameters Used to Quantify Exposures for Each Medium and Receptor (continued)

Parameter	Units	Security Guard/ Maintenance Worker (1)	Hunter/ Trapper (2)	Child Trespasser (3)	National Guard Trainee (4)	Open Recreator (5)	Open Industrial Worker (6)	Resident Farmer (7)
Carcinogen averaging time	days	NA	25550 <sup>a</sup>	25550 <sup>a</sup>	25550 <sup>a</sup>	25550 <sup>a</sup>	NA	25550 <sup>a</sup>
Noncarcinogen averaging time	days	NA	10950 <sup>a</sup>	3650 <sup>a</sup>	9125 <sup>a</sup>	10950 <sup>a</sup>	NA	10950 <sup>a</sup>
Conversion Factor	(kg-cm <sup>2</sup> )/(mg-m <sup>2</sup> )	NA	0.01	0.01	0.01	0.01	NA	0.01
<b>Inhalation of VOCs and dust</b>								
Inhalation rate	m <sup>3</sup> /day	NA	20 <sup>a</sup>	20 <sup>a</sup>	20 <sup>a</sup>	20 <sup>a</sup>	NA	20 <sup>a</sup>
Exposure time	hours/day	NA	2 <sup>b</sup>	2 <sup>q</sup>	8 <sup>b</sup>	1 <sup>b</sup>	NA	NA
Exposure frequency	days/year	NA	90 <sup>b</sup>	50 <sup>q</sup>	28 <sup>b</sup>	75 <sup>c</sup>	NA	350 <sup>a</sup>
Exposure duration	years	NA	30 <sup>b</sup>	10 <sup>q</sup>	25 <sup>b</sup>	30 <sup>a</sup>	NA	30 <sup>a</sup>
Body weight	kg	NA	70 <sup>a</sup>	45 <sup>r</sup>	70 <sup>a</sup>	70 <sup>a</sup>	NA	70 <sup>a</sup>
Carcinogen averaging time	days	NA	25550 <sup>a</sup>	25550 <sup>a</sup>	25550 <sup>a</sup>	25550 <sup>a</sup>	NA	25550 <sup>a</sup>
Noncarcinogen averaging time	days	NA	10950 <sup>a</sup>	3650 <sup>a</sup>	9125 <sup>a</sup>	10950 <sup>a</sup>	NA	10950 <sup>a</sup>
Conversion Factor	days/hour	NA	0.042	0.042	0.042	0.042	NA	NA
<i>Surface Water</i>								
<b>Incidental ingestion while swimming/wading/showering</b>								
Drinking water ingestion rate	L/day	NA	NA	NA	NA	NA	NA	2 <sup>a</sup>
Incidental water ingestion rate	L/hour	NA	0.05 <sup>g</sup>	0.05 <sup>g</sup>	0.05 <sup>g</sup>	0.05 <sup>g</sup>	NA	NA
Exposure time	hours/day	NA	2 <sup>b</sup>	2 <sup>q</sup>	8 <sup>b</sup>	1 <sup>b</sup>	NA	NA
Exposure frequency	days/year	NA	90 <sup>b</sup>	50 <sup>q</sup>	28 <sup>b</sup>	45 <sup>b</sup>	NA	350 <sup>a</sup>
Exposure duration	years	NA	30 <sup>b</sup>	10 <sup>q</sup>	25 <sup>b</sup>	30 <sup>a</sup>	NA	30 <sup>a</sup>
Body weight	kg	NA	70 <sup>a</sup>	45 <sup>r</sup>	70 <sup>a</sup>	70 <sup>a</sup>	NA	70 <sup>a</sup>
Carcinogen averaging time	days	NA	25550 <sup>a</sup>	25550 <sup>a</sup>	25550 <sup>a</sup>	25550 <sup>a</sup>	NA	25550 <sup>a</sup>
Noncarcinogen averaging time	days	NA	10950 <sup>a</sup>	3650 <sup>a</sup>	9125 <sup>a</sup>	10950 <sup>a</sup>	NA	10950 <sup>a</sup>
<b>Dermal contact while swimming/wading/showering</b>								
Skin area	m <sup>2</sup>	NA	0.53 <sup>e</sup>	1.733 <sup>i</sup>	0.53 <sup>e</sup>	1.94 <sup>c</sup>	NA	1.94 <sup>c</sup>
Exposure time	hours/day	NA	2 <sup>b</sup>	2 <sup>q</sup>	8 <sup>b</sup>	1 <sup>b</sup>	NA	0.25 <sup>c</sup>
Exposure frequency	days/year	NA	90 <sup>b</sup>	50 <sup>q</sup>	28 <sup>b</sup>	45 <sup>b</sup>	NA	350 <sup>a</sup>
Exposure duration	years	NA	30 <sup>b</sup>	10 <sup>q</sup>	25 <sup>b</sup>	30 <sup>a</sup>	NA	30 <sup>a</sup>
Body weight	kg	NA	70 <sup>a</sup>	45 <sup>r</sup>	70 <sup>a</sup>	70 <sup>a</sup>	NA	70 <sup>a</sup>
Carcinogen averaging time	days	NA	25550 <sup>a</sup>	25550 <sup>a</sup>	25550 <sup>a</sup>	25550 <sup>a</sup>	NA	25550 <sup>a</sup>
Noncarcinogen averaging time	days	NA	10950 <sup>a</sup>	3650 <sup>a</sup>	9125 <sup>a</sup>	10950 <sup>a</sup>	NA	10950 <sup>a</sup>

Table C-1. Parameters Used to Quantify Exposures for Each Medium and Receptor (continued)

Parameter	Units	Security Guard/ Maintenance Worker (1)	Hunter/ Trapper (2)	Child Trespasser (3)	National Guard Trainee (4)	Open Recreator (5)	Open Industrial Worker (6)	Resident Farmer (7)
Conversion Factor	(m/cm)(L/m <sup>3</sup> )	NA	10	10	10	10	NA	10
<b>Inhalation of VOCs</b>								
Inhalation rate	m <sup>3</sup> /day	NA	20 <sup>a</sup>	20 <sup>a</sup>	20 <sup>a</sup>	20 <sup>a</sup>	NA	20 <sup>a</sup>
Exposure time	hours/day	NA	2 <sup>b</sup>	2 <sup>q</sup>	8 <sup>b</sup>	1 <sup>b</sup>	NA	NA
Exposure frequency	days/year	NA	90 <sup>b</sup>	50 <sup>q</sup>	28 <sup>b</sup>	45 <sup>b</sup>	NA	350 <sup>a</sup>
Exposure duration	years	NA	30 <sup>b</sup>	10 <sup>q</sup>	25 <sup>b</sup>	30 <sup>a</sup>	NA	30 <sup>a</sup>
Body weight	kg	NA	70 <sup>a</sup>	45 <sup>r</sup>	70 <sup>a</sup>	70 <sup>a</sup>	NA	70 <sup>a</sup>
Carcinogen averaging time	days	NA	25550 <sup>a</sup>	25550 <sup>a</sup>	25550 <sup>a</sup>	25550 <sup>a</sup>	NA	25550 <sup>a</sup>
Noncarcinogen averaging time	days	NA	10950 <sup>a</sup>	3650 <sup>a</sup>	9125 <sup>a</sup>	10950 <sup>a</sup>	NA	10950 <sup>a</sup>
Conversion Factor	days/hour	NA	0.042	0.042	0.042	0.042	NA	NA
Volatilization factor	L/m <sup>3</sup>	NA	0.5 <sup>a</sup>	0.5 <sup>a</sup>	0.5 <sup>a</sup>	0.5 <sup>a</sup>	NA	0.5 <sup>a</sup>
<i>Groundwater</i>								
<b>Drinking water ingestion</b>								
Drinking water ingestion rate	L/day	NA	NA	NA	1 <sup>a</sup>	NA	NA	2 <sup>a</sup>
Exposure frequency	days/year	NA	NA	NA	180 <sup>b</sup>	NA	NA	350 <sup>a</sup>
Exposure duration	years	NA	NA	NA	25 <sup>b</sup>	NA	NA	30 <sup>a</sup>
Body weight	kg	NA	NA	NA	70 <sup>a</sup>	NA	NA	70 <sup>a</sup>
Carcinogen averaging time	days	NA	NA	NA	25550 <sup>a</sup>	NA	NA	25550 <sup>a</sup>
Noncarcinogen averaging time	days	NA	NA	NA	9125 <sup>a</sup>	NA	NA	10950 <sup>a</sup>
<b>Dermal contact while showering</b>								
Skin area	m <sup>2</sup>	NA	NA	NA	1.94 <sup>h</sup>	NA	NA	1.94 <sup>h</sup>
Exposure time	hours/day	NA	NA	NA	0.25 <sup>c</sup>	NA	NA	0.25 <sup>c</sup>
Exposure frequency	days/year	NA	NA	NA	180 <sup>b</sup>	NA	NA	350 <sup>a</sup>
Exposure duration	years	NA	NA	NA	25 <sup>b</sup>	NA	NA	30 <sup>a</sup>
Body weight	kg	NA	NA	NA	70 <sup>a</sup>	NA	NA	70 <sup>a</sup>
Carcinogen averaging time	days	NA	NA	NA	25550 <sup>a</sup>	NA	NA	25550 <sup>a</sup>
Noncarcinogen averaging time	days	NA	NA	NA	9125 <sup>a</sup>	NA	NA	10950 <sup>a</sup>
Conversion Factor	(m/cm)(L/m <sup>3</sup> )	NA	NA	NA	10	NA	NA	10

Table C-1. Parameters Used to Quantify Exposures for Each Medium and Receptor (continued)

Parameter	Units	Security Guard/ Maintenance Worker (1)	Hunter/ Trapper (2)	Child Trespasser (3)	National Guard Trainee (4)	Open Recreator (5)	Open Industrial Worker (6)	Resident Farmer (7)
<b>Inhalation of VOCs during household water use</b>								
Inhalation rate	m <sup>3</sup> /day	NA	NA	NA	20 <sup>a</sup>	NA	NA	20 <sup>a</sup>
Exposure frequency	days/year	NA	NA	NA	180 <sup>b</sup>	NA	NA	350 <sup>a</sup>
Exposure duration	years	NA	NA	NA	25 <sup>b</sup>	NA	NA	30 <sup>a</sup>
Body weight	kg	NA	NA	NA	70 <sup>a</sup>	NA	NA	70 <sup>a</sup>
Carcinogen averaging time	days	NA	NA	NA	25550 <sup>a</sup>	NA	NA	25550 <sup>a</sup>
Noncarcinogen averaging time	days	NA	NA	NA	9125 <sup>a</sup>	NA	NA	10950 <sup>a</sup>
Volatilization factor	L/m <sup>3</sup>	NA	NA	NA	0.5 <sup>a</sup>	NA	NA	0.5 <sup>a</sup>
<i>Foodstuffs</i>								
<b>Ingestion of venison</b>								
Conversion factor	unitless	NA	1.25	NA	NA	NA	NA	1.25
Browse ingestion rate	kg dry weight/day	NA	0.87 <sup>b</sup>	NA	NA	NA	NA	0.87 <sup>b</sup>
Fraction browse ingested from site	unitless	NA	0.46 <sup>b</sup>	NA	NA	NA	NA	0.46 <sup>b</sup>
Fat ratio (venison to beef)	unitless	NA	0.20	NA	NA	NA	NA	0.20
Venison ingestion rate	kg/day	NA	0.03 <sup>b</sup>	NA	NA	NA	NA	0.03 <sup>b</sup>
Fraction ingested	unitless	NA	1 <sup>b</sup>	NA	NA	NA	NA	1 <sup>b</sup>
Exposure frequency	days/year	NA	365 <sup>b</sup>	NA	NA	NA	NA	365 <sup>b</sup>
Exposure duration	years	NA	30 <sup>b</sup>	NA	NA	NA	NA	30 <sup>a</sup>
Body weight	kg	NA	70 <sup>a</sup>	NA	NA	NA	NA	70 <sup>a</sup>
Carcinogen averaging time	days	NA	25550 <sup>a</sup>	NA	NA	NA	NA	25550 <sup>a</sup>
Noncarcinogen averaging time	days	NA	10950 <sup>a</sup>	NA	NA	NA	NA	10950 <sup>a</sup>
<b>Ingestion of beef, pork</b>								
Resuspension multiplier	unitless	NA	NA	NA	NA	NA	NA	0.25 <sup>j</sup>
Quantity of pasture ingested	kg dry weight/day	NA	NA	NA	NA	NA	NA	7.2 <sup>k</sup>
Fraction of year cow is on-site	unitless	NA	NA	NA	NA	NA	NA	1 <sup>b</sup>
Fraction of cow's food from on-site	unitless	NA	NA	NA	NA	NA	NA	0.9 <sup>b</sup>
Quantity of soil ingested by cow	kg/day	NA	NA	NA	NA	NA	NA	1 <sup>l</sup>
Beef ingestion rate	kg/day	NA	NA	NA	NA	NA	NA	0.075 <sup>m</sup>
Fraction ingested	unitless	NA	NA	NA	NA	NA	NA	1 <sup>b</sup>
Exposure frequency	days/year	NA	NA	NA	NA	NA	NA	365 <sup>b</sup>

**Table C-1. Parameters Used to Quantify Exposures for Each Medium and Receptor (continued)**

Parameter	Units	Security Guard/ Maintenance Worker (1)	Hunter/ Trapper (2)	Child Trespasser (3)	National Guard Trainee (4)	Open Recreator (5)	Open Industrial Worker (6)	Resident Farmer (7)
Exposure duration	years	NA	NA	NA	NA	NA	NA	30 <sup>a</sup>
Body weight	kg	NA	NA	NA	NA	NA	NA	70 <sup>a</sup>
Carcinogen averaging time	days	NA	NA	NA	NA	NA	NA	25550 <sup>a</sup>
Noncarcinogen averaging time	days	NA	NA	NA	NA	NA	NA	10950 <sup>a</sup>
<b>Ingestion of milk products</b>								
Resuspension multiplier	unitless	NA	NA	NA	NA	NA	NA	0.25 <sup>j</sup>
Quantity of pasture ingested	kg dry weight/day	NA	NA	NA	NA	NA	NA	16.1 <sup>k</sup>
Fraction of year cow is on-site	unitless	NA	NA	NA	NA	NA	NA	1 <sup>b</sup>
Fraction of cow's food from on-site	unitless	NA	NA	NA	NA	NA	NA	0.6 <sup>b</sup>
Quantity of soil ingested by cow	kg/day	NA	NA	NA	NA	NA	NA	1 <sup>l</sup>
Milk ingestion rate (Adult)	kg/day	NA	NA	NA	NA	NA	NA	0.305 <sup>m</sup>
Milk ingestion rate (Child)	kg/day	NA	NA	NA	NA	NA	NA	0.509 <sup>n</sup>
Fraction ingested	unitless	NA	NA	NA	NA	NA	NA	1 <sup>b</sup>
Exposure frequency	days/year	NA	NA	NA	NA	NA	NA	365 <sup>b</sup>
Exposure duration (Adult)	years	NA	NA	NA	NA	NA	NA	24 <sup>a</sup>
Exposure duration (Child)	years	NA	NA	NA	NA	NA	NA	6 <sup>a</sup>
Body weight (Adult)	kg	NA	NA	NA	NA	NA	NA	70 <sup>a</sup>
Body weight (Child)	kg	NA	NA	NA	NA	NA	NA	15 <sup>a</sup>
Carcinogen averaging time	days	NA	NA	NA	NA	NA	NA	25550 <sup>a</sup>
Noncarcinogen averaging time (Adult)	days	NA	NA	NA	NA	NA	NA	8760 <sup>a</sup>
Noncarcinogen averaging time (Child)	days	NA	NA	NA	NA	NA	NA	2190 <sup>a</sup>
<b>Ingestion of vegetables</b>								
Resuspension multiplier	unitless	NA	NA	NA	NA	NA	NA	0.26 <sup>o</sup>
Vegetable ingestion rate	kg/day	NA	NA	NA	NA	NA	NA	0.2 <sup>m</sup>
Fraction ingested	unitless	NA	NA	NA	NA	NA	NA	0.4 <sup>m</sup>
Exposure frequency	days/year	NA	NA	NA	NA	NA	NA	365 <sup>b</sup>
Exposure duration	years	NA	NA	NA	NA	NA	NA	30 <sup>a</sup>
Body weight	kg	NA	NA	NA	NA	NA	NA	70 <sup>a</sup>
Carcinogen averaging time	days	NA	NA	NA	NA	NA	NA	25550 <sup>a</sup>
Noncarcinogen averaging time	days	NA	NA	NA	NA	NA	NA	10950 <sup>a</sup>

**Table C-1. Parameters Used to Quantify Exposures for Each Medium and Receptor (continued)**

<b>Parameter</b>	<b>Units</b>	<b>Security Guard/ Maintenance Worker (1)</b>	<b>Hunter/ Trapper (2)</b>	<b>Child Trespasser (3)</b>	<b>National Guard Trainee (4)</b>	<b>Open Recreator (5)</b>	<b>Open Industrial Worker (6)</b>	<b>Resident Farmer (7)</b>
<b>Ingestion of fish</b>								
Fish ingestion rate	kg/day	NA	0.054 <sup>p</sup>	NA	NA	NA	NA	0.054 <sup>p</sup>
Fraction ingested	unitless	NA	1 <sup>b</sup>	NA	NA	NA	NA	1 <sup>b</sup>
Exposure frequency	days/year	NA	365 <sup>b</sup>	NA	NA	NA	NA	365 <sup>b</sup>
Exposure duration	years	NA	30 <sup>b</sup>	NA	NA	NA	NA	30 <sup>a</sup>
Body weight	kg	NA	70 <sup>a</sup>	NA	NA	NA	NA	70 <sup>a</sup>
Carcinogen averaging time	days	NA	25550 <sup>a</sup>	NA	NA	NA	NA	25550 <sup>a</sup>
Noncarcinogen averaging time	days	NA	10950 <sup>a</sup>	NA	NA	NA	NA	10950 <sup>a</sup>

NA = not applicable for this scenario.

<sup>a</sup> RAGS, Part B (EPA 1991c).

<sup>b</sup> Site-specific (value assumed for site or value obtained from site personnel).

<sup>c</sup> Security Guard/Maintenance Worker = Adult Groundskeeper (95<sup>th</sup> percentile); Hunter/Trapper = Residential Default; Child Trespasser = Child Default and Teen Soccer (95<sup>th</sup> percentile); National Guard Trainee = Construction Worker (95<sup>th</sup> percentile); Open Recreator = Adult Soccer (95<sup>th</sup> percentile); Open Industrial Worker = Industrial Default; Resident Farmer = Adult Farmer (95<sup>th</sup> percentile) (USACE 2000b)

<sup>d</sup> Security Guard/Maintenance Worker, National Guard Trainee, and Open Industrial = Industrial Default; Hunter/Trapper, Open Recreator, and Resident Farmer = Adult Residential Default

<sup>e</sup> Average surface area for head, hands, forearms, torso, and lower legs for a child (EPA 1992b).

<sup>f</sup> RAGS, Part A (EPA 1989c).

<sup>g</sup> Average total body surface area for an adult (EPA 1992b).

<sup>h</sup> Average total body surface area for a child (EPA 1992b).

<sup>i</sup> Plant mass loading factor for pasture (Hinton 1992).

<sup>j</sup> International Atomic Energy agency 1994.

<sup>k</sup> Soil ingestion by dairy cattle (Darwin 1990).

<sup>l</sup> Exposure Factors Handbook (EPA 1989d).

<sup>m</sup> Pao, et al., 1982.

<sup>n</sup> Plant mass loading factor for vegetables (Pinder 1989).

<sup>o</sup> Standard default Exposure Factors (EPA 1991b).

<sup>p</sup> OEPA personal communication, June 1999, assumes exposure age 8-18.

<sup>q</sup> Average body weight for child age 8-18 (EPA, 1992b)



**FINAL**

**Part II**

**Quality Assurance Project Plan Addendum  
for the Phase II Remedial Investigation  
of Load Line 12  
at the Ravenna Army Ammunition Plant,  
Ravenna, Ohio**

**September 2000**

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## CONTENTS

### PART II – QUALITY ASSURANCE PROJECT PLAN ADDENDUM

TABLES .....	v
ABBREVIATIONS .....	v
INTRODUCTION .....	vii
1.0 PROJECT DESCRIPTION .....	1-1
1.1 SITE HISTORY/BACKGROUND INFORMATION .....	1-1
1.2 PAST DATA COLLECTION ACTIVITY/CURRENT STATUS .....	1-1
1.3 PROJECT OBJECTIVES AND SCOPE .....	1-1
1.4 SAMPLE NETWORK DESIGN AND RATIONALE .....	1-1
1.5 PARAMETERS TO BE TESTED AND FREQUENCY .....	1-1
1.6 PROJECT SCHEDULE .....	1-1
2.0 PROJECT ORGANIZATION AND RESPONSIBILITY .....	2-1
3.0 QUALITY ASSURANCE OBJECTIVES FOR MEASUREMENT .....	3-1
3.1 DATA QUALITY OBJECTIVES .....	3-1
3.2 LEVEL OF QUALITY CONTROL EFFORT .....	3-1
3.3 ACCURACY, PRECISION, AND SENSITIVITY OF ANALYSIS .....	3-1
3.4 COMPLETENESS, REPRESENTATIVENESS, AND COMPARABILITY .....	3-1
4.0 SAMPLING PROCEDURES .....	4-1
5.0 SAMPLE CUSTODY .....	5-1
5.1 FIELD CHAIN-OF-CUSTODY PROCEDURES .....	5-1
5.2 LABORATORY CHAIN-OF-CUSTODY PROCEDURES .....	5-1
5.3 FINAL EVIDENCE FILES CUSTODY PROCEDURES .....	5-1
6.0 CALIBRATION PROCEDURES AND FREQUENCY .....	6-1
6.1 FIELD INSTRUMENTS/EQUIPMENT .....	6-1
6.2 LABORATORY INSTRUMENTS .....	6-1
7.0 ANALYTICAL PROCEDURES .....	7-1
7.1 LABORATORY ANALYSIS .....	7-1
7.2 FIELD SCREENING ANALYTICAL PROTOCOLS .....	7-2
8.0 INTERNAL QUALITY CONTROL CHECKS .....	8-1
8.1 FIELD SAMPLE COLLECTION .....	8-1
8.2 FIELD MEASUREMENT .....	8-1
8.3 LABORATORY ANALYSIS .....	8-1
9.0 DATA REDUCTION, VALIDATION, AND REPORTING .....	9-1
9.1 DATA REDUCTION .....	9-1
9.2 DATA VALIDATION .....	9-1
9.3 DATA REPORTING .....	9-1
10.0 PERFORMANCE AND SYSTEM AUDITS .....	10-1

10.1	FIELD AUDITS .....	10-1
10.2	LABORATORY AUDITS .....	10-1
11.0	PREVENTIVE MAINTENANCE PROCEDURES .....	11-1
11.1	FIELD INSTRUMENTS AND EQUIPMENT .....	11-1
11.2	LABORATORY INSTRUMENTS .....	11-1
12.0	SPECIFIC ROUTINE PROCEDURES TO ASSESS DATA PRECISION, ACCURACY, AND COMPLETENESS .....	12-1
12.1	FIELD MEASUREMENTS DATA .....	12-1
12.2	LABORATORY DATA .....	12-1
13.0	CORRECTIVE ACTIONS .....	13-1
13.1	SAMPLE COLLECTION/FIELD MEASUREMENTS .....	13-1
13.2	LABORATORY ANALYSES .....	13-1
14.0	QA REPORTS TO MANAGEMENT .....	14-1
15.0	REFERENCES .....	15-1

## TABLES

1-1	Sampling and Analytical Requirements for the Phase II RI at Load Line 12 .....	1-2
4-1	Container Requirements for Water, Soil, and Sediment Samples for the Load Line 12 Phase II RI at Ravenna Army Ammunition Plant <sup>a</sup> .....	4-2

## ABBREVIATIONS

A-E	Architect-Engineer
ASTM	American Society of Testing and Materials
COC	chain of custody
CX	Center of Expertise
DQO	data quality objective
EM	Engineering Manual
EPA	U.S. Environmental Protection Agency
FSP	Field Sampling Plan
HTRW	Hazardous, Toxic, and Radioactive Waste
LCS	laboratory control sample
MS	matrix spike
MSD	matrix spike duplicate
QA	quality assurance
QAMP	Quality Assurance Management Plan
QAPP	Quality Assurance Project Plan
QC	quality control
RDX	hexahydro-1,3,5-trinitro-1,3,5-triazine
RI	Remedial Investigation
RVAAP	Ravenna Army Ammunition Plant
SAIC	Science Applications International Corporation
SAP	Sampling and Analysis Plan
SOP	standard operating procedure
STL	Severn Trent Laboratories
TAL	Target Analyte List
TCL	Target Compound List
TNT	trinitrotoluene
USACE	U.S. Army Corps of Engineers
XRF	X-ray fluorescence

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## **INTRODUCTION**

This Quality Assurance Project Plan (QAPP) addendum addresses supplemental project-specific information in relation to the revised Facility-wide QAPP for the Ravenna Army Ammunition Plant (RVAAP), which is currently issued as a draft revision under review (USACE 2000a). Any additional relevant requirements specified by the final revision of the revised Facility-wide QAPP will be addressed by field change order or addendum, as appropriate. Each QAPP section is presented documenting adherence to the Facility-wide QAPP or stipulating project-specific addendum requirements.

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## **1.0 PROJECT DESCRIPTION**

### **1.1 SITE HISTORY/BACKGROUND INFORMATION**

This information is contained in Section 1.1 of the Field Sampling Plan (FSP) of this Load Line 12 Phase II Remedial Investigation (RI) Sampling and Analysis Plan (SAP) Addendum No. 1.

### **1.2 PAST DATA COLLECTION ACTIVITY/CURRENT STATUS**

This information is contained in Section 1.2 of the FSP of this Load Line 12 Phase II RI SAP Addendum.

### **1.3 PROJECT OBJECTIVES AND SCOPE**

This information is contained in Chapter 3.0 of the FSP of this Load Line 12 Phase II RI SAP Addendum.

### **1.4 SAMPLE NETWORK DESIGN AND RATIONALE**

This information is contained in Chapter 4.0 of the FSP of this Load Line 12 Phase II RI SAP Addendum.

### **1.5 PARAMETERS TO BE TESTED AND FREQUENCY**

Sample matrix types, analytical parameters, and analytical methods are discussed in Chapter 4.0 of the FSP of the Load Line 12 Phase II RI SAP Addendum. These sampling and analysis requirements are summarized in **Table 1-1** of this Quality Assurance Project Plan (QAPP) addendum, in conjunction with anticipated sample numbers, quality assurance (QA) sample frequencies, and field quality control (QC) sample frequencies.

### **1.6 PROJECT SCHEDULE**

The Load Line 12 Phase II RI project schedule is discussed in Chapter 2.0 of the FSP of this SAP Addendum.



Table 1-1. Sampling and Analytical Requirements for the Phase II RI at Load Line 12

Parameter	Methods	Field Samples	Field Duplicate Samples	Site Source Water <sup>a</sup>	Sampler Rinsates	Trip Blanks	Total A-E Samples	USACE QA Split Samples	USACE Trip Blanks
<i>Soils</i>									
Field TNT/RDX Screening	RVAAP SOP 2000	191	19	-	-	-	210	-	-
Field Metals Screening	SW-846, 6200	194	19	-	-	-	213	-	-
Volatile Organics, TCL	SW-846, 5030/8260B	25	3	-	-	-	28	3	-
Semivolatile Organics, TCL	SW-846, 3540/8270C	40	4	-	-	-	44	4	-
Pesticides, TCL	SW-846, 3540/8081A	30	3	-	-	-	33	3	-
PCBs, TCL	SW-846, 3540/8082	43	5	-	-	-	48	5	-
Explosives	SW-846, 8330	69	7	-	-	-	76	7	-
Propellants	SW-846, 8330	20	2	-	-	-	22	2	-
Metals, TAL	SW-846, 6010B/7471	194	19	-	-	-	213	19	-
Cyanide	SW-846, 9011/9010	19	2	-	-	-	21	2	-
Nitrate, soluble	EPA 353.2 mod.	19	2	-	-	-	21	2	-
TOC	Walkley/Black Method	21	2	-	-	-	23	2	-
Grain Size (sieve/hydrometer)	ASTM D422	33	-	-	-	-	33	-	-
Moisture Content	ASTM D2216	33	-	-	-	-	33	-	-
Atterberg Limits	ASTM D4318	33	-	-	-	-	33	-	-
USCS Classification	N/A	33	-	-	-	-	33	-	-
Bulk Density	ASTM D4531	21	-	-	-	-	21	-	-
Porosity	EM1110-2-1906	21	-	-	-	-	21	-	-
Hydraulic Cond.	ASTM D5084	21	-	-	-	-	21	-	-
Specific Gravity	ASTM D854	21	-	-	-	-	21	-	-
Redox Potential	ASTM D1498	21	-	-	-	-	21	-	-
pH	SW-846 9045	21	-	-	-	-	21	-	-
<i>Sediments</i>									
Volatile Organics, TCL	SW-846, 5030/8260B	24	3	-	-	-	27	3	-
Semivolatile Organics, TCL	SW-846, 3540/8270C	24	3	-	-	-	27	3	-
Pesticides, TCL	SW-846, 3540/8081A	24	3	-	-	-	27	3	-
PCBs	SW-846, 3540/8082	24	3	-	-	-	27	3	-
Explosives	SW-846, 8330	24	3	-	-	-	27	3	-
Propellants	SW-846, 8330	2	1	-	-	-	3	1	-
Metals, TAL	SW-846, 6010B/7471	24	3	-	-	-	27	3	-
Cyanide	SW-846, 9011/9010	24	3	-	-	-	27	3	-
Nitrate, soluble	EPA 353.2 mod.	24	3	-	-	-	27	3	-

**Table 1-1. Sampling and Analytical Requirements for the Phase II RI at Load Line 12 (continued)**

Parameter	Methods	Field Samples	Field Duplicate Samples	Site Source Water <sup>a</sup>	Sampler Rinsates	Trip Blanks	Total A-E Samples	USACE QA Split Samples	USACE Trip Blanks
TOC	Walkley/Black Method	24	3	-	-	-	27	3	-
USCS Classification	N/A	24	-	-	-	-	24	-	-
Grain Size (sieve)	ASTM D422	24	-	-	-	-	24	-	-
<i>Surface Waters/Ground Waters</i>									
Volatile Organics, TCL	SW-846, 5030/8260B	35	4	2	1	7	49	4	2
Semivolatile Organics, TCL	SW-846, 3520/8270C	35	4	2	1	-	42	4	-
Pesticides, TCL	SW-846, 3520/8081A	35	4	2	1	-	42	4	-
PCBs, TCL	SW-846, 3520/8082	35	4	2	1	-	42	4	-
Explosives	SW-846, 8330	35	4	2	1	-	42	4	-
Propellants	SW-846, 8330	16	2	2	1	-	21	2	-
Metals (total), TAL	SW-846, 6010A/7470	35	4	2	1	-	42	4	-
Cyanide	SW-846, 9010	35	4	2	1	-	42	4	-
Nitrate	EPA 353.2	35	4	2	1	-	42	4	-

<sup>a</sup>Source waters = one potable water source and one ASTM water supply lot for the project.

A-E = Architect-Engineer

TNT = 2,4,6-trinitrotoluene

RDX = hexahydro-1,3,5-trinitro-1,3,5-triazine

TCL = Target Compound List

TAL = Target Analyte List

QA = Quality Assurance

USACE = U.S. Army Corps of Engineers

RVAAP = Ravenna Army Ammunition Plant

EPA = U.S. Environmental Protection Agency

ASTM = American Society of Testing and Materials

EM = Engineering Manual (USACE)

## **2.0 PROJECT ORGANIZATION AND RESPONSIBILITY**

The functional project organization and responsibilities are described in Chapter 2.0 of the Facility-wide SAP and the Load Line 12 Phase II RI SAP Addendum No. 1.

Analytical support for this work has been assigned to Severn Trent Laboratories, Inc. (formerly Quanterra). The majority of analysis will be completed by STL's North Canton, Ohio facility, with explosive determinations being performed by the Knoxville, Tennessee facility and nitrocellulose/nitroguanidine analyses being performed by the Sacramento, California facility. These laboratories have been validated by the U.S. Army Corp of Engineers (USACE) Hazardous, Toxic, and Radioactive Waste (HTRW) Center of Expertise (CX), Omaha, Nebraska. Severn Trent Laboratories' Quality Assurance Management Plan (QAMP), Revision 3, November 1998, is available for review upon request. The laboratory's organizational structure, roles, and responsibilities are identified in Section 1 of their QAMP and facility-specific appendices. Addresses and telephone numbers for each of the Severn Trent Laboratories (STL) facilities are as follows:

Severn Trent Laboratories, Inc. – general analytical services:

North Canton, OH Facility  
4101 Shuffel Drive, N.W.  
North Canton, OH 44720

Tel: (330) 497-9396

Fax: (330) 497-0772

Severn Trent Laboratories, Inc. – explosives analyses:

Knoxville, TN Facility  
5815 Middlebrook Pike  
Knoxville, TN 37921

Tel: (423) 588-6401

Fax: (423) 584-4315

Severn Trent Laboratories, Inc. – nitrocellulose/nitroguanidine analyses:

Sacramento, CA Facility  
880 Riverside Parkway  
West Sacramento, CA 95605

Tel: (916) 373-5600

Fax: (916) 372-1059

S&ME, Inc. – soil and sediment geotechnical analyses:

Louisville, TN Facility  
1413 Topside Road  
Louisville, TN 37777  
Tel: (865) 970-0003  
Fax: (865) 970-2312

Field analytical support for colorimetric analysis of TNT and RDX will be provided by the SAIC field team. Also, X-ray fluorescence (XRF) metal determinations will be provided by Onsite Environmental Laboratories headquartered in Fremont, California (Tel: 510-490-8570, Fax: 510-490-8572).

Comprehensive data validation will be independently performed by the Louisville USACE-approved firm of Kismet Scientific Services in Bearenton, Oregon (Tel: 503-524-6124, Fax; 503-524-6124).

### **3.0 QUALITY ASSURANCE OBJECTIVES FOR MEASUREMENT**

#### **3.1 DATA QUALITY OBJECTIVES**

Data quality objectives (DQO) summaries for this investigation will follow Tables 3-1 and 3-2 in the Facility-wide QAPP. All QC parameters stated in the specific U.S. Environmental Protection Agency (EPA) SW-846 methods will be adhered to for each chemical listed. The SW-846 method references found in the Facility-wide QAPP have been revised to the Update III methods (i.e., 8260A is now 8260B, 8270B is now 8270C, etc.). Laboratories are required to comply with all methods as written; recommendations are considered requirements. Concurrence with the USACE Shell Document for Analytical Chemistry Requirements, version 1.0, 2 Nov 98 (USACE 1998) and Environmental Data Assurance Guideline, USACE-Louisville, May 2000 (USACE 2000b) is expected.

#### **3.2 LEVEL OF QUALITY CONTROL EFFORT**

QC efforts will follow Section 3.2 of the Facility-wide QAPP. Field QC measurements will include field source water blanks, trip blanks, field duplicates, and equipment rinsate blanks. Laboratory QC measurements will include method blanks, laboratory control samples (LCSs), laboratory duplicates, and matrix spike/matrix spike duplicate (MS/MSD) samples.

#### **3.3 ACCURACY, PRECISION, AND SENSITIVITY OF ANALYSIS**

Accuracy, precision, and sensitivity goals identified in Section 3.3 and Tables 3-1 through 3-9 of the Facility-wide QAPP will be imposed for this investigation.

#### **3.4 COMPLETENESS, REPRESENTATIVENESS, AND COMPARABILITY**

Completeness, representativeness, and comparability goals identified in Section 3.4 and Tables 3-1 and 3-2 of the Facility-wide QAPP will be imposed for this investigation.

## **4.0 SAMPLING PROCEDURES**

Sampling procedures are discussed in Chapter 4.0 of the Facility-wide SAP and SAP Addendum for the Phase II RI at Load Line 12.

**Table 4-1** summarizes sample container, preservation, and holding time requirements for the soil, sediment, and water matrices for this investigation. The number of containers required is estimated in this table.

**Table 4-1. Container Requirements for Water, Soil, and Sediment Samples for the Load Line 12 Phase II RI at Ravenna Army Ammunition Plant<sup>a</sup>**

Analyte Group	Approx. No. of Containers incl. Field QC	Container	Minimum Sample Size	Preservative	Holding Time
<i>Groundwater and Surface Water</i>					
Volatile Organic Compounds	165	Three, 40-mL glass vials with Teflon®-lined septum (no headspace)	80 mL	HCl to pH <2 Cool, 4°C	14 d
Semivolatile Organic Compounds	92	Two, 1-L amber glass bottles with Teflon®-lined lid	1000 mL	Cool, 4°C	7 d (extraction) 40 d (analysis)
Pesticide Compounds	92	Two, 1-L amber glass bottles with Teflon®-lined lid	1000 mL	Cool, 4°C	7 d (extraction) 40 d (analysis)
PCB Compounds	92	Two, 1-L amber glass bottles with Teflon®-lined lid	1000 mL	Cool, 4°C	7 d (extraction) 40 d (analysis)
Explosive Compounds	92	Two, 1-L amber glass bottles with Teflon®-lined lid	1000 mL	Cool, 4°C	7 d (extraction) 40 d (analysis)
Propellant Compounds	46	Two, 1-L amber glass bottles with Teflon®-lined lid	1000 mL	Cool, 4°C	7 d (extraction) 40 d (analysis)
Metals (total)	46	1-L polybottle	500 mL	HNO <sub>3</sub> to pH <2 Cool, 4°C	180 d
Cyanide	46	1-L polybottle	500 mL	NaOH to pH >12 Cool, 4°C	14 d
Nitrate	46	1-250 ml polybottle	50 mL	H <sub>2</sub> SO <sub>4</sub> to pH <2 Cool, 4°C	28 d
<i>Soils and Sediments</i>					
Volatile Organic Compounds	61	One 2-oz. Glass jar with Teflon-lined cap (no headspace)	20 grams	Cool, 4°C	14 d
Semivolatile Organic Compounds	78	One 4-ounce glass jar with Teflon-lined cap	100 grams	Cool, 4°C	14 days (extraction) 40 days (analysis)
Pesticide Compounds	-	One 4-ounce glass jar with Teflon-lined cap Use same container as SVOC.	100 grams	Cool, 4°C	14 days (extraction) 40 days (analysis)
PCB Compounds	9	Use same container as SVOC where possible.	100 grams	Cool, 4°C	14 days (extraction) 40 days (analysis)
Explosive Compounds	113	One 4-ounce glass jar with Teflon-lined cap	100 grams	Cool, 4°C	14 days (extraction) 40 days (analysis)
Propellant Compounds	28	One 4-ounce glass jar with Teflon-lined cap	100 grams	Cool, 4°C	14 days (extraction) 40 days (analysis)
Metals	262	One 4-ounce wide-mouth poly bottle	50 grams	Cool, 4°C	180 d
Cyanide	-	Use same container as metals	25 grams	Cool, 4°C	14 d
Nitrate	-	Use same container as metals	25 grams	Cool, 4°C	28d
Total Organic Carbon	55	One 4-ounce glass jar with Teflon-lined cap	10 grams	Cool, 4°C	28 d
Geotechnical Parameters	21/36	Undisturbed = Shelby Tube Disturbed = 32-ounce wide-mouth container	1000 grams	None	None

<sup>a</sup>One sample will be tripled in volume for the laboratory to perform appropriate laboratory quality control analysis.

PCB = polychlorinated biphenyl

QC = quality control

## **5.0 SAMPLE CUSTODY**

### **5.1 FIELD CHAIN-OF-CUSTODY PROCEDURES**

Sample handling, packaging, and shipment procedures will follow those identified in Section 5.1 of the Facility-wide QAPP.

### **5.2 LABORATORY CHAIN-OF-CUSTODY PROCEDURES**

Laboratory chain of custody (COC) will follow handling and custody procedures identified in Section 8.5.3 of the STL QAMP.

### **5.3 FINAL EVIDENCE FILES CUSTODY PROCEDURES**

Custody of evidence files will follow those criteria defined in Section 5.3 of the Facility-wide QAPP.



## **6.0 CALIBRATION PROCEDURES AND FREQUENCY**

### **6.1 FIELD INSTRUMENTS/EQUIPMENT**

Field instruments and equipment calibrations will follow those identified in Section 6.1 of the Facility-wide QAPP.

### **6.2 LABORATORY INSTRUMENTS**

Calibration of laboratory equipment will follow procedures identified in Section 8.5.4 of the STL QAMP, corporate, and facility-specific operating procedures.

## **7.0 ANALYTICAL PROCEDURES**

### **7.1 LABORATORY ANALYSIS**

Analytical methods, parameters and quantitation or detection limits are those listed in Tables 3-3 through 3-9 of the Facility-wide QAPP.

STL's QAMP Section 8.0 and the facility-specific addenda for the North Canton, Knoxville, and Sacramento facilities will be followed during the analysis of these samples. The following laboratory Standard Operating Procedures (SOPs) will implement the defined EPA methods.

- Gas Chromatograph (GC)/Mass Spectrometer (MS) Volatile Organics Analysis Based on Methods 8240B and 8260B, SW-846, CORP-MS-0002, rev 2, 12/15/97.
- GC/MS Semivolatile Analysis Based on Methods 8270C, SW-846, CORP-MS-0001, Rev. 2, 12/15/97.
- GC Analysis Based on Method 8000A, 8010B, 8020A, 8021A, 8080A, 8081, 8082, 8150B, and 8051, SW-846, CORP-GC-0001, Rev. 5.1, 3/30/99.
- Extraction and Cleanup of Organic Compounds from Waters and Soils, Based on SW-846 3500 Series, 3600 Series, 8150, 8151, and 600 Series Methods, CORP-OP-0001, Rev. 3.4, 4/15/99.
- Analysis of Nitroaromatic and Nitramine Explosives by HPLC, KNOX-LC-0001, Rev. 1, 4/28/97.
- Total Organic Carbon and Total Inorganic Carbon, NC-WC-0017, Rev. 2, 2/15/99.
- Inductively Coupled Plasma-Atomic Emission Spectroscopy, Spectrometric Method for Trace Element Analysis, Methods 6010B and 200.7, CORP-MT-0001, Rev. 2, 12/15/97.
- Graphite Furnace Atomic Absorption Spectroscopy, SW-846 Methods 7000A and MCAWW 200 series methods, CORP-MT-0003, Rev. 1, 08/22/95.
- Mercury in Aqueous Samples by Cold Vapor Atomic Absorption, SW-846 7470A and MCAWW 245.1, CORP-MT-0005NC, Rev. 1.1, 04/19/97.
- Mercury in Solid Samples by Cold Vapor Atomic Absorption, SW846 7471A and McAWW 245.5, CORP-MT-0005NC, Rev. 1.1, 04/19/97.
- Preparation and analysis of Nitrocellulose in Aqueous, Soil, and Sediments by Colorimetric Autoanalyzer, SAC-WC-0050, Rev. 0.
- Determination of Nitroaromatics, Nitramines, and Specialty Explosives in Water and Soil by High Performance Liquid Chromatography/Ultraviolet Detector (HPLC/UV) and Liquid Chromatography/Thermospray/Mass Spectrometry (LC/TSP/MS), SAC-LC-0001, Rev. 5.0.

STL facilities will at all times maintain a safe and contaminant free environment for the analysis of samples. The laboratories will demonstrate, through instrument blanks, holding blanks, and analytical method blanks, that the laboratory environment and procedures will not and do not impact analytical results.

STL facilities will also implement all reasonable procedures to maintain project reporting levels for all sample analyses. Where contaminant and sample matrix analytical interferences impact the laboratory's ability to obtain project reporting levels, the laboratory will institute sample clean-up processes, minimize dilutions, adjust instrument operational parameters, or propose alternative analytical methods or procedures. Elevated reporting levels will be kept to a minimum throughout the execution of this work.

## **7.2 FIELD SCREENING ANALYTICAL PROTOCOLS**

Procedures for field analysis are identified in Chapter 6.0 of the Facility-wide SAP and in Chapter 4.0 of the FSP of this SAP Addendum. Only screening of samples for organic vapors using a photoionization detector will be conducted. Headspace analysis will not be conducted.

Field screening analysis for 2,4,6-trinitrotoluene (2,4,6-TNT) and hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX) will be performed using the RVAAP Standard Operating Procedure "Field Method for Determination of 2,4,6-TNT and RDX in Soil and Sediment." This SOP is a formal attachment to the Facility-wide QAPP and is contained in Appendix C of the SAP Addendum.

Field screening analysis for metals will be performed using the SW846 Method 6200 "Field Portable X-Ray Fluorescence Spectrometry for the Determination of Elemental Concentrations in Soil and Sediment."

## **8.0 INTERNAL QUALITY CONTROL CHECKS**

### **8.1 FIELD SAMPLE COLLECTION**

Field QC sample types, numbers, and frequencies are identified in Chapters 4.0 and 5.0 of the FSP of this SAP Addendum. In general, field duplicates will be collected at a frequency of 10%, field equipment rinsates and blanks will be collected at a frequency of 10% for samples collected with non-dedicated equipment, and volatile organic trip blanks will accompany all shipments containing volatile organic water samples.

### **8.2 FIELD MEASUREMENT**

Refer to Chapter 4.0 of the FSP of this SAP Addendum for details regarding these measurements. In addition, refer to the field screening methods for TNT, RDX, and metals.

### **8.3 LABORATORY ANALYSIS**

Analytical QC procedures will follow those identified in the referenced EPA methodologies. These will include method blanks, LCS, MS, MSD, laboratory duplicate analysis, calibration standards, internal standards, surrogate standards, and calibration check standards.

STL facilities will conform to their QAMP, facility-specific appendices, and implement their established SOPs to perform the various analytical methods required by the project. QC frequencies will follow those identified in Section 8.3 of the Facility-wide QAPP.

Analyses will also be consistent with direction provided by the USACE Shell Document for Analytical Chemistry Requirements (USACE 1998) and the Environmental Data Assurance Guideline of USACE-Louisville (USACE 2000b).

## **9.0 DATA REDUCTION, VALIDATION, AND REPORTING**

### **9.1 DATA REDUCTION**

Sample collection and field measurements will follow the established protocols defined in the Facility-wide QAPP, Facility-wide SAP, and this Load Line 12 Phase II RI SAP Addendum. Laboratory data reduction will follow Severn Trent's QAMP (Section 8.6) guidance and conform to general direction provided by the Facility-wide QAPP, the USACE Shell Document (USACE 1998), and the Environmental Data Assurance Guideline of USACE-Louisville (USACE 2000b).

### **9.2 DATA VALIDATION**

Validation of 10% of the data will follow the direction provided in the Facility-wide QAPP and the Environmental Data Assurance Guideline of USACE-Louisville (USACE 2000b). An independent data validation subcontractor qualified by USACE Louisville District will perform this data validation.

All data will be reviewed and verified by SAIC according to the Facility-wide QAPP.

### **9.3 DATA REPORTING**

Analytical data reports will follow the direction provided in the Facility-wide QAPP.

## **10.0 PERFORMANCE AND SYSTEM AUDITS**

### **10.1 FIELD AUDITS**

A minimum of one field surveillance for the investigation will be performed by the Science Applications International Corporation (SAIC) QA Officer and/or the SAIC Field Team Leader. This audit will encompass the sampling of groundwater, surface water, soil, and sediment from the wells, ditches, ponds, land areas, and storm and sanitary sewers. Surveillances will follow SAIC QAPP No. 18.3.

USACE, EPA Region 5, or Ohio EPA audits may be conducted at the discretion of the respective agency.

### **10.2 LABORATORY AUDITS**

Routine USACE HTRW CX on-site laboratory audits may be conducted by the USACE, EPA Region 5, or Ohio EPA at the discretion of the respective agency.

Internal performance and systems audits will be conducted by STL's QA staff as defined in the laboratory QAMP, Section 9.2.

## **11.0 PREVENTIVE MAINTENANCE PROCEDURES**

### **11.1 FIELD INSTRUMENTS AND EQUIPMENT**

Maintenance of all field analytical and sampling equipment will follow direction provided in Section 11.1 of the Facility-wide QAPP.

### **11.2 LABORATORY INSTRUMENTS**

Routine and preventive maintenance for all laboratory instruments and equipment will follow the direction of Section 8.11 of STL's QAMP.

## **12.0 SPECIFIC ROUTINE PROCEDURES TO ASSESS DATA PRECISION, ACCURACY, AND COMPLETENESS**

### **12.1 FIELD MEASUREMENTS DATA**

Field data will be assessed as outlined in Section 12.1 of the Facility-wide QAPP.

### **12.2 LABORATORY DATA**

Laboratory data will be assessed as outlined in Section 12.2 of the Facility-wide QAPP.



## **13.0 CORRECTIVE ACTIONS**

### **13.1 SAMPLE COLLECTION/FIELD MEASUREMENTS**

Field activity corrective action protocol will follow directions provided in Section 13.1 of the Facility-wide QAPP.

### **13.2 LABORATORY ANALYSES**

Laboratory activity corrective action protocol will follow directions provided in Section 13.2 of the Facility-wide QAPP and Section 9.1 of STL's QAMP.

## **14.0 QA REPORTS TO MANAGEMENT**

Procedures and reports will follow the protocol identified in Section 14.0 of the Facility-wide QAPP and those directed by Section 9.4 of STL's QAMP.

## 15.0 REFERENCES

USACE (U.S. Army Corps of Engineers) 1998. *Shell Document for Analytical Chemistry Requirements*, Version 1.0, November 1998.

USACE (U.S. Army Corps of Engineers) 2000a. *Facility-wide Sampling and Analysis Plan for Environmental Investigations at the Ravenna Army Ammunition Plant, Ravenna, Ohio*, DACA62-00-D-0001, Delivery Order CY02, Draft, July 2000.

USACE (U.S. Army Corps of Engineers) 2000b. *Environmental Data Quality Assurance Guideline, Louisville District*, May 2000 (Draft).

Additional references to the Facility-wide QAPP are:

STL (Severin-Trent Laboratories, Inc.) 1998. *Quality Assurance Management Plan*, Revision 3, November 2, 1998.

GC/MS Volatile Organics Analysis Based on Methods 8240B and 8260B, SW-846, CORP-MS-0002, rev 2, 12/15/97.

GC/MS Semivolatile Analysis Based on Methods 8270C, SW-846, CORP-MS-0001, Rev. 2, 12/15/97.

Gas Chromatographic Analysis Based on Method 8000A, 8010B, 8020A, 8021A, 8080A, 8081, 8082, 8150B, and 8051, SW-846, CORP-GC-0001, Rev. 5.1, 3/30/99.

Extraction and Cleanup of Organic Compounds from Waters and Soils, Based on SW-846 3500 Series, 3600 Series, 8150, 8151, and 600 Series Methods, CORP-OP-0001, Rev. 3.4, 4/15/99.

Analysis of Nitroaromatic and Nitramine Explosives by HPLC, KNOX-LC-0001, Rev. 1, 4/28/97.

Total Organic Carbon and Total Inorganic Carbon, NC-WC-0017, Rev. 2, 2/15/99.

Inductively Coupled Plasma-Atomic Emission Spectroscopy, Spectrometric Method for Trace Element Analysis, Methods 6010B and 200.7, CORP-MT-0001, Rev. 2, 12/15/97.

Graphite Furnace Atomic Absorption Spectroscopy, SW-846 Methods 7000A and MCAWW 200 series methods, CORP-MT-0003, Rev. 1, 08/22/95.

Mercury in Aqueous Samples by Cold Vapor Atomic Absorption, SW-846 7470A and MCAWW 245.1, CORP-MT-0005NC, Rev. 1.1, 04/19/97.

Mercury in Solid Samples by Cold Vapor Atomic Absorption, SW-846 7471A and MCAWW 245.5, CORP-MT-0007NC, Rev. 1.1, 04/17/97.

Analysis of Nitroaromatic and Nitramine Explosives by High Performance Liquid Chromatography, KNOX-LC-0001, Rev. 1, 04/28/97.

Preparation and Analysis of Nitrocellulose in Aqueous, Soil, and Sediments by Colorimetric Autoanalyzer, SAC-WC-0500, Rev. 0.0.

Determination of nitroaromatics, nitramines, and specialty explosives in water and soil by high performance liquid chromatography/ultraviolet detector (HPLC/UV) and liquid chromatography/thermospray/mass spectrometry (LC/TSP/MS), SAC-LC-0001, Rev. 5.0.

**Draft Sampling and Analysis Addendum No. 1 for the Phase II Remedial Investigation  
of Load Line 12 at the Ravenna Army Ammunition Plant  
Comment Resolution**

COMMENT NUMBER	PAGE OR SHEET	COMMENT	RESPONSE
<i>Paul Zorko, CELRL-ED-EE</i>			
1	Cover	Title should read "...Ammunition <i>Plant</i> "	Agreed. Title has been corrected as requested.
2	p. 1-1, line 33	Operations date to September 1941.	Agreed. Text has been changed as requested.
3	Figure 1-2	The LL12 boundary in the NE corner needs to be adjusted (the AOC boundary resembles a rectangle and not as shown).	Clarification. The site AOC boundary includes surface water drainage to Cobb's Pond and is consistent with that established in the Phase I RI. No figure/boundary changes required.
4	Figure 1-3	Footprints for Bldgs. 900 through 906 are identical. As long as this plan won't be used to locate sampling sites its ok but if this is not the case then it should be changed to resemble the configurations shown for 902, 905 & 906. Also the row of footings shown on the plan along the road just west of Bldg's. 900, 901 and 902 have been removed from the site.	Agreed. Footprint outlines for Bldgs. 900, 903, and 904 have been changed to those as shown for Bldgs. 901, 902, 905, and 906. Footings have been removed as requested.
5	p. 1-5, line 42	"...demolition in <i>early 2000</i> ". In line 43 the ending statement should read "the remaining structures were removed between 1998 and 2000."	Agreed. Text has been changed as requested.
6	Table 1-1	Add Construction began August 1940, and Production commenced Sept. 1941. Under the date "1965 to 1967" line should read " <i>Hercules Alchlor</i> "	Agreed. Text has been changed as requested.
7	Figure 1-4	Missing symbol for transformer pads	Agreed. Symbol has been added as requested.
8	p. 3-15, line 15	I believe site should be changed to <i>facility</i> , in this context, to be consistent with previous usage.	Agreed. However, "the site" has been changed to "RVAAP."
9	Table 4-1	Sub-area 1, description should read " <i>Hercules Alchlor</i> ."	Agreed. Text has been changed as requested.
10	P. 4-6, line 16	Is there a reason that 6.25-ID augers are being used instead of 4.25" ID?	The use of 4.25-inch ID augers should have been specified instead of 6.25-inch ID augers. Text has been corrected.
11	p. 4-6, line	Change lithologic logging to stratigraphic logging unless you're going to	Agreed. Text has been changed as requested.

**Draft Sampling and Analysis Addendum No. 1 for the Phase II Remedial Investigation  
of Load Line 12 at the Ravenna Army Ammunition Plant  
Comment Resolution**

COMMENT NUMBER	PAGE OR SHEET	COMMENT	RESPONSE
	18	describe the mineralogy of individual sand and gravel grains.	
12	Sect. 4.1.8	Seeing as how only a single slug out test is planned, will it be possible to do a repeat test for each well in order to get some sort of confirmation that the first was performed in an acceptable fashion?	Clarification. A corresponding falling head test will be performed provided the additional level of effort does not impact overall project schedule. The text of the SAP addendum has been adjusted to reflect this approach.
13	p. 4-9, line 8/9	Alternate method to have RVAAP team approval.	Agreed. Text has been changed as requested.
14	Sect. 4.2.1.1	It should be noted somewhere in this section that subsequent to the demolition of the site buildings fill material (primarily from the blast embankment west of Bldg. 903) was used in several areas and care must be exercised when sampling in areas in order to get a native soil sample.	Agreed. Text has been changed as requested. Also, the information has been added to Section 1.4.
15	Sect. 4.2.2.2	Please note the potential ammonium nitrate to interfere with field TNT/RDX testing and the proposed corrective measure.	Agreed. The use of Alumin-A-cartridges to correct for nitrate interference has been added to the SAP Addenda.
16	Sect. 4.2.2.3	The section needs to state that the depth interval for the lower UD tube will be in the center of the individual screened interval of each well rather than at the bottom of the well.	Agreed. The information has been added as requested.
17	4.3	Add provisions to decontaminate the metal detector in between boring locations.	Agreed. Provisions for decontamination of down-hole tools or use of disposable plastic sleeves for Schondstat hand-held magnetometers have been added as requested.
18.	Sect. 4.3.1.1	Same comment as in comment 14 of this table.	Agreed. Text has been changed as requested.
19	Sect. 4.6.1, line 47	Change LL1 to LL 12 and delete reference to storm sewer system (LL12 has none).	Agreed. Text has been changed as requested.

**Draft Sampling and Analysis Addendum No. 1 for the Phase II Remedial Investigation  
of Load Line 12 at the Ravenna Army Ammunition Plant  
Comment Resolution**

COMMENT NUMBER	PAGE OR SHEET	COMMENT	RESPONSE
<i>LTC Tom Tadesn, Ohio ARNG</i>			
1	N/A	I have no personal comments, recommendations, or changes to submit.	Comment Noted.
<i>Jerry Simms, CIH - CELRL-ED-EE</i>			
1	Cover page	Please correct the typo plant appears as plan.	Agreed. Text has been changed as requested.
2	Sect. 4.0	The plan states requirements are outlined in Table 2-2 of the Facility Health and Safety Plan. Training requirements are listed in Table 4-1 of the FSHP.	Clarification. The text of the document has been changed to state "Table 2-2 of this SSHP Addendum" to clarify that the table references are to the SSHP Addendum rather than the Facility-Wide Work Plan.
3	Sect. 6.0	Section 6.0 Medical Surveillance - the plan references the FSHP and Table 2-2 of the addendum. No medical surveillance information appears in Table 2-2.	See response to Simm's comment No. 2.
4	Table 7-1 Monitoring Require- ments and Action Limits	Flammability and oxygen content with combustible gas indicator – the limit is stated as greater than 19.5% for O <sub>2</sub> content but does not reference the upper limit of 23.5%.	Agreed. The table has been changed as requested.
5	References	Please include the following:  US Army Corps of Engineers Safety and Health Manual EM 385-1-1 3 September 1996.  US Army Corps of Engineers ER 385-1-92 Safety and Occupational Health Requirements for Radioactive Waste (HTRW) and Ordnance and Explosive Waste (OEW) Activities – Appendix B.	Agreed. The references have been added as requested.

**Draft Sampling and Analysis Addendum No. 1 for the Phase II Remedial Investigation  
of Load Line 12 at the Ravenna Army Ammunition Plant  
Comment Resolution**

COMMENT NUMBER	PAGE OR SHEET	COMMENT	RESPONSE
<i>David Brancato, CELRL-ED-EE</i>			
1		<p>A. Use of 8270 to achieve the reporting limits for PAHs – Emphasis must be made to the need to reach reporting limits of 60 ppb for the PAHs</p> <p>B. Reporting limits for DNT isomers. The 8330 method may not be able to achieve a reporting limit of 0.7 ppm for the 2,4- and 2,6-DNT isomers. In this case method 8290 is required.</p> <p>C. Thallium remains an issue....Trace ICP is the needed method to achieve the lower detection limits.</p>	<p>A. Clarification. Current facility-wide reporting levels (RLs) for PAHs by 8270 are established at 330 µg/kg, whereas the method detection levels (MDLs) are normally below 50 µg/kg. Analyses are reported as estimated (J-flagged) when the values are observed between the MDL and the RL. If a 60 µg/kg RL is required, then a specific work plan addendum will need to specify this requirement and reference Table 3.6 of the Facility-wide work plan for PAHs by method 8310 (HPLC). This method will reduce the actual RLs for all PAHs to below 60 µg/kg with the exception of acenaphthene, acenaphthylene, and naphthalene. Consistent with projects at RVAAP over the past 3 years, we propose to continue to use method 8270, and accept estimated values (J-flagged) between the MDL and the RL in assessment of nature and extent and the risk assessment.</p> <p>B. Current facility-wide reporting levels are at 0.25 mg/kg for these compounds. These levels are achievable by Method 8330 and should not require adding an additional method.</p> <p>C. Current facility-wide reporting levels are at 0.2 mg/kg and may be achieved by either Trace ICP, ICP-MS, or graphite furnace AA. The facility-wide work plan, and by inference any AOC-specific addenda, allows any of these methods to be used.</p>
2	Chapter 3	<p>In reference to your question 2, and based on Exhibit 3.4 of the new dermal guidance....there are no defaults for metals or volatiles. We have a default for SVOC which will be used, i.e. 0.1. If the value is not listed in the table, and if it is not a SVOC then we remain absent that value for ABS. <u>[This does not preclude the use of earlier RAGS Guidance, for substances not covered in Exhibit 3.4]</u></p>	<p>Comment is in response to a technical question posed by SAIC during preparation of the work plans for Load Line 12 and Load Line 1 as follows: ABS – SAIC had said we would use values of 0.1% for inorganics and 1% for organics if chemical-specific data are not available. The new guidance has a value of 0.1 (I don't know if its 0.1% or a factor of 0.1 which would = 10%) for SVOCs. It does not have values for inorganics or VOCs. Should we use 0.1% for inorganics, 1% for VOCs and 0.1 (%) for SVOCs, and is the value for SVOCs 0.1% or 10%?</p>



**Draft Sampling and Analysis Addendum No. 1 for the Phase II Remedial Investigation  
of Load Line 12 at the Ravenna Army Ammunition Plant  
Comment Resolution**

COMMENT NUMBER	PAGE OR SHEET	COMMENT	RESPONSE
2 (continued)		Regarding your question 1....If absorption is > 50% then 100% will be used. If less than 50% then the actual absorption estimate from the GI study is used. Table 4.1 of the new guidance covers the inorganic of interest at Ravenna.	Comment noted. The comment is in response to a technical question posed by SAIC during preparation of the work plans for Load Line 12 and Load Line 1 as follows: GAF – USACE had originally asked that we use default GAF values of 0.9 for organics and 0.05 for inorganics if no chemical-specific value is available. The pages from the Region V guidance that USACE sent do not include these defaults (they have > 50% for organics and no inorganic default).
<i>Eileen Mohr, Ohio EPA</i>			
1	Pages 1-5, 1-9, and 4-21.	Text indicates that no above-grade structures remain at Load Line 12. Please clarify whether this includes floor slabs, as the text on page 4-15 (lines 23-25) indicates that there will be difficulty in obtaining soil samples from beneath the slabs. If there are floor slabs in place, the text should be revised on page 1-5 to indicate that there is the potential for contamination beneath the floor slabs, if the integrity of the concrete is not intact (ie., cracks in the floor etc.). In addition, will cores of the floor slabs be obtained?	Agreed. Building 19 may have part or all of a floor slab remaining. Core samples of the concrete pads (if present) are not planned considering that a low potential exists that the actual concrete material is contaminated due to its low porosity and permeability. Text added to pages 1-5 and 1-9 as requested.
2	Page 1-5.	Revise the text that reads: “The potential surface and subsurface contamination exists....”	Agreed. The text has been corrected as requested.
3	Page 1-7.	Refer to previous Ohio EPA comments regarding the use of the U.S. Geological Survey (USGS) Ohio reference values for soil. The reference numbers are of limited value given the minimal number of soil samples, especially in the northeast quadrant of the state. Inorganic constituents should be compared to the installation background that was determined as part of the Winklepeck Burning Grounds (WBG) Remedial Investigation (RI). Page 1-7 lines 38-39 and page 1-9 lines 1-2).	Clarification. The information contained on page 1-7 and page 1-9 is in reference to the Phase I RI investigation. In the Phase I RI, soil data were compared to USGS reference values. In the Phase II RI, soil data from both the Phase I and II efforts will be pooled and compared to RVAAP background values (see Chapter 3.0).
4	Figure 1-4.	Revise the caption to read: “Load Line 12 Phase I RI Sampling Location Map.” (page 1-8)	Agreed. The caption has been revised as requested.

**Draft Sampling and Analysis Addendum No. 1 for the Phase II Remedial Investigation  
of Load Line 12 at the Ravenna Army Ammunition Plant  
Comment Resolution**

COMMENT NUMBER	PAGE OR SHEET	COMMENT	RESPONSE
5	Page 3-2.	Revise text (lines 7-9), to indicate that during the Phase I RI, most samples obtained for metals analyses included only process-related metals, i.e., target analyte list (TAL) metals were not analyzed for in each sample. This may have an impact upon the number of metals that were determined to be above background. In addition, please revise the text to indicate that the "background" determined during the Phase I RI does not represent the installation-wide background.	Agreed. The text has been revised as requested.
6	Page 3-2.	The text (lines 3-37) indicates that the metals contaminants were concentrated at levels above risk-based screening criteria, primarily around former process areas and in the tributary to upper Cobbs Pond. Please specify what risk-based screening criteria were utilized.	Clarification. Per Section 5.4 of the Phase I RI, Region 4 U.S. EPA sediment criteria and ORNL Toxicity Benchmarks were used as risk screening criteria.
7	Page 3-3.	Please provide additional details regarding the source of information for the groundwater flow divide that may exist at the southern portion of this AOC. (lines 18-19)	Agreed. Additional text has been added stating that based on topographic characteristics, a potential groundwater flow divide exists in the southern portion of the AOC.
8	Page 3-3.	The text (line 33) indicates that storm sewers were not installed at Load Line 12. This contradicts texts on page 4-21, line 47, and page 4-22, lines 14, 16, and 37. Please explain/correct the discrepancies.	Agreed. Chapter 4 references to storm sewers have been deleted.
9	Page 3-4.	Revise the text (line 12) to indicate that the current stage of work being conducted at Load Line 12 is a Phase II RI.	Agreed. The text has been revised as requested.
10	Page 3-5.	Provide information in the text of the workplan as to the generation of the 35 mg/kg chromium cut-off concentration. (line 14)	Clarification. The 35 mg/kg value was derived from the SOW dated 5/12/00. This value equals 2X the background values established under the Phase I RI to which the data were compared. The 35 mg/kg value is consistent with that employed for the Winklepeck Burning Grounds Phase II RI. No text changes required.

**Draft Sampling and Analysis Addendum No. 1 for the Phase II Remedial Investigation  
of Load Line 12 at the Ravenna Army Ammunition Plant  
Comment Resolution**

COMMENT NUMBER	PAGE OR SHEET	COMMENT	RESPONSE
11	Page 3-6.	Provide additional details in the text as to the source of the aggregate number of 20 samples. (line 43)	Clarification. The aggregate number of 20 samples is derived from the frequency of detection screening value of 5%. One detect in 20 samples is the minimum required to achieve the 5% screening value. If the sample population is less than 20 samples, by default one detect is greater than a 5% frequency of detection and the constituent would not be eliminated as a site-related contaminant. Therefore, the screen is applied only to a sample population of at least 20. No text changes have been made.
12	Sections 3.5 and 3.6.	Please refer to the introductory portion of this correspondence as it pertains to ensuring that this workplan is consistent with the decisions reached between all major stakeholders regarding the human health and ecological risk assessment pathways, processes, and assumptions, etc. This comment is pertinent to Sections 3.4 (human health risk assessment) and 3.5 screening ecological risk assessment) and Appendix C.	Comment noted. Per the SOW dated 5/12/00, a technical memorandum will be issued to the RVAAP Team prior to execution of the baseline risk assessment. The memorandum will detail the proposed approach to be employed and associated technical assumptions. The approach to be used in the Phase II RI report will be based on the review and response resolution of the information presented in the technical memorandum.
13	Tables 3-1 through 3-6.	The titles for Table 3-1, 3-2, 3-3, 3-4, 3-5, and 3-6 should clearly indicate that the criteria detailed in these tables represent installation-wide, or facility-wide background.	Agreed. The titles have been revised as requested.
14	Page 3-14.	Please correct the spelling of Trumbull County. (lines 33 and 35)	Agreed. The text has been revised as requested.
15	Table 3-7.	On Table 3-7. Conceptual Exposure Model for Load Line 12 at RVAAP (page 3-16):  A. Is there the potential for an industrial worker to encounter perched groundwater? If so, please adjust the chart accordingly.  B. Please revise the section under “sediment” to indicate that there may be incidental sediment ingestion or dermal contact with sediment.	A. A groundwater exposure pathway was not considered for the industrial worker scenario, which is consistent with the baseline risk assessment protocol for the Winklepeck Burning Grounds Phase II RI. State of Ohio OSHA regulations require protection of workers in any excavation in part through pumping/dewatering. No standing water is allowed within an excavation in which work will be conducted.  B. Agreed. Note – the term “soil” was changed to “sediment.”

**Draft Sampling and Analysis Addendum No. 1 for the Phase II Remedial Investigation  
of Load Line 12 at the Ravenna Army Ammunition Plant  
Comment Resolution**

COMMENT NUMBER	PAGE OR SHEET	COMMENT	RESPONSE
16	Page 3-23	<p>On Figure 3-1: Exposure Pathways for Terrestrial and Aquatic Receptors (page 3-23):</p> <p>A. Please re-evaluate this figure with respect to the text found on page 3-22. The figure indicates that the surface water/sediment is not a complete pathway, while the text on page 3-22 indicates that the pathway is complete. Please resolve the discrepancy.</p> <p>B. Please confirm that there isn't the potential for burrowing animals to be in contact with shallow perched groundwater.</p>	<p>A. Agreed. The figure has been revised to show two complete pathways involving ingestion to aquatic receptors.</p> <p>B. Clarification. Burrowing animals like earthworms and some small mammals could be exposed via moist soil to shallow groundwater. This has been recognized as a complete pathway evaluated qualitatively (i.e., using written evaluation, logic processes, and technical assumptions) on the conceptual ecological risk model.</p>
17	Page 4-1.	In the introductory text for Section 4.0, please provide some text which details what impact the demolition activities may have had on the Phase I RI sampling locations and data, and how the Phase I data will be used (if it is) in the Phase II report.	Agreed. However, this information was added to the Phase II RI DQOs section (Section 3.2.6) where decision rules regarding data are presented.
18	Table 4-1	Provide an explanation for the discrepancy between the number of samples detailed on this table with the number of samples that were initially projected during the April 2000 scoping meetings. In most instances, the number of samples projected during the meetings, as being necessary to adequately characterize the AOC, has been decreased for each sub-area. In some cases, the number of samples in the workplan substantially differ from the numbers scoped in April.	Clarification. Table 4-1 provides a summary of the number of <u>stations</u> to be sampled rather than the number of samples to be collected. The numbers of samples planned for the Load Line 12 Phase II RI are equal or very similar to those planned in the scoping meeting. Refer to Tables 5-1, 5-2, and 5-3 for detailed sampling information.
19	Page 4-4.	Provide an explanation for collecting both filtered and unfiltered groundwater samples for TAL metals. In correspondence to USACE, dated December 7, 1998 (with an attached memorandum), it was decided that filtered groundwater samples would be utilized for risk assessment purposes at the CERCLA AOCs. In addition, this statement in the text contradicts Table 5-3 found on page 5-15. (lines 20-21)	Agreed. The reference to unfiltered samples has been deleted from the SAP addendum.
20	Page 4-5.	Remove line 21 from the workplan that indicates that core samples may be transferred to Ohio EPA, NEDO, for storage.	Agreed. Text has been revised as requested.

**Draft Sampling and Analysis Addendum No. 1 for the Phase II Remedial Investigation  
of Load Line 12 at the Ravenna Army Ammunition Plant  
Comment Resolution**

COMMENT NUMBER	PAGE OR SHEET	COMMENT	RESPONSE
21	Page 4-12.	The word “surface” should be changed to “sub-surface” as this section deals with sub-surface soil collection. (lines 26, 29, and 31)	Agreed. Text has been revised as requested.
22	Page 4-13.	Provide the rationale for substantially decreasing the number of contingency samples scoped for this phase of work from the initial scoping meetings to the generation of this workplan. (line 38) What course of action will be pursued if the number of contingency samples are not adequate to evaluate the horizontal extent of surface soil contamination?	Clarification. Only two contingency samples associated with Bldg. 901 discussed in the scoping meeting were not included in the SOW dated 5/12/00. However, three additional contingency samples associated with transformer pads were added. Should nature and extent of contamination not be completely addressed in this Phase II RI, additional characterization efforts may be required under a subsequent phase of work (i.e., feasibility study or Supplemental RI).
23	Page 4-14.	Revise the text (line 26) to read “...explosives >= 1 mg/kg (TNT or RDX)....”	Agreed. Text has been revised as requested.
24	Page 4-18.	Revise the text (line 39), to indicate that 2% acid rinse will be utilized in the decontamination procedure.	Agreed. Text has been revised as requested.
25	Page 4-23.	The text (Section 4.7) should detail how the excavated soils will be managed. In addition, a location map showing the approximate location of the proposed trenches should be added to the workplan.	Agreed. Additional text has been added as requested detailing how soils excavated from the test pits will be managed.
HASP - 1	General.	OEPA has no comment on the HASP.	Comment noted.