Final
Site Inspection Report
CC RVAAP-71 Barn No. 5 Petroleum Release
Revision 0

Former Ravenna Army Ammunition Plant
Portage and Trumbull Counties, Ohio

February 12, 2015

Contract No. W912QR-04-D-0039
Delivery Order: 0004

Prepared for:

US Army Corps of Engineers®

United States Army Corps of Engineers
Louisville District
600 Martin Luther King Jr. Place
Louisville, Kentucky 40202-2267

Prepared by:

Environmental Chemical Corporation
33 Boston Post Road West
Suite 420
Marlborough, Massachusetts 01752

This page intentionally left blank.

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ADDRESS.

1. REPORT DATE *(DD-MM-YYYY)*	2. REPORT TYPE	3. DATES COVERED *(From - To)*
12-02-2015	Technical	December 2011 - February 2015

4. TITLE AND SUBTITLE
Final Site Inspection Report
CC RVAAP-71 Barn No. 5 Petroleum Release
Former Ravenna Army Ammunition Plant
Portage and Trumbull Counties, Ohio

5a. CONTRACT NUMBER
W912QR-04-D-0039

5b. GRANT NUMBER
NA

5c. PROGRAM ELEMENT NUMBER
NA

6. AUTHOR(S)
Easterday, Al (Environmental Chemical Corporation)
Gina Calderone (Environmental Chemical Corporation)

5d. PROJECT NUMBER
5161.004

5e. TASK NUMBER
Delivery Order No. 0004

5f. WORK UNIT NUMBER
NA

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Environmental Chemical Corporation
33 Boston Post Road West
Suite 420
Marlborough, Massachusetts 01752

8. PERFORMING ORGANIZATION REPORT NUMBER
NA

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
United States Army Corps of Engineers
Louisville District
600 Martin Luther King Jr. Place
Louisville, Kentucky 40202-0059

10. SPONSOR/MONITOR'S ACRONYM(S)
USACE

11. SPONSORING/MONITORING AGENCY REPORT NUMBER
NA

12. DISTRIBUTION AVAILABILITY STATEMENT
Reference distribution page.

13. SUPPLEMENTARY NOTES
None.

14. ABSTRACT
This Site Inspection (SI) report documents the SI activities conducted at CC RVAAP-71 Barn No. 5 Petroleum Release at the former Ravenna Army Ammunition Plant, Portage and Trumbull counties, Ohio. The purpose of the SI was to determine the presence or absence of contamination and whether the Barn No. 5 Petroleum Release Area of Concern (AOC) warranted further investigation pursuant to the Comprehensice Environmental Response, Compensation, and Liability Act (CERCLA) of 1980. The sampling completed for this SI indicates there is no contamination present at the Barn No. 5 Petroleum Release AOC that would warrant further investigation. This SI report recommends No Further Action.

15. SUBJECT TERMS
Site Inspection, Barn No. 5, CERCLA, petroleum release, No Further Action

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE	SAR	10,851	Al Easterday
U	U	U			19b. TELEPONE NUMBER (*Include area code*) 508-229-2270 x22109

INSTRUCTIONS FOR COMPLETING SF 298

1. REPORT DATE. Full publication date, including day, month, if available. Must cite at lest the year and be Year 2000 compliant, e.g., 30-06-1998; xx-08-1998; xx-xx-1998.

2. REPORT TYPE. State the type of report, such as final, technical, interim, memorandum, master's thesis, progress, quarterly, research, special, group study, etc.

3. DATES COVERED. Indicate the time during which the work was performed and the report was written, e.g., Jun 1997 - Jun 1998; 1-10 Jun 1996; May - Nov 1998; Nov 1998.

4. TITLE. Enter title and subtitle with volume number and part number, if applicable. On classified documents, enter the title classification in parentheses.

5a. CONTRACT NUMBER. Enter all contract numbers as they appear in the report, e.g. F33615-86-C-5169.

5b. GRANT NUMBER. Enter all grant numbers as they appear in the report, e.g. 1F665702D1257.

5c. PROGRAM ELEMENT NUMBER. Enter all program element numbers as they appear in the report, e.g. AFOSR-82-1234.

5d. PROJECT NUMBER. Enter al project numbers as they appear in the report, e.g. 1F665702D1257; ILIR.

5e. TASK NUMBER. Enter all task numbers as they appear in the report, e.g. 05; RF0330201; T4112.

5f. WORK UNIT NUMBER. Enter all work unit numbers as they appear in the report, e.g. 001; AFAPL30480105.

6. AUTHOR(S). Enter name(s) of person(s) responsible for writing the report, performing the research, or credited with the content of the report. The form of entry is the last name, first name, middle initial, and additional qualifiers separated by commas, e.g. Smith, Richard, Jr.

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES). Self-explanatory.

8. PERFORMING ORGANIZATION REPORT NUMBER. Enter all unique alphanumeric report numbers assigned by the performing organization, e.g. BRL-1234; AFWL-TR-85-4017-Vol-21-PT-2.

9. SPONSORING/MONITORS AGENCY NAME(S) AND ADDRESS(ES). Enter the name and address of the organization(s) financially responsible for and monitoring the work.

10. SPONSOR/MONITOR'S ACRONYM(S). Enter, if available, e.g. BRL, ARDEC, NADC.

11. SPONSOR/MONITOR'S REPORT NUMBER(S). Enter report number as assigned by the sponsoring/ monitoring agency, if available, e.g. BRL-TR-829; -215.

12. DISTRIBUTION/AVAILABILITY STATEMENT. Use agency-mandated availability statements to indicate the public availability or distribution limitations of the report. If additional limitations/restrictions or special markings are indicated, follow agency authorization procedures, e.g. RD/FRD, PROPIN, ITAR, etc. Include copyright information.

13. SUPPLEMENTARY NOTES. Enter information not included elsewhere such as: prepared in cooperation with; translation of; report supersedes; old edition number, etc.

14. ABSTRACT. A brief (approximately 200 words) factual summary of the most significant information.

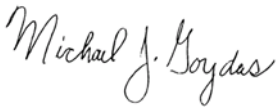
15. SUBJECT TERMS. Key words or phrases identifying major concepts in the report.

16. SECURITY CLASSIFICATION. Enter security classification in accordance with security classification regulations, e.g. U, C, S, etc. If this form contains classified information, stamp classification level on the top and bottom of this page.

17. LIMITATION OF ABSTRACT. This block must be completed to assign a distribution limitation to the abstract. Enter UU (Unclassified Unlimited) or SAR (Same as Report). An entry in this block is necessary if the abstract is to be limited.

CONTRACTOR'S STATEMENT OF INDEPENDENT TECHNICAL REVIEW

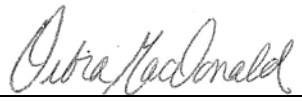
Environmental Chemical Corporation has completed the *Final Site Inspection Report, CC RVAAP-71 Barn No. 5 Petroleum Release, Revision 0, Former Ravenna Army Ammunition Plant, Portage and Trumbull Counties, Ohio.* Notice is hereby given that an independent technical review has been conducted that is appropriate to the level of risk and complexity inherent in the project. During the independent technical review, compliance with established policy principles and procedures, utilizing justified and valid assumptions, was verified. This included review of project data quality objectives, technical assumptions, methods, procedures, and materials used. The appropriateness of the data used, level of data obtained, and reasonableness of the results, including whether the product meets the customer's needs, are consistent with law and existing U.S. Army Corps of Engineers policy.



February 3, 2015

Michael Goydas, P.G. Date

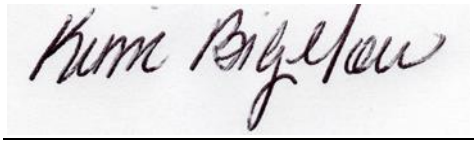
Senior Hydrogeologist



February 4, 2015

Debra MacDonald, P.E., PMP Date

Project Manager



February 5, 2015

Kim Bigelow Date

Technical Writer

This page intentionally left blank.

OhioEPA

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

February 19, 2015

Re: US Army Ravenna Ammunition Plt RVAAP
Assessment
Remedial Response
Portage County
267000859

Mr. Mark Leeper, P.G., MBA
Restoration/Cleanup Program Manager
ARNG Directorate
111 S. George Mason Dr
Arlington, VA 22204

Subject: Ohio EPA's Review of the Final Site Inspection Report, CC-RVAAP-71 Barn No. 5 Petroleum Release, February 12, 2015, Project No. 267-000859-155

Dear Mr. Leeper:

On February 13, 2015, the Ohio Environmental Protection Agency (Ohio EPA), Northeast District Office (NEDO), received a copy of the Final Site Inspection Report for CC-RVAAP-71, Building 1037, Barn No. 5 Petroleum Release. The document was prepared by ECC under contract no. W912QR-04-D-0039.

Ohio EPA has reviewed the document. It is hereby approved.

If you have any questions or concerns related to this review or would like to schedule a meeting or conference call, please free feel to contact me at (330) 963-1170.

Sincerely,

Edward D'Amato
Project Coordinator
Ohio EPA - Division of Environmental Response and Revitalization

ED/nvr

ec: Rodney Beals, DERR, NEDO
Justin Burke, DERR-CO

cc: Katie Tait, OHARNG RTLS
Gregory F. Moore, USACE
Gail Harris, Vista Sciences Corp.
Kevin Sedlak, ARNG
Mark Nichter, USACE
Rebecca Haney, Vista Sciences Corp.

This page intentionally left blank.

Final
Site Inspection Report
CC RVAAP-71 Barn No. 5 Petroleum Release
Revision 0

Former Ravenna Army Ammunition Plant
Portage and Trumbull Counties, Ohio

February 12, 2015

Contract No. W912QR-04-D-0039
Delivery Order: 0004

Prepared for:

United States Army Corps of Engineers,
Louisville District
600 Martin Luther King Jr. Place
Louisville, Kentucky 40202-2267

Prepared by:

Environmental Chemical Corporation
33 Boston Post Road West
Suite 420
Marlborough, Massachusetts 01752

This page intentionally left blank.

DOCUMENT DISTRIBUTION
for the
Final Site Inspection Report
CC RVAAP-71 Barn No. 5 Petroleum Release
Revision 0
Former Ravenna Army Ammunition Plant
Portage and Trumbull Counties, Ohio

Name	Organization	Number of Printed Copies	Number of Electronic Copies
TBD	Ohio Environmental Protection Agency–Northeast District Office	Transmittal letter only	
Rod Beals	Ohio Environmental Protection Agency–Northeast District Office	Transmittal letter only	
Justin Burke	Ohio Environmental Protection Agency–Central District Office Division of Environmental Response and Remediation	0	1
Ed D'Amato	Ohio Environmental Protection Agency–Northeast District Office	1	2
Mark Leeper	Army National Guard	0	1
Kevin Sedlak	Army National Guard	1	1
Katie Tait	Ohio Army National Guard	1	1
Eric Cheng	U.S. Army Corps of Engineers–Louisville District	2	2
Administrative Records Manager	Ravenna Army Ammunition Plant	2	2
Ravenna Environmental Information Management System		0	1
Al Easterday	Environmental Chemical Corporation	1	1

This page intentionally left blank.

TABLE OF CONTENTS

TABLE OF CONTENTS (CONTINUED)

TABLE OF CONTENTS (CONTINUED)

TABLE OF CONTENTS (CONTINUED)

LIST OF FIGURES

LIST OF FIGURES (CONTINUED)

LIST OF TABLES

LIST OF APPENDICES

LIST OF APPENDICES (CONTINUED)

This page intentionally left blank.

ACRONYMS AND ABBREVIATIONS

^{o}F	Degrees Fahrenheit
µg/d	Micrograms per Day
µg/kg	Micrograms per Kilogram
amsl	Above Mean Sea Level
AOC	Area of Concern
APA	Abbreviated Preliminary Assessment
ARNG	Army National Guard
AST	Above Ground Storage Tank
beta-BHC	beta-Hexachlorocylohexane
bgs	Below Ground Surface
BRAC	Base Realignment and Closure
BRACO	Base Realignment and Closure Office
BUSTR	Bureau of Underground Storage Tank Regulations
C	Carbon
CC	Army Environmental Compliance-Related Cleanup Program
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cm	Centimeter
COC	Chemical of Concern
COPC	Chemical of Potential Concern
CR	Compliance Restoration
CT	CT Laboratories, LLC
DFFO	Director's Final Findings and Orders
DI	Deionized
DO	Delivery Order
DoD	Department of Defense
DOT	Department of Transportation
DRO	Diesel Range Organic
DSB	Deep Soil Boring
DU	Decision Unit
ECC	Environmental Chemical Corporation
EPA	Environmental Protection Agency
ERO	Extended Range Organic

ACRONYMS AND ABBREVIATIONS (CONTINUED)

ft	Feet
FWCUG	Facility-Wide Cleanup Goal
FWSAP	Facility-Wide Sampling and Analysis Plan
FWFSP	Facility-Wide Field Sampling Plan
FWQAPP	Facility-Wide Quality Assurance Project Plan
gpm	Gallons per Minute
GRO	Gasoline Range Organic
HQ	Hazard Quotient
HRR	Historical Records Review
HTRW	Hazardous, Toxic or Radioactive Waste
ID	Identification
IDW	Investigation-Derived Waste
IRP	Installation Restoration Program
ISM	Incremental Sampling Methodology
J	Estimated
km	Kilometer
km^2	Square Kilometer
LOD	Limit of Detection
m	Meter
MARC	Multiple Award Remediation Contract
MDC	Maximum Detected Concentration
MEC	Munitions and Explosives of Concern
mg/d	Milligram per Day
mg/kg	Milligram per Kilogram
MMRP	Military Munitions Response Program
MTBE	Methyl-Tertiary-Butyl Ether
MS/MSD	Matrix Spike/Matrix Spike Duplicate
NAD	North American Datum
NCP	National Contingency Plan
ND	Non-Detect

ACRONYMS AND ABBREVIATIONS (CONTINUED)

NFA	No Further Action
NGB	National Guard Bureau
NGT	National Guard Trainee
No.	Number
ODNR	Ohio Department of Natural Resources
OHARNG	Ohio Army National Guard
Ohio EPA	Ohio Environmental Protection Agency
Or	Orrville Silt Loam
PAH	Polycyclic Aromatic Hydrocarbon
PBA	Performance-Based Acquisition
PCB	Polychlorinated Biphenyl
PID	Photoionization Detector
PWS	Performance Work Statement
QA	Quality Assurance
QC	Quality Control
QAPP	Quality Assurance Project Plan
QSM	Quality Systems Manual
RAFLU	Reasonably Anticipated Future Land Use
RCI	Reactivity, Corrosivity, and Ignitability
RDA	Recommended Daily Allowance
RDI	Recommended Daily Intake
RI	Remedial Investigation
RmB	Remsen Silt Loam
RRSE	Relative Risk Site Evaluation
RSL	Regional Screening Level
RVAAP	Ravenna Army Ammunition Plant
SAIC	Science Applications International Corporation
SB	Soil Boring
SI	Site Inspection
SIM	Selective Ion Monitoring
SOHIO	Standard Oil of Ohio
SRC	Site-Related Chemical
SVOC	Semi-volatile Organic Compound

ACRONYMS AND ABBREVIATIONS (CONTINUED)

TAL	Target Analyte List
TCLP	Toxicity Characteristic Leaching Procedure
TNT	2,4,6-Trinitrotoluene
TPH	Total Petroleum Hydrocarbon
TR	Target Risk
USACE	United States Army Corps of Engineers
USACHPPM	United States Army Center for Health Promotion and Preventive Medicine
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
UST	Underground Storage Tank
UTM	Universal Transverse Mercator
VOC	Volatile Organic Compound
WOE	Weight of Evidence

EXECUTIVE SUMMARY

Environmental Chemical Corporation (ECC) was contracted by the United States Army Corps of Engineers (USACE) Louisville District to complete a Site Inspection (SI) at a Compliance Restoration (CR) site CC RVAAP-71 Barn No. 5 Petroleum Release at the former Ravenna Army Ammunition Plant (RVAAP), in Portage and Trumbull Counties, Ohio. The SI was completed under Contract Number W912QR-04-D-0039, Delivery Order (DO) Number 0004, Modification Number 1.

The SI was completed in accordance with the Final Site Inspection/Remedial Investigation Work Plan Addendum for Army Environmental Compliance-Related Cleanup Program Sites (CC) RVAAP-71 and CC RVAAP-83 (ECC 2013). The SI for CC RVAAP-71 was conducted in accordance with the United States Environmental Protection Agency's (USEPA) *Interim Final Guidance for Performing Site Inspections Under Comprehensive Environmental Response, Compensation, and Liability Act* (CERCLA) (USEPA 1992).

CC RVAAP-71 Area of Concern (AOC), the site of a 1964 gasoline release from a broken underground pipeline near Barn No. 5, was recommended for further investigation based on the Historical Records Review (HRR) (ECC 2012). No previous environmental sampling was conducted at this AOC (ECC 2012). According to the historic spill records, petroleum-related chemicals (gasoline range hydrocarbons) associated with the former buried gasoline pipeline were released to the environment. The pipeline was located outside the southern installation fence in the vicinity of Barn No. 5.

This SI at CC RVAAP-71 was conducted to assess the potential presence of contamination related to the gasoline release from the pipeline in 1964. Due to the nature of the source (subsurface release of gasoline from underground pipeline), only the subsurface soils were sampled for this SI. No surface soil samples were collected as part of the SI as the release occurred 47 years ago, and residual surface soil impacts are considered to be unlikely.

The objectives of this site investigation at CC RVAAP-71 were to:

- Conduct Incremental Sampling Methodology (ISM) sampling of subsurface soils.

- Provide sufficient Quality Assurance (QA)/Quality Control (QC) sampling to evaluate the overall quality of both the field and laboratory sampling procedures.

- Perform AOC-Specific Screen of sample analytical results to determine if a chemical is a Site-Related Chemical (SRC). The identified SRCs were further used to perform a risk-based screen by comparing the maximum detected result to the Facility-Wide Cleanup Goals (FWCUGs) (SAIC 2010). The reported concentrations were compared to the

most stringent value for the receptors at the 1.0×10^{-6} cancer risk level or the non-carcinogenic hazard quotient (HQ) = 0.1. In the event that a FWCUG was not established for a particular chemical, the reported concentration was compared to the EPA Regional Screening Levels (RSLs) (EPA 2013).

- Identify the presence of chemicals of potential concern (COPC) at the AOC and provide recommendations whether exposure pathways exist and if further investigation is warranted.

The ISM sampling was conducted at the Barn No. 5 Petroleum Release AOC within an approximate 5,950 square feet (sq. ft) area corresponding to the suspected release area. The subsurface soil samples were analyzed for volatile organic compounds (VOCs), including methyl tertiary butyl ether (MTBE), semi-volatile organic compounds (SVOCs), total petroleum hydrocarbon (TPH) gasoline range organic (GRO) and diesel range organic (DRO) carbon chain compounds, and lead.

The following numbers of subsurface soil samples were collected during this SI:

- Two horizontal subsurface soil ISM samples were collected (depths of 1 – 4 and 4 – 7 feet below ground surface [ft bgs]).
- Fourteen vertical subsurface soil ISM samples were collected (1 – 7 ft bgs).
- One deeper subsurface soil sample was collected from 7 - 13 ft bgs to characterize the subsurface soils to 13 ft bgs.
- No sediment or surface water samples were collected as this media would not be impacted from the source area of this AOC (subsurface release of gasoline).
- No groundwater samples were collected as groundwater is being evaluated on a facility-wide basis (RVAAP-66 Facility-Wide Groundwater). Any future potential groundwater contamination associated with this AOC will be evaluated as part of the investigation activities under RVAAP-66.

A summary of the SI results for CC RVAAP-71 Barn No. 5 Petroleum Release is as follows:

- SRCs were identified in the subsurface soil samples based upon the background screen, frequency of detection screen and essential nutrient screen.

- The following SRCs were identified in this SI: one VOC; seventeen SVOCs including polycyclic aromatic hydrocarbon (PAH) compounds; one pesticide; two TPH GRO carbon chain compounds; three TPH DRO carbon chain compounds; and three metals.

- The identified SRCs were further evaluated and used to perform a risk-based screen and compared against their respective FWCUG for the Resident Receptor and the National

Guard Trainee and the State of Ohio Bureau of Underground Storage Tank Regulations (BUSTR) criteria (only the TPH DRO and TPH GRO carbon chain compounds).

- Chemicals of potential concern (COPCs) were identified using the most stringent of the FWCUGs at the 1.0×10^{-6} risk level or the HQ = 0.1 in the subsurface soils collected at the CC RVAAP-71 Barn No. 5 Petroleum Release.

One SVOC (benzo(a)pyrene) was identified in one sample collected at soil boring SB14 in the 1 - 7 ft bgs interval at a concentration of 23.0 micrograms per kilogram (µg/kg) exceeding the Resident Receptor FWCUG of 22.0 µg/kg. The reported concentration (23.0 µg/kg) exceeds the Resident Receptor FWCUG by 1.0 µg/kg and is less than the National Guard Trainee FWCUG of 477 µg/kg. The one reported detection of benzo(a)pyrene is not considered to be associated with the 1964 gasoline release and was not considered to be a contaminant related to the gasoline release. Literature studies indicate the concentration reported at CC RVAAP-71 of benzo(a)pyrene is indicative of a release from common anthropogenic sources such as road dust, vehicle exhaust, tire wear particles, pavement, and slag used as fill (ATSDR 1995; Bradley et. al. 1994; IEPA 2005; MassDEP 2002; Teaf et. al. 2008). No PAHs or PAH-containing materials were used at CC RVAAP-71 (gasoline release) and no burning was conducted at CC RVAAP-71. There are no CERCLA release-related sources of PAHs at CC RVAAP-71. Various lines of evidence listed below were used to support that benzo(a)pyrene is not related to the 1964 gasoline release at CC RVAAP-71 AOC:

(1) Benzo(a)pyrene was detected in 17 of the 19 subsurface soil samples collected at CC RVAAP-71, which reported concentrations ranging from 0.29 to 23 µg/kg, and only 1 of 19 samples reported an exceedance of the Resident Receptor FWCUG.

(2) The soil sampling location (SB14) is within 3 ft of the former asphalt pavement.

(3) The detected concentrations of benzo(a)pyrene in the horizontal ISM subsurface soil samples decrease in concentration with sampling depth, ranging from 13 µg/kg (1 - 4 ft) to 0.72 J µg/kg (4 - 7 ft). This finding suggests a probable surficial source for the chemical.

(4) The detected concentration of benzo(a)pyrene at SB14 is much less than the Bureau of Underground Storage Tank Regulations (BUSTR) Class 1 Soil Action Level of 1.1 mg/kg (1,100 µg/kg), which is used for gasoline-related contamination.

(5) No other gasoline constituents, such as benzene, toluene, ethylbenzene, and total xylenes (BTEX) or TPH GRO, were reported in the subsurface soil at SB14.

Based on these lines of evidence, benzo(a)pyrene is not identified as a COPC at CC RVAAP-71.

One metal (aluminum) was detected in soil boring SB11 in the 1 - 7 ft bgs interval at a concentration of 32,200 J (estimated) milligrams per kilogram (mg/kg) which exceeds the background criteria of 19,500 mg/kg and the Resident Receptor and National Guard Trainee FWCUGs of 7,380 mg/kg and 3,496 mg/kg, respectively. Aluminum is found in soils throughout soils at Ravenna and was detected in all the samples taken for the two background studies. This soil sample was collected within 2 ft of the rusted metal chain-link security fence that was expected to be coated with an aluminum alloy for corrosion protection. Various lines of evidence were used to determine that the aluminum detection within the one sample is not related to the 1964 gasoline release at CC RVAAP-71. These lines of evidence include:

(1) The soil sample was collected from the subsurface soil within 2 ft of the very rusted metal security fence and is the highest reported aluminum concentration for all subsurface soil samples collected and analyzed for metals during the SI at this AOC.

(2) Aluminum is not a component of gasoline and, therefore, would not be associated with the 1964 gasoline release to the environment at this AOC.

(3) There is no indication that CC RVAAP-71 AOC was used for the storage of metal debris or other minerals containing aluminum. The only reported contaminant release at this AOC was from the subsurface gasoline pipeline in 1964.

The elevated concentration of aluminum (32,200 J mg/kg) reported in the one sample at SB11 is expected to be from the rusted metal security fence that is within 2 ft of the sample location, rather than from the gasoline spill at CC RVAAP-71. Further, aluminum is not a typical additive to gasoline formulations (USEPA 2006). Aluminum is not considered to be related to the 1964 gasoline release from the pipeline nor the historical practices at CC RVAAP-71 and was not identified as a COPC.

- Since TPH GRO and TPH DRO have no established FWCUGs, the BUSTR criteria were used for screening these organic compounds. No TPH GRO or TPH DRO carbon chain compounds were reported exceeding the BUSTR criteria. Therefore, no TPH GRO or TPH DRO carbon chain compounds were identified as COPCs at CC RVAAP-71.

The conclusions of this SI are as follows:

- Subsurface soil was evaluated at CC RVAAP-71 Barn No. 5 Petroleum Release to a maximum depth of 13 ft bgs.

- A total of twenty-seven SRCs were identified consisting of one VOC, seventeen SVOCs, three metals, one pesticide and five TPH GRO/DRO carbon chain compounds.

- Only two of the twenty-seven SRCs exceeded FWCUGs as described above and presented below.

1. Benzo(a)pyrene was reported at a concentration exceeding the Resident Receptor FWCUG by 1.0 µg/kg at boring location SB14 at the 1 - 7 ft bgs interval.

2. Aluminum was reported at a concentration exceeding the Resident Receptor and National Guard Trainee FWCUGs of 7,380 mg/kg and 3,496 mg/kg, respectively at soil boring SB11 in the 1 - 7 ft bgs interval.

- No SRCs, other than benzo(a)pyrene and aluminum were reported exceeding the Resident Receptor or National Guard Trainee FWCUG in the samples collected at CC RVAAP-71 Barn No. 5 Petroleum Release.

- There were no BUSTR exceedances of gasoline-constituents related with the 1964 gasoline release reported in any of the subsurface soil samples collected at CC RVAAP-71 Barn No. 5 Petroleum Release.

- The two SRCs that exceeded FWCUGs are not considered to be chemicals related to the gasoline release or historical practices at CC RVAAP-71. Therefore, no COPCs were identified in the subsurface soil sampled at CC RVAAP-71 Barn No. 5 Petroleum Release.

- Groundwater associated with CC RVAAP-71 is currently being addressed separately under CC RVAAP-66 Facility-Wide Groundwater.

The results of this SI indicate that No Further Action (NFA) is warranted at CC RVAAP-71 Barn No. 5 Petroleum Release AOC.

This page intentionally left blank.

1.0 INTRODUCTION

Environmental Chemical Corporation (ECC) was contracted by the United States Army Corps of Engineers (USACE) Louisville District to complete a Site Inspection (SI) at a Compliance Restoration (CR) site at the former Ravenna Army Ammunition Plant (RVAAP), in Portage and Trumbull Counties, Ohio, under Contract Number W912QR-04-D-0039, Delivery Order (DO) Number 0004, Modification Number 1. This document was prepared by ECC under the USACE Louisville District, Multiple Award Remediation Contract (MARC) W912QR-04-D-0039, Delivery Order (DO) Number 0004, Modification Number 1.

Planning and performance of this contract are in accordance with the requirements of the Ohio Environmental Protection Agency (Ohio EPA) Director's Final Findings and Orders (DFFO) for RVAAP, dated June 10, 2004 (Ohio EPA 2004). The DFFO requires conformance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the National Contingency Plan (NCP) to complete the SI for Area of Concern (AOC) CC (Army Environmental Compliance-Related Cleanup Program) RVAAP-71.

The SI for CC RVAAP-71 was conducted in accordance with the United States Environmental Protection Agency's (USEPA) *Interim Final Guidance for Performing Site Inspections Under CERCLA* (USEPA 1992). The work described in this SI Report was conducted in accordance with the *Final Site Inspection and Remedial Investigation Work Plan Addendum at Compliance Restoration Sites CC RVAAP-71 Barn No. 5 Petroleum Release and CC RVAAP-83 Former Buildings 1031 and 1039, Revision 1* (ECC 2013).

The SI includes the following components:

- Site descriptions and operational histories
- Waste characteristics and management practices
- Summary of field investigation and pre-mobilization activities
- Summary of the analytical data and results of the field investigation activities
- Comparison of results with the most recent Facility-Wide Cleanup Goals (FWCUG)
- Exposure pathways evaluation for surface soil, subsurface soil, air, surface water, and groundwater
- Summary of results and conclusions
- References

1.1 PURPOSE AND SCOPE

ECC is submitting this SI Report to the USACE Louisville District in accordance with the Performance Work Statement (PWS), MARC Contract No. W912QR-04-D-0039, DO No. 0004,

Modification 1 under a firm-fixed price Performance-Based Acquisition (PBA) to provide environmental investigation and remediation services at CC RVAAP-71 at the RVAAP, Ravenna, Ohio (Figure 1-1 and Figure 1-2). The DO was issued by the USACE, Louisville District on August 15, 2011.

Environmental work at RVAAP under the Installation Restoration Program (IRP) began in 1989, with 32 environmental Areas of Concern (AOC). The U.S. Army Center for Health Promotion and Preventive Medicine (USACHPPM) collected environmental samples at each of the AOCs and performed a Relative Risk Site Evaluation (RRSE), which prioritized each AOC into three groups: low, medium, and high priorities. Environmental restoration work has proceeded primarily by addressing the highest priority sites first. In 1998, the number of environmental AOCs was increased from 32 to 51. Again, relative risk rankings were performed to prioritize those additional environmental AOCs. Since 1998, new environmental AOCs have been added. This SI discusses one of these AOCs, CC RVAAP-71 Barn No.5 Petroleum Release (Figure 1-3).

The SI conducted for this AOC included a comprehensive background historical review and an initial intrusive investigation to confirm the presence or absence of gasoline related contamination associated with the documented 1964 gasoline release from the underground pipeline. The background historical review followed the guidance and requirements for a CERCLA Abbreviated Preliminary Assessment (APA), *USEPA Improving Site Assessment: Abbreviated Preliminary Assessments* (EPA 1999).

Historical information for CC RVAAP-71 is presented in the *Final Historical Records Review Report for CC RVAAP-71 Barn No. 5 Petroleum Release and CC RVAAP-83 Former Buildings 1031 and 1039, Revision 0* (ECC 2012). The Historical Records Review (HRR) identified the historic uses and potential environmental concerns at this site with respect to possible Hazardous Toxic and Radioactive Waste (HTRW) and/or Military Munitions Response Program (MMRP) issues. A brief description and history of CC RVAAP-71 is provided in Section 2.0.

1.2 FACILITY DESCRIPTION

The facility, consisting of 21,683 acres, is located in northeastern Ohio within Portage and Trumbull counties, approximately 4.8 kilometers (3 miles) east/northeast of the City of Ravenna and approximately 1.6 kilometers (1 mile) northwest of the City of Newton Falls. The facility, previously known as the RVAAP, was formerly used as a load, assemble, and pack facility for munitions production. As of September 2013, administrative accountability for the entire acreage of the facility has been transferred to the United States Property and Fiscal Officer (USP&FO) for Ohio and subsequently licensed to the Ohio Army National Guard (OHARNG) for use as a military training site (the facility). References in this document to former RVAAP

relate to previous activities at the facility as related to former munitions production activities or to activities being conducted under the restoration/cleanup program.

1.3 DEMOGRAPHY AND LAND USE

The facility consists of 21,683 acres in northeastern Ohio, approximately 23 miles (37 km) east–northeast of Akron and 30 miles (48.3 km) west–northwest of Youngstown. The facility occupies east–central Portage County and southwestern Trumbull County. The 2010 Census reports that populations of Portage and Trumbull counties are 161,419 and 210,312, respectively. Population centers closest to the facility are Ravenna, with a population of 11,724, and Newton Falls, with a population of 4,795.

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

The facility is licensed to the OHARNG for use as a military training site. Training and related activities at Camp Ravenna include field operations and bivouac training, convoy training, equipment maintenance, C-130 aircraft drop zone operations, helicopter operations, and storage of heavy equipment.

1.4 FACILITY ENVIRONMENTAL SETTING

This section describes the physical features, topography, geology, hydrogeology, and environmental characteristics of the facility. The environmental setting specific to CC RVAAP-71 is included in Section 6.0.

1.4.1 Physiographic Setting

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

1.4.2 Surface Features and Topography

The topography of the facility is gently undulating with an overall decrease in ground elevation from a topographic high of approximately 1,220 feet (ft) above mean sea level (amsl) in the far western portion of the facility to low areas at approximately 930 ft amsl in the far eastern portion of the facility. The average surface elevation for CC RVAAP-71 is 1071 ft amsl.

USACE mapped the facility topography in February 1998 using a 2-ft (60.1-centimeter [cm]) contour interval with an accuracy of 0.02 ft (0.61 cm). USACE based the topographic information on aerial photographs taken during the spring of 1997. The USACE survey is the basis for the topographical information illustrated in figures included in this report.

1.4.3 Regional Geology and Soils

1.4.3.1 Regional Geology

The regional geology at the facility consists of horizontal to gently dipping bedrock strata of Mississippian- and Pennsylvanian-age overlain by varying thicknesses of unconsolidated glacial deposits of varying thickness. The bedrock and unconsolidated surficial deposits are described in the following subsections.

1.4.3.2 Soil and Glacial Deposits

Bedrock is overlain by deposits of the Wisconsin-age Lavery Till in the western portion of the facility and the younger Hiram Till and associated outwash deposits in the eastern two-thirds of the facility (Figure 1-4). Unconsolidated glacial deposits vary considerably in thickness across the facility, from nonexistent in some of the eastern portions of the facility to an estimated 150 ft (46 meters [m]) in the south-central portion.

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

Soil at the facility is generally derived from the Wisconsin-age silty clay glacial till. Distributions of soil types are discussed and mapped in the *Soil Survey of Portage County, Ohio,*

which describes soil as nearly level to gently sloping and poor to moderately well drained (USDA 2011). Much of the native soil at the facility was disturbed during construction activities in former production and operational areas of the facility.

Several soil types are present at the facility, as shown in Figure 1-5 and Figure 1-6. The primary soil types present at CC RVAAP-71 are shown in Figure 1-7 and summarized in Table 1-1.

Table 1-1: Area Soil Types at Barn No. 5 Petroleum Release Area

Soil Series Classification	Parent Material	Geographic Setting	Slope %	Drainage	Surface Runoff	Permeability
Remsen Silt Loam (RmB)	Deep soils that formed in silty clay glacial till	Gently sloping soil in convex upland areas	2-6 %	Poorly drained	Medium to rapid	Slow
Orrville Silt Loam (Or)	Deep soils that formed in loamy alluvium	Nearly level soil on narrow flood plains	0 -2 %	Somewhat poorly drained	Very low	Slow

1.4.3.3 Bedrock Geology

The Sharon Sandstone Member (informally referred to as the Sharon Conglomerate) of the Pennsylvanian Pottsville Formation, is the primary bedrock beneath the facility (Figure 1-8). The Sharon Sandstone Member, the lowest unit of the Pottsville Formation, is a highly porous, loosely cemented, permeable, cross-bedded, frequently fractured and weathered, orthoquartzite sandstone, which is locally conglomeratic. Thin shale lenses occur in the upper portion of the unit (Winslow and White 1966).

In the western portion of the facility, the upper members of the Pottsville Formation, including the Sharon Shale, Connoquenessing Sandstone (also known as the Massillon Sandstone), Mercer Shale, and uppermost Homewood Sandstone, have been observed (Figure 1-8). The regional dip of the Pottsville Formation measured in the west portion of RVAAP is between 1.5 and 3.5 meters per 1.6 km (5 to 11.5 ft per mile) to the south.

The Sharon Shale is a gray to black, sandy to micaceous shale containing thin coal, underclay, and sandstone lenses. The Mercer Member of the Pottsville Formation consists of silty to carbonaceous shale with abundant thin, discontinuous sandstone lenses in the upper portion. Regionally, the Mercer also has been noted to contain interbeds of coal.

The Homewood Sandstone Member is the uppermost unit of the Pottsville Formation. It typically occurs as a caprock on bedrock highs in the subsurface, and ranges from well-sorted, coarse-grained, white quartzose sandstone to a tan, poorly sorted, clay-bonded, micaceous, medium- to fine-grained sandstone. Thin shale layers are prevalent in the Homewood Sandstone, as indicated by a darker gray shade of color.

1.4.4 Hydrogeology

1.4.4.1 Regional Hydrogeology

Sand and gravel aquifers are present in the buried-valley and outwash deposits in Portage County, as described in the *Phase I Remedial Investigation Report for High-Priority Areas of Concern at the Ravenna Army Ammunition Plant, Ravenna, Ohio* (USACE 1998). Generally, these saturated zones are too thin and localized to provide large quantities of water for industrial or public water supplies; however, yields are sufficient for residential water supplies. Lateral extent and continuity of these aquifers are unknown. Recharge of these units comes from surface water infiltration of precipitation and surface streams. Specific groundwater recharge and discharge areas at the facility have not been delineated. The regional potentiometric surface at the facility for unconsolidated surficial deposits and minor bedrock aquifers are presented in Figures 1-9 and 1-10, respectively (EQM 2012).

The thickness of unconsolidated surficial deposits at the facility ranges from thin to absent in the eastern and northeastern portion of the facility to an estimated 150 ft (46 m) in the central portion of the facility. The water table (Figure 1-9) is encountered within the unconsolidated zone in many areas of the facility. Because of the heterogeneous nature of the unconsolidated glacial material, groundwater flow patterns are difficult to determine with a high degree of accuracy. Aquifer recharge from precipitation likely occurs via infiltration along root zones, desiccation cracks, and partings within the soil column. Laterally, most groundwater flow in the surficial deposits likely follows topographic contours and stream drainage patterns (Figure 1-8), with preferential flow along pathways (e.g., sand seams, channel deposits, or other stratigraphic discontinuities) having higher permeabilities than surrounding clay or silt-rich material.

Beneath the facility, the principle bedrock aquifer is the Sharon Conglomerate (Figure 1-11) (EQM 2012). Depending on overburden thickness, the Sharon Conglomerate ranges from an unconfined to a leaky artesian aquifer hydraulically. According to one source, well yields from on-site supply wells completed in the Sharon Conglomerate range from 30 to 400 gallons per minute (gpm) (USATHMA 1978). Well yields of 5 to 200 gpm have also been reported for on-site bedrock wells completed in the Sharon Conglomerate (Kammer 1982).

Other local bedrock units capable of producing water include the Homewood Sandstone (Figure 1-10), which is generally thinner and capable only of well yields less than 10 gpm, and the Connoquenessing Sandstone. Wells completed in the Connoquenessing Sandstone in Portage County yield from 5 to 100 gpm, but are typically less productive than those in the Sharon Conglomerate due to lower permeabilities in the sandstone.

The hydraulic gradient in the Sharon Conglomerate bedrock aquifer results in a regional eastward flow of groundwater (Figure 1-11) that appears to be more uniform than in the unconsolidated deposits (Figure 1-9) because local surface topography influences the latter. Due to the lack of well data in the western portion of the facility, general flow patterns are difficult to discern. For much of the eastern half of the facility, the bedrock hydraulic head elevations are higher than those in overlying unconsolidated deposits, indicating an upward vertical hydraulic gradient. These data suggest there is a confining layer separating the two aquifers in some areas. In the far eastern area, there is little difference in the head elevations, suggesting a hydraulic connection exists between the two.

1.4.4.2 Groundwater Usage and Domestic Water Supply

The facility historically used groundwater for both domestic and industrial supplies. Groundwater utilized at the facility during past operations was obtained from production wells located throughout the facility, with the majority of wells screened in the Sharon Conglomerate. The Army discontinued use of most of the groundwater production wells prior to 1993, when the facility was placed in modified caretaker status. Currently, one of the four remaining original groundwater production wells remains in use by the Army. This well, located in the former Administration Area, is not used as a potable water source of supply, but supplies sanitary water for active-use buildings in that area.

In addition, as of 2011, OHARNG has installed two bedrock aquifer production wells at the facility for use as a groundwater supply. These two OHARNG supply wells are installed in the Sharon Conglomerate aquifer near Buildings 1067 and 1068 within the former Administration Area. These water supply wells are used solely for on-site activities and are not used for public distribution, livestock, or commercial groundwater potable supply. There is also one inactive non-potable groundwater supply well just south of Winklepeck Burning Grounds, along the east side of George Road which was formerly used to supply water for environmental restoration activities.

The closest population center to the facility, the city of Newton Falls, obtains municipal supplies from the east branch of the Mahoning River. Currently, most residential groundwater use in the area surrounding the facility is primarily for domestic and livestock supply, with the Sharon Conglomerate acting as the major producing aquifer in the area. The Connoquenessing and

Homewood sandstones also provide limited groundwater supplies, primarily to the western half of the facility. Unconsolidated deposits can also be an important source of groundwater, as many of the domestic wells and small public water supplies located near the facility obtain sustainable quantities of water from wells completed in unconsolidated, surficial deposits.

In the unconsolidated aquifer, groundwater flows predominantly eastward; however, the unconsolidated zone shows numerous local flow variations influenced by topography and drainage patterns (Figure 1-9). Local variations in flow direction suggest the following: (1) groundwater in the unconsolidated deposits is generally in direct hydraulic communication with surface water; and (2) surface water drainage ways may also act as groundwater discharge locations. In addition, topographic ridges between surface water drainage features act as groundwater divides in the unconsolidated deposits.

Local groundwater within and surrounding the facility contains proportionately high levels of iron, manganese, and carbonate compounds. As such it is classified as "hard" water. Hard water has an associated metallic taste that can be unpalatable if not properly treated for human consumption (OHARNG 2008).

1.4.4.3 Regional Surface Water

The facility resides within the Mahoning River watershed, which is part of the Ohio River basin. The west branch of the Mahoning River is the main surface stream in the area. The west branch flows adjacent to the west end of the facility, generally in a north to south direction, before flowing into the Michael J. Kirwan Reservoir, which is located south of State Route 5 (Figure 1-3). The west branch flows out of the reservoir and parallels the facility's southern boundary before joining the Mahoning River east of the facility. The western and northern portions of the facility display low hills and a dendritic surface drainage pattern. The eastern and southern portions are characterized by an undulating to moderately level surface, with less dissection of the surface drainage. The facility is marked with marshy areas and flowing and intermittent streams whose headwaters are located in the upland areas of the facility.

The three primary watercourses that drain the facility are as follows (Figure 1-3):

- South fork of Eagle Creek
- Sand Creek
- Hinkley Creek

All of these watercourses have many associated tributaries. Sand Creek, with a drainage area of 13.9 square miles (36 square kilometers [km^2]), flows generally in a northeast direction to its confluence with the south fork of Eagle Creek. In turn, the south fork of Eagle Creek continues

in a northerly direction for 2.7 miles (4.3 km) to its confluence with Eagle Creek. The drainage area of the south fork of Eagle Creek is 26.2 square miles (67.8 km^2), including the area drained by Sand Creek. Hinkley Creek originates just southeast of the intersection between State Route 88 and State Route 303 to the north of the facility. Hinkley Creek, with a drainage area of 11.0 square miles (28.5 km^2), flows in a southerly direction through the facility, and converges with the west branch of the Mahoning River south of the facility (USACE 2001).

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

Approximately 50 ponds are scattered throughout the facility. Many were constructed within natural drainage ways to function as settling ponds or basins for process effluent and runoff. Others are natural in origin, resulting from glacial action or beaver activity. Water bodies at the facility could support aquatic vegetation and biota. Storm water runoff is controlled primarily by natural drainage, except in former operations areas where an extensive storm sewer network helps to direct runoff to drainage ditches and settling ponds. Additionally, the storm sewer system was one of the primary drainage mechanisms for process effluent during the period that production facilities were in operation.

1.4.5 Climate

The general climate of the facility area is continental and is characterized by moderately warm and humid summers, reasonably cold and cloudy winters, and wide variations in precipitation from year to year. Climate data for the facility area presented below were obtained from available National Weather Service records for the 30-year period of record from 1981 to 2010 at the Youngstown Regional Airport, Ohio (http://www.nws.noaa.gov/climate/xmacis.php?wfo=cle). Wind speed data for Youngstown, Ohio, are from the National Climatic Data Center (http://www.ncdc.noaa.gov/data-access/quick-links#wind) for the available 66-year period of record from 1930 through 1996.

Average annual rainfall in the facility area is 38.86 inches (98.7 cm), with the highest monthly average occurring in July (4.31 inches [10.9 cm]) and the lowest monthly average occurring in February (2.15 inches [5.46 cm]). Average annual snowfall totals approximately 63.4 inches (161.0 cm) with the highest monthly average occurring in January (17.1 inches [43.43 cm]). Due to the influence of lake-effect snowfall events associated with Lake Erie, located approximately 35 miles (56.3 km) northwest of the facility, snowfall totals vary widely throughout northeastern Ohio.

The average annual daily temperature in the area is 49.3 degrees Fahrenheit (ºF), with an average daily high temperature of 59.0 ºF and an average daily low temperature of 39.7 ºF. The record high temperature of 100 ºF occurred in July 1988, and the record low temperature of -22º F occurred in January 1994. The prevailing wind direction at the facility is from the west southwest, with the highest average wind speed occurring in January (12 miles [19.3 km] per hour) and the lowest average wind speed occurring in August (7 miles [11.3 km] per hour). As per the National Climatic Data Center, 20 storm events (category Thunderstorm Wind) were reported between January 1, 1996 and July 31, 2013 (http://tinyurl.com/k2kn47o). The facility area is susceptible to tornadoes; minor structural damage to several buildings on facility property occurred as the result of a tornado in 1985.

1.5 REPORT ORGANIZATION

The SI report is organized into the following sections:

- Chapter 1 (Introduction) - Provides an overview of the purpose and scope of this SI, a general facility description, demography, and land use of the facility. This section provides an overview of the environmental setting at the facility.

- Chapter 2 (Site Description and Operational History) – Provides the site descriptions and land use history of the site. The physical property characteristics, chronological history, military operations, and a summary of past investigations are included.

- Chapter 3 (Historical or Former Operations) – Summarizes the historical waste sources, types, known waste characteristics, and management practices at the site.

- Chapter 4 (Field Investigation) - Addresses the scope of activities performed as part of this SI. This section discusses sampling rationale for placement of environmental media sampling locations, field activity procedures, laboratory methods, and protocols. Included in this section are descriptions of pre-mobilization activities and field sampling methods for the subsurface soil Incremental Sampling Methodology (ISM) sampling. Any deviations from the work plan are outlined in this section. Site surveying and the collection and characterization of investigation-derived wastes (IDW) generated during this SI are discussed in this section.

- Chapter 5 (Results) – Provides a summary of the subsurface soil ISM sampling results and comparison of the analytical results to the human health FWCUGs for the facility. A discussion of the IDW characterization results is included in this section.

- Chapter 6 (Exposure Pathways) - Summarizes physical conditions, hydrological and hydrogeological settings, and provides conclusions for the exposure pathways identified for soil, air, surface water, and groundwater at the site.

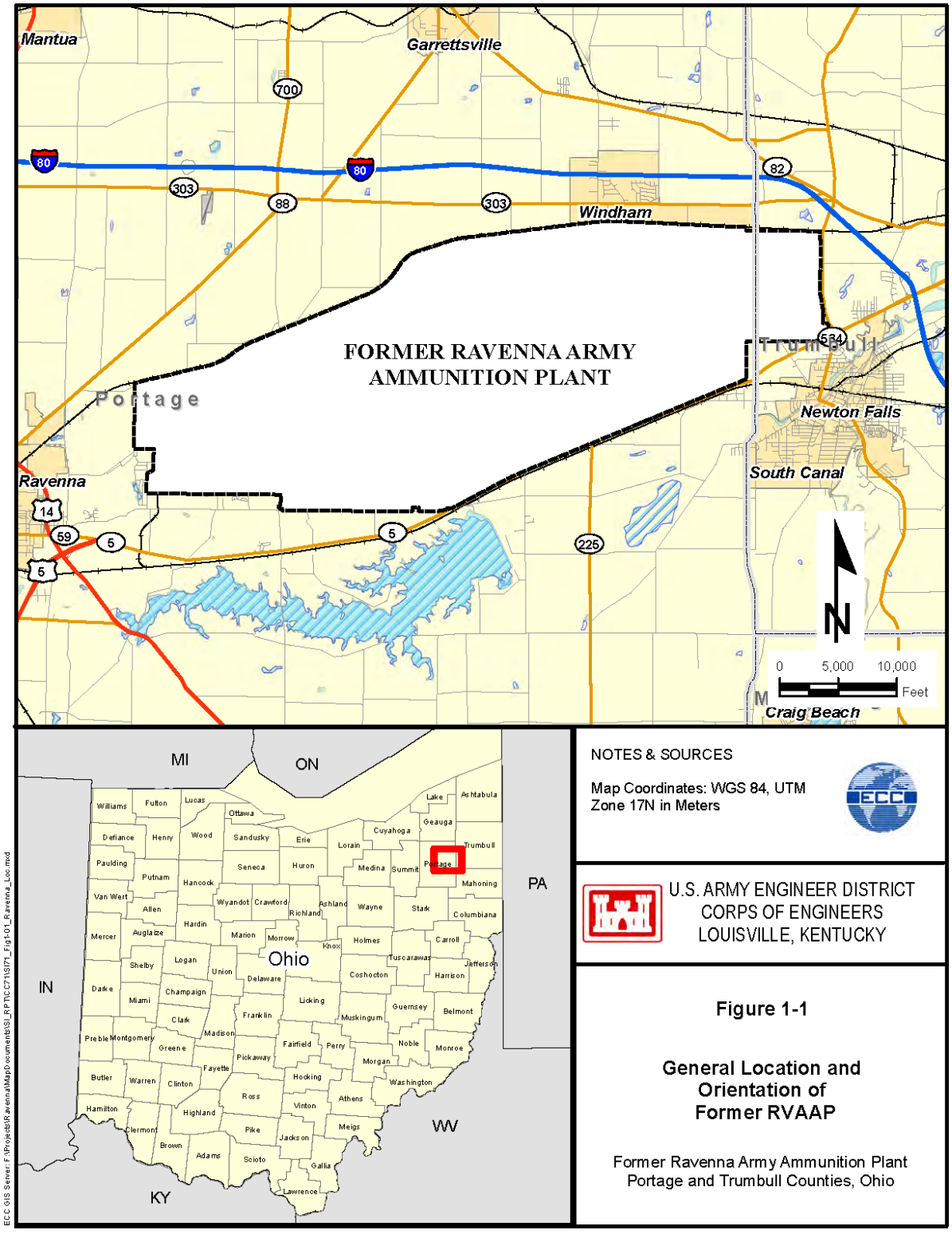
- Chapter 7 (Summary of Results and Conclusions) - Summarizes the findings of the results of the SI sampling. The conclusions of the SI are provided.

- Chapter 8 (References) - Lists references used during report preparation.

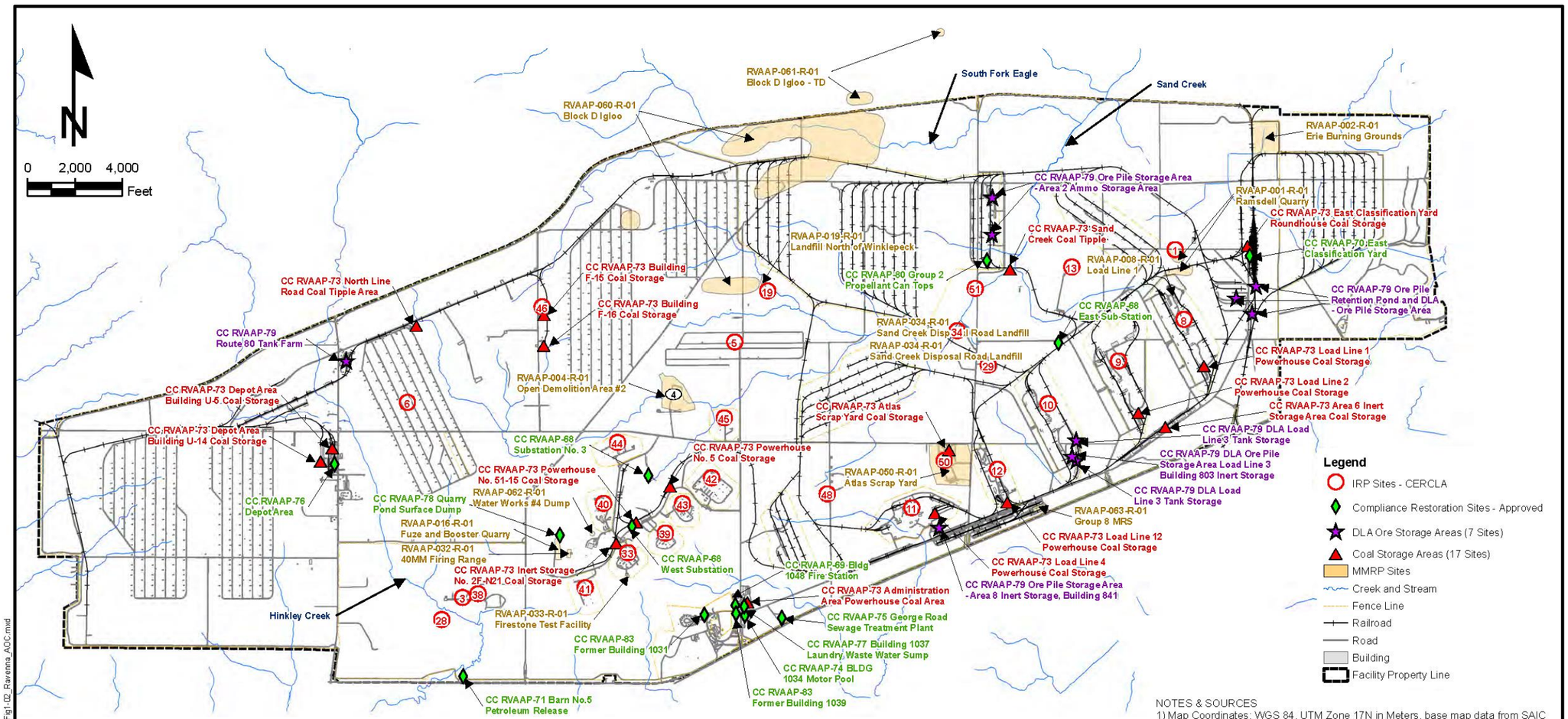
Report appendices contain summarized investigation data as follows:

Appendix A – Historical Aerial Photographs
Appendix B – Field Activity Forms
Appendix C – Boring Logs
Appendix D – Data Verification Report
Appendix E – Laboratory Analytical Results, Laboratory Data, and Chain of Custody Forms
Appendix F – Data Validation Report
Appendix G – IDW Disposal Letter Report
Appendix H – Site Photographs
Appendix I – Regulatory Correspondence and Responses to Comments

This page intentionally left blank.


Mantua
Garrettsville
700
80
303
88
Windham
82
FORMER RAVENNA ARMY
AMMUNITION PLANT
534
Portage
Newton Falls
South Canal
Ravenna
14
59
5
225
N
0
5,000
10,000
Feet
Craig Beach
MI
ON
PA
IN
WV
KY
Ohio
NOTES & SOURCES
Map Coordinates: WGS 84, UTM
Zone 17N in Meters
ECC
U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
LOUISVILLE, KENTUCKY
Figure 1-1
General Location and
Orientation of
Former RVAAP
Former Ravenna Army Ammunition Plant
Portage and Trumbull Counties, Ohio
ECC GIS Server: F:\Projects\Ravenna\Map Documents\SI_RPT\CC71SI71_Fig1-01_Ravenna_Loc.mxd

This page intentionally left blank.



NOTES & SOURCES
1) Map Coordinates: WGS 84, UTM Zone 17N in Meters, base map data from SAIC
2) DLA = Defense Logistics Agency
3) MMRP = Military Munitions Response Program
4) RCRA = Resource Conservation and Recovery Act

ECC GIS Server: F:\Projects\RavennaMapDocuments\SGI_RPT\CC71\SI71_Fig1-02_Ravenna_AOC.mxd

IRP SITES - CERCLA

1	CC RVAAP-01	Ramsdell Quarry Landfill
3	CC RVAAP-03	Open Demolition Area #1
5	CC RVAAP-05	Winklepeck Burning Grounds
6	CC RVAAP-06	C Block Quarry
8	CC RVAAP-08	Load Line 1
9	CC RVAAP-09	Load Line 2
10	CC RVAAP-10	Load Line 3
11	CC RVAAP-11	Load Line 4
12	CC RVAAP-12	Load Line 12
13	CC RVAAP-13	Building 1200 - Dilution\Settling Pond
19	CC RVAAP-19	Landfill North of Winklepeck Burning Grounds
28	CC RVAAP-28	Mustard Agent Burial Site
29	CC RVAAP-29	Upper and Lower Cobbs Ponds
33	CC RVAAP-33	Load Line 6
34	CC RVAAP-34	Sand Creek Disposal Road Landfill
38	CC RVAAP-38	NACA Test Area
39	CC RVAAP-39	Load Line 5
40	CC RVAAP-40	Load Line 7
41	CC RVAAP-41	Load Line 8
42	CC RVAAP-42	Load Line 9
43	CC RVAAP-43	Load Line 10
44	CC RVAAP-44	Load Line 11
45	CC RVAAP-45	Wet Storage Area
46	CC RVAAP-46	Building F-15 and F-16
48	CC RVAAP-48	Anchor Test Area
50	CC RVAAP-50	Atlas Scrap Yard
51	CC RVAAP-51	Dump Along Paris Windham Rd.
	CC RVAAP-66	Facility-Wide Groundwater
	CC RVAAP-67	Facility-Wide Sewer

COMPLIANCE RESTORATION SITES (13 SITES)

CC RVAAP-68	Electronic Substations (E,W,No.3)
CC RVAAP-69	Former Building 1048 Fire Station
CC RVAAP-70	East Classification Yard
CC RVAAP-71	Barn No .5 Petroleum Release
CC RVAAP-72	Facility-Wide USTs (45 Sites)
CC RVAAP-73	Facility-Wide Coal Storage
CC RVAAP-74	Building 1034 Motor Pool Hydraulic Lift
CC RVAAP-75	George Road Sewage Treatment Plant
CC RVAAP-76	Depot Area
CC RVAAP-77	Building 1037 - Laundry Waste Water Sump
CC RVAAP-78	Quarry Pond Surface Dump
CC RVAAP-80	Group 2 Propelant Can Tops
CC RVAAP-83	Former Building 1031and 1039

MMRP SITES (14 SITES)

RVAAP-001-R-01	DLA Ore Storage Sites
RVAAP-002-R-01	Erie Burning Grounds MRS
RVAAP-004-R-01	Open Demolition Area #2 MRS
RVAAP-008-R-01	Load Line 1 MRS
RVAAP-016-R-01	Fuze and Booster Quarry MRS
RVAAP-019-R-01	Landfill North of Winklepeck MRS
RVAAP-032-R-01	40 mm Firing Range MRS
RVAAP-033-R-01	Firestone Test Facility MRS
RVAAP-034-R-01	Sand Creek Dump MRS
RVAAP-050-R-01	Atlas Scrap Yard MRS
RVAAP-060-R-01	Block D Igloo MRS
RVAAP-061-R-01	Block D Igloo - TD MRS
RVAAP-062-R-01	Water Works #4 Dump MRS
RVAAP-063-R-01	Group 8

OTHER REGULATORY - RCRA

4	CC RVAAP-04 Open Demolition Area #2

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
LOUISVILLE, KENTUCKY

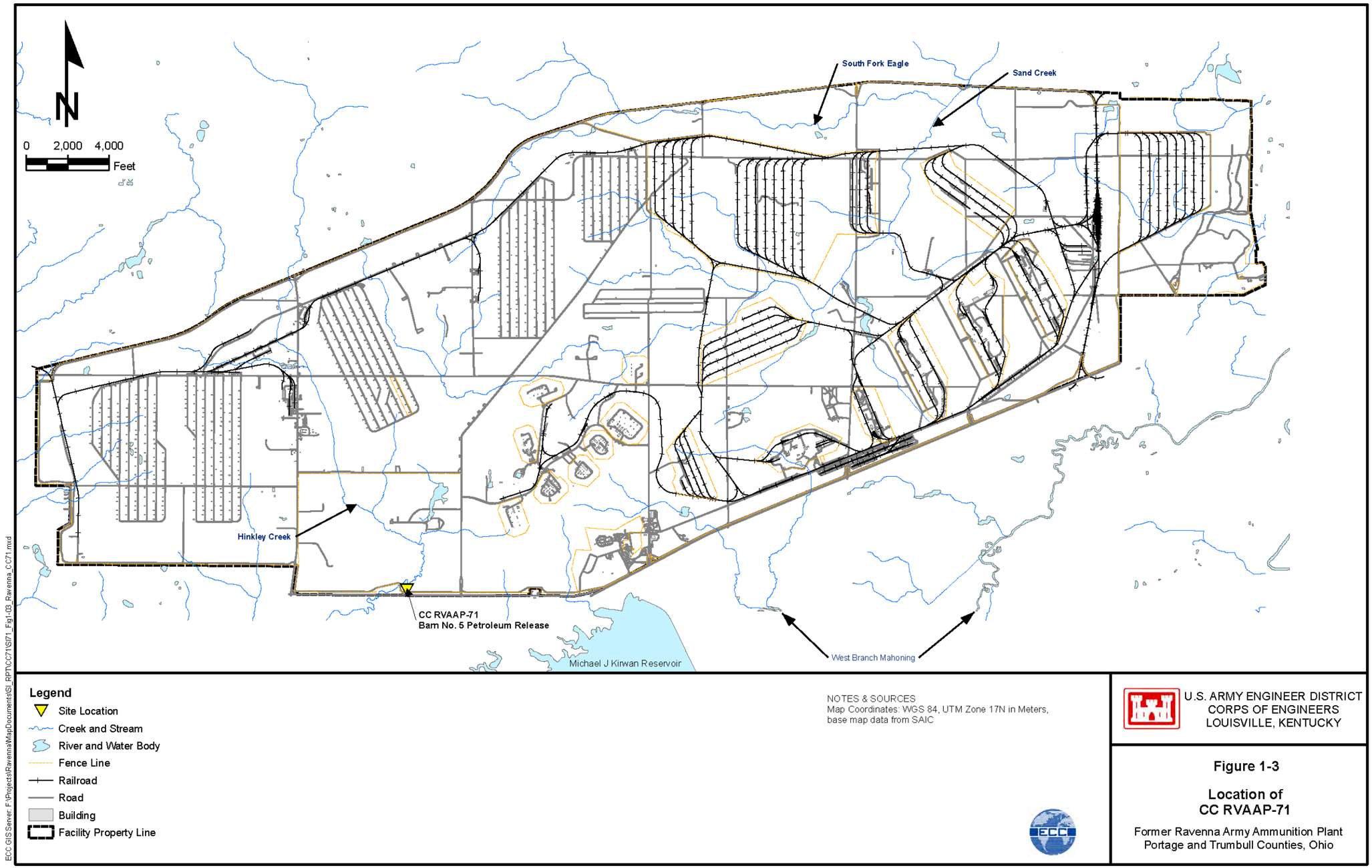
Figure 1-2

Location of Compliance Restoration Sites

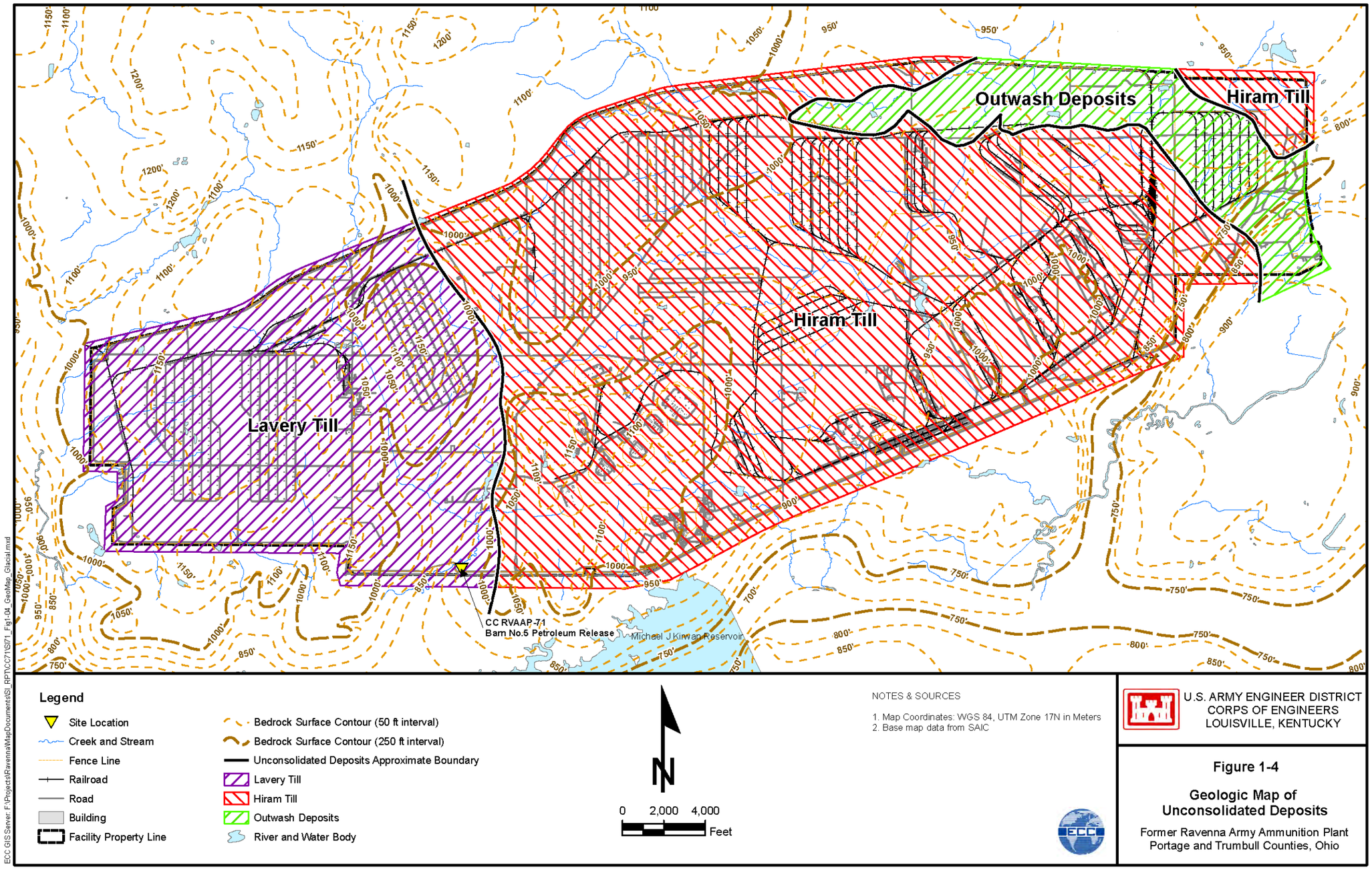
Former Ravenna Army Ammuntion Plant
Portage and Trumbull Counties, Ohio

This page intentionally left blank.

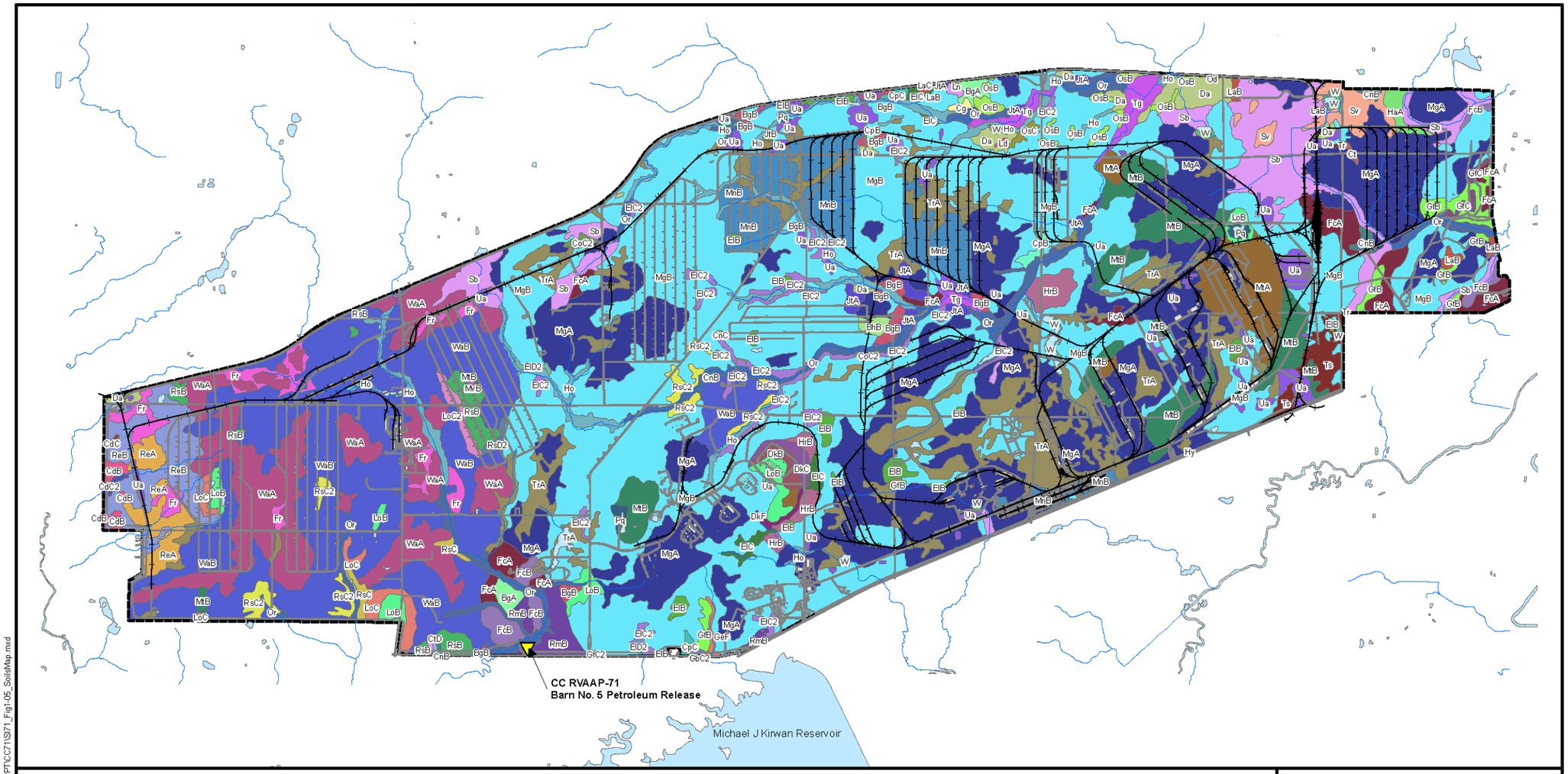
1


N
0 2,000 4,000
Feet
South Fork Eagle
Sand Creek
Hinkley Creek
CC RVAAP-71
Barn No. 5 Petroleum Release
Michael J Kirwan Reservoir
West Branch Mahoning
ECC GIS Server: F:\Projects\RavennaMapDocuments\SI_RPT\CC71\SI71_Fig1-03_Ravenna_CC71.mxd
Legend
Site Location
Creek and Stream
River and Water Body
Fence Line
Railroad
Road
Building
Facility Property Line
NOTES & SOURCES
Map Coordinates: WGS 84, UTM Zone 17N in Meters,
base map data from SAIC
U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
LOUISVILLE, KENTUCKY
Figure 1-3
Location of
CC RVAAP-71
Former Ravenna Army Ammunition Plant
Portage and Trumbull Counties, Ohio

This page intentionally left blank.


Outwash Deposits
Hiram Till
Hiram Till
Lavery Till
CC RVAAP-71
Barn No.5 Petroleum Release
Michael J Kirwan Reservoir
Legend
Site Location
Creek and Stream
Fence Line
Railroad
Road
Building
Facility Property Line
Bedrock Surface Contour (50 ft interval)
Bedrock Surface Contour (250 ft interval)
Unconsolidated Deposits Approximate Boundary
Lavery Till
Hiram Till
Outwash Deposits
River and Water Body
N
0 2,000 4,000
Feet
NOTES & SOURCES
1. Map Coordinates: WGS 84, UTM Zone 17N in Meters
2. Base map data from SAIC
U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
LOUISVILLE, KENTUCKY
Figure 1-4
Geologic Map of
Unconsolidated Deposits
Former Ravenna Army Ammunition Plant
Portage and Trumbull Counties, Ohio
ECC GIS Server: F:\Projects\Ravenna\MapDocuments\SI_RPT\CC71SI71_Fig1-04_GeoMap_Glacial.mxd

This page intentionally left blank.


CC RVAAP-71
Barn No. 5 Petroleum Release
Michael J Kirwan Reservoir
Legend
Site Location
Creek and Stream
Railroad
Road
River and Waterbody
Building
Facility Property Line
Soil Mapping Unit
BgA BgB BhB CdB CdC CdC2 Cg CnB CnC CoC2 CpB CpC Ct CtD Da DkB DkC DkF ElB ElC ElC2 ElD2 FcA FcB Fr GbC2 GeF GfB GfC GfC2 HaA Ho HrB Hy JtA JtB LaB LaC Ld LoB LoC LoC2 MgA MgB MnB MtA MtB MvB OsB OsC Pq ReA ReB RmB RsB RsC RsC2 RsD2 Sb Sv Tg Tr TrA Ts Ua W WaA WaB
NOTES & SOURCES
1. Map Coordinates: WGS 84, UTM Zone 17N in Meters.
2. Base map data from SAIC.
3. See Figure 1-6 for soil mapping unit definitions.
N
0 2,000 4,000
Feet
U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
LOUISVILLE, KENTUCKY
Figure 1-5
Soils Map
Former Ravenna Army Ammunition Plant
Portage and Trumbull Counties, Ohio
ECC GIS Server: F:\Projects\Ravenna\MapDocuments\SI_RPT\CC71\SI71_Fig1-05_SoilsMap.mxd

This page intentionally left blank.

Legend

Soil Mapping Unit

- BgA, Bogart silt loam, 0 to 2% slopes
- BgB, Bogart silt loam, 2 to 6% slopes
- BhB, Bogart-Haskins complex, 2 to 6% slopes
- CdB, Canfield silt loam, 2 to 6% slopes
- CdC, Canfield silt loam, 6 to 12% slopes
- CdC2, Canfield silt loam, 6 to 12% slopes, moderately eroded
- Cg, Carlisle muck
- CnB, Chili loam, 2 to 6% slopes
- CnC, Chili loam, 6 to 12% slopes
- CoC2, Chili gravelly loam, 6 to 12% slopes, moderately eroded
- CpB, Chili silt loam, 2 to 6% slopes
- CpC, Chili silt loam, 6 to 12% slopes
- Ct, Chili-Oshtemo complex
- CtD, Chili-Oshtemo complex, 12 to 18% slopes
- Da, Damascus loam
- DkB, Dekalb channery loam, 2 to 6% slopes
- DkC, Dekalb channery loam, 6 to 12% slopes
- DkF, Dekalb channery loam, 25 to 70% slopes
- ElB, Ellsworth silt loam, 2 to 6% slopes
- ElC, Ellsworth silt loam, 6 to 12% slopes
- ElC2, Ellsworth silt loam, 6 to 12% slopes, moderately eroded
- ElD2, Ellsworth silt loam, 12 to 18% slopes, moderately eroded
- FcA, Fitchville silt loam, 0 to 2% slopes
- FcB, Fitchville silt loam, 2 to 6% slopes
- Fr, Frenchtown silt loam
- GbC2, Geeburg silt loam, 6 to 12% slopes, moderately eroded
- GeF, Geeburg and Glenford silt loams, steep
- GfB, Glenford silt loam, 2 to 6% slopes
- GfC, Glenford silt loam, 6 to 12% slopes
- GfC2, Glenford silt loam, 6 to 12% slopes, moderately eroded
- HaA, Haskins loam, 0 to 2% slopes
- Ho, Holly silt loam
- HrB, Hornell silt loam, 3 to 8% slopes
- Hy, Holly silt loam, frequently flooded
- JtA, Jimtown loam, 0 to 2% slopes
- JtB, Jimtown loam, 2 to 6% slopes
- LaB, Lakin loamy sand, 2 to 6% slopes
- LaC, Lakin loamy sand, 6 to 12% slopes
- Ld, Linwood muck
- Ln, Lorain silty clay loam
- LoB, Loudonville silt loam, 2 to 6% slopes
- LoC, Loudonville silt loam, 6 to 12% slopes
- LoC2, Loudonville silt loam, 6 to 12% slopes, moderately eroded
- MgA, Mahoning silt loam, 0 to 2% slopes
- MgB, Mahoning silt loam, 2 to 6% slopes
- MnB, Mahoning-Urban land complex, undulating
- MtA, Mitiwanga silt loam, 0 to 2% slopes
- MtB, Mitiwanga silt loam, 2 to 6% slopes
- MvB, Mitiwanga silt loam, 2 to 6% slopes, moderately weill drained variant
- Od, Olmsted loam
- Or, Orrville silt loam
- OsB, Oshtemo sandy loam, 2 to 6% slopes
- OsC, Oshtemo sandy loam, 6 to 12% slopes
- Pq, Pits, quarries
- ReA, Ravenna silt loam, 0 to 2% slopes
- ReB, Ravenna silt loam, 2 to 6% slopes
- RmB, Remsen silt loam, 2 to 6% slopes
- RsB, Rittman silt loam, 2 to 6% slopes
- RsC, Rittman silt loam, 6 to 12% slopes
- RsC2, Rittman silt loam, 6 to 12% slopes, moderately eroded
- RsD2, Rittman silt loam, 12 to 18% slopes, moderately eroded
- Sb, Sebring slit loam
- Sv, Sebring silt loam, dark surface variant
- Tg, Tioga loam
- Tr, Trumbull silt loam
- TrA, Trumbull silt loam, 0 to 2% slopes
- Ts, Trumbull silty clay loam
- Ua, Udorthents
- W, Water
- WaA, Wadsworth silt loam, 0 to 2% slopes
- WaB, Wadsworth silt loam, 2 to 6% slopes

NOTES & SOURCES

1. Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture. Web Soil Survey. Available online at http://websoilsurvey.nrcs.usda.gov/. Accessed 12/28/2012.
2. See Figure 1-5 for soils map.

U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
LOUISVILLE, KENTUCKY

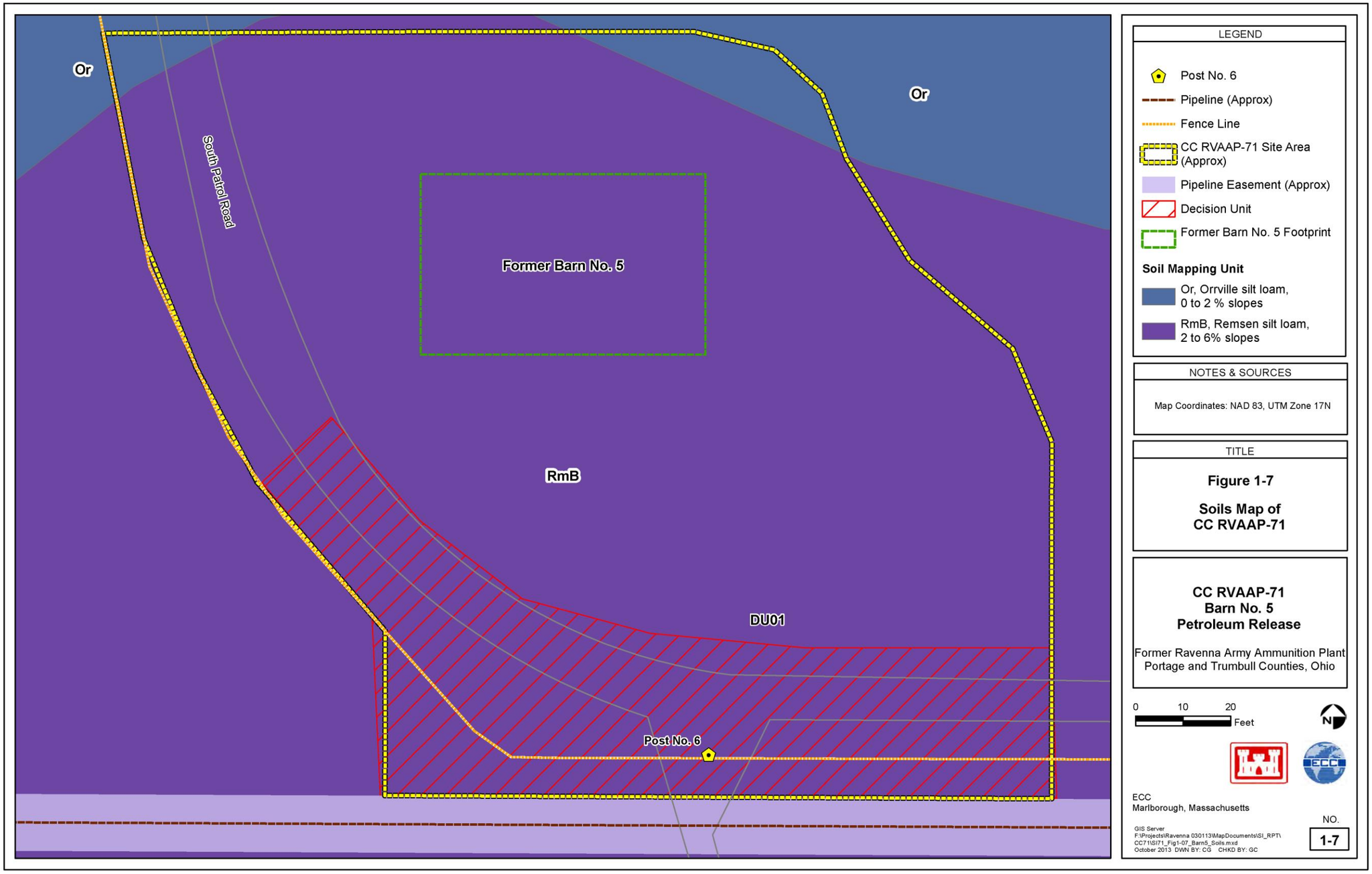
Figure 1-6

Description of Soil Mapping Units

Former Ravenna Army Ammunition Plant
Portage and Trumbull Counties, Ohio

ECC GIS Server: F:\Projects\Ravenna\MapDocuments\SI_RPT\CC71\SI71_Fig1-06_SoilsMapLegend.mxd

This page intentionally left blank.


Or
Or
South Patrol Road
Former Barn No. 5
RmB
DU01
Post No. 6
LEGEND
Post No. 6
Pipeline (Approx)
Fence Line
CC RVAAP-71 Site Area (Approx)
Pipeline Easement (Approx)
Decision Unit
Former Barn No. 5 Footprint
Soil Mapping Unit
Or, Orrville silt loam, 0 to 2 % slopes
RmB, Remsen silt loam, 2 to 6% slopes
NOTES & SOURCES
Map Coordinates: NAD 83, UTM Zone 17N
TITLE
Figure 1-7
Soils Map of CC RVAAP-71
CC RVAAP-71
Barn No. 5
Petroleum Release
Former Ravenna Army Ammunition Plant
Portage and Trumbull Counties, Ohio
0 10 20
Feet
N
ECC
Marlborough, Massachusetts
GIS Server
F:\Projects\Ravenna 030113\MapDocuments\SI_RPT\CC71\SI71_Fig1-07_Barn5_Soils.mxd
October 2013 DWN BY: CG CHKD BY: GC
NO.
1-7

This page intentionally left blank.

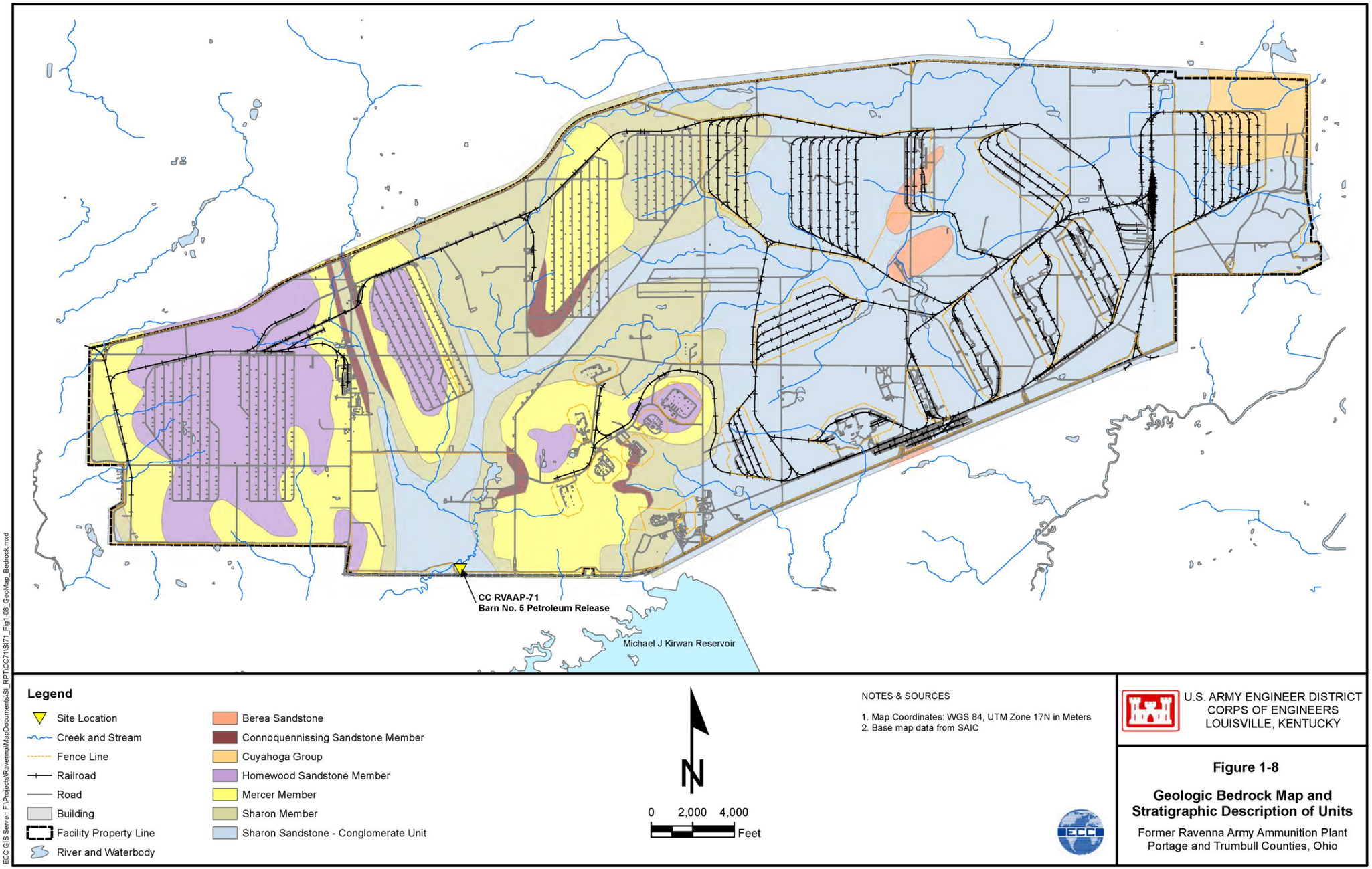
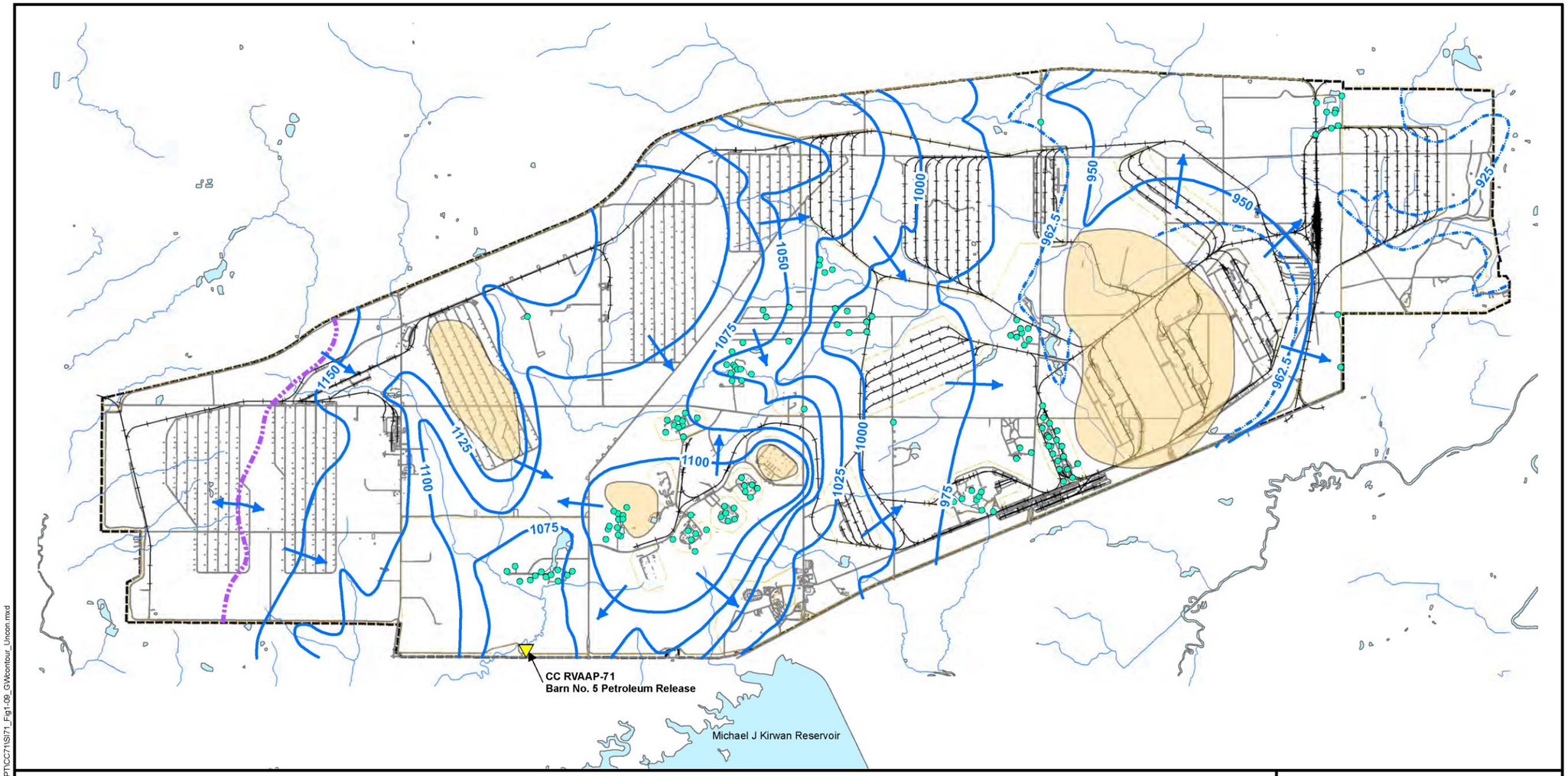


Figure 1-8

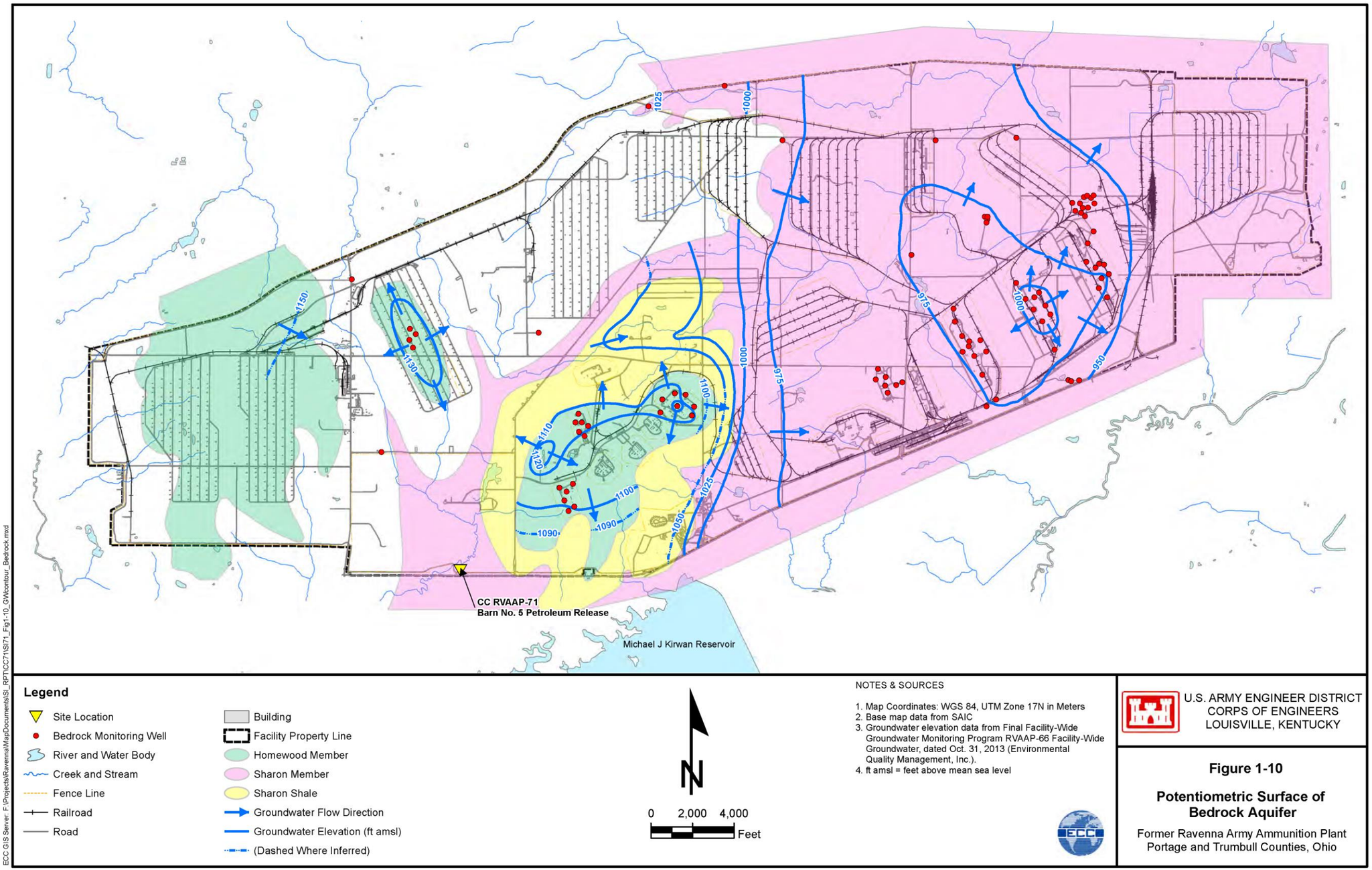
Geologic Bedrock Map and Stratigraphic Description of Units

Former Ravenna Army Ammunition Plant
Portage and Trumbull Counties, Ohio

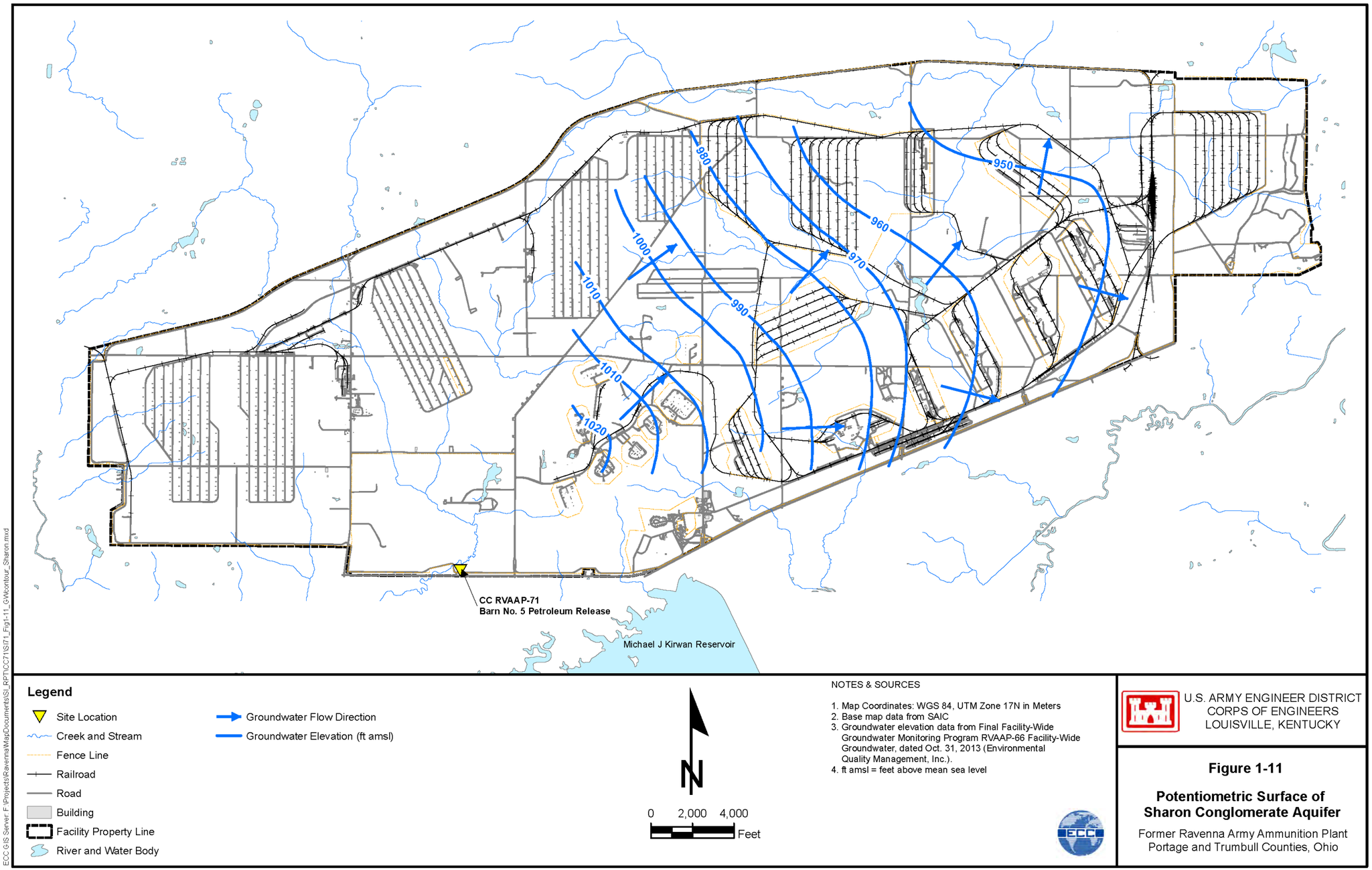
This page intentionally left blank.


1150
1125
1100
1075
1050
1000
962.5
950
925
975
1025
CC RVAAP-71
Barn No. 5 Petroleum Release
Michael J Kirwan Reservoir
Legend
Site Location
Creek and Stream
Fence Line
Railroad
Road
Building
Facility Property Line
Unconsolidated Monitoring Well
Inferred Groundwater Divide
Unconsolidated Aquifer Missing
River and Water Body
Groundwater Flow Direction
Groundwater Elevation (ft amsl)
(Dashed Where Inferred)
N
0 2,000 4,000
Feet
NOTES & SOURCES
1. Map Coordinates: WGS 84, UTM Zone 17N in Meters
2. Base map data from SAIC
3. Groundwater elevation data from Final Facility-Wide Groundwater Monitoring Program RVAAP-66 Facility-Wide Groundwater, dated Oct. 31, 2013 (Environmental Quality Management, Inc.).
4. ft amsl = feet above mean sea level
U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
LOUISVILLE, KENTUCKY
Figure 1-9
Potentiometric Surface of Unconsolidated Aquifer
Former Ravenna Army Ammunition Plant
Portage and Trumbull Counties, Ohio
ECC GIS Server: F:\Projects\RavennaMapDocuments\SI_RPT\CC71SI71_Fig1-09_GWcontour_Uncon.mxd

This page intentionally left blank.


1025
1000
1150
1130
975
1000
950
1100
1110
1120
1025
1100
1090
1090
1050
CC RVAAP-71
Barn No. 5 Petroleum Release
Michael J Kirwan Reservoir
Legend
Site Location
Bedrock Monitoring Well
River and Water Body
Creek and Stream
Fence Line
Railroad
Road
Building
Facility Property Line
Homewood Member
Sharon Member
Sharon Shale
Groundwater Flow Direction
Groundwater Elevation (ft amsl)
(Dashed Where Inferred)
N
0 2,000 4,000
Feet
NOTES & SOURCES
1. Map Coordinates: WGS 84, UTM Zone 17N in Meters
2. Base map data from SAIC
3. Groundwater elevation data from Final Facility-Wide Groundwater Monitoring Program RVAAP-66 Facility-Wide Groundwater, dated Oct. 31, 2013 (Environmental Quality Management, Inc.).
4. ft amsl = feet above mean sea level
U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
LOUISVILLE, KENTUCKY
Figure 1-10
Potentiometric Surface of Bedrock Aquifer
Former Ravenna Army Ammunition Plant
Portage and Trumbull Counties, Ohio
ECC GIS Server: F:\Projects\RavennaMapDocuments\SI_RPT\CC71\SI71_Fig1-10_GWcontour_Bedrock.mxd

This page intentionally left blank.


980
1000
1010
990
1010
1020
960
970
950
CC RVAAP-71
Barn No. 5 Petroleum Release
Michael J Kirwan Reservoir
Legend
Site Location
Creek and Stream
Fence Line
Railroad
Road
Building
Facility Property Line
River and Water Body
Groundwater Flow Direction
Groundwater Elevation (ft amsl)
N
0 2,000 4,000
Feet
NOTES & SOURCES
1. Map Coordinates: WGS 84, UTM Zone 17N in Meters
2. Base map data from SAIC
3. Groundwater elevation data from Final Facility-Wide Groundwater Monitoring Program RVAAP-66 Facility-Wide Groundwater, dated Oct. 31, 2013 (Environmental Quality Management, Inc.).
4. ft amsl = feet above mean sea level
U.S. ARMY ENGINEER DISTRICT
CORPS OF ENGINEERS
LOUISVILLE, KENTUCKY
Figure 1-11
Potentiometric Surface of
Sharon Conglomerate Aquifer
Former Ravenna Army Ammunition Plant
Portage and Trumbull Counties, Ohio
ECC G:\S Server F:\Projects\RavennaWapDocuments\SI_RPT\CC71\SI71_Fig1-11_GWcontour_Sharon.mxd

This page intentionally left blank.

2.0 SITE DESCRIPTION AND OPERATIONAL HISTORY

2.1 SITE DESCRIPTION

The CC RVAAP-71 Barn No. 5 Petroleum Release AOC is considered to be approximately 0.6 acres including the footprint of Barn No. 5 and the land between the barn and fence line in the vicinity of Post No. 6. As identified in the HRR, Barn No. 5 was also referred to as the 'twin silo' barn, noted for the two silos that were located on the east end of the barn. The barn foundation was constructed of concrete. The frame and wall were constructed of wood and the roof was fortified with steel trusses. According to Mr. McGee (Project Manager, RVAAP), who was interviewed as part of the HRR, the twin silos were constructed of vitrified clay tiles, and most likely stored corn or grain. Barn No. 5 was demolished sometime between 1966 and 1979. The site features are presented in Figure 2-1 of this report.

CC RVAAP-71 is located in the western portion of RVAAP along the southern property fence line. South Patrol Road, which is a dirt and gravel road, runs within the former RVAAP property lines and the fence line. Old State Route 5, which is currently named Newton Falls Road and is a two-lane, paved road, runs outside the fence line and to the south of the AOC. The Barn No. 5 footprint is located directly north of Post No. 6, which is a gate that was previously used to access the former RVAAP. A portion of Hinkley Creek runs northwest of the AOC and flows under South Patrol Road from northeast to southwest (shown on Figure 2-1).

The incident of the historic gasoline release at CC RVAAP-71 has been documented in a letter prepared by C.F. Craver, former RVAAP Security Manager (Security Chief) to H.M. Krengel, Ravenna Arsenal, Inc. General Manager and dated May 13, 1964. The 1964 pipeline break caused a consequent release of an estimated 20 barrels of gasoline at the AOC. The only documentation of this gasoline release states the following information (Appendix E of the HRR) (ECC 2012):

> "*At 8:00 pm, May 12, 1964, Dan McMinemen reported that a yellow liquid was coming out of the ground inside of our south fence near Barn No. 5. Mr. Blunt* [Buckeye Pipeline Company] *informed the guard that the product was SOHIO gasoline and he estimated that 20 barrels was lost.*" (Craver 1964).

2.2 LAND USE AND OWNERSHIP HISTORY

Barn No. 5 was built prior to 1937, before the Army purchased the land. The length of the 'twin silo barn' ran east to west, parallel to State Route 5, and was constructed with two silos along the eastern side. After the Army acquired the land, the barn was used for the boarding of horses used for patrol of the former RVAAP perimeter in the early 1950's. The horse patrol was only in

existence for two years and was followed by a year of motor scooter patrol. Patrol by pickup truck replaced the motor scooter patrol and the use of the barn was discontinued (ECC 2012). Review of the site aerial photographs indicate that the barn was present in 1959 and 1966 but was not present in the 1979 photograph or any thereafter. The barn was demolished sometime between 1966 and 1979. The fence and access gate were constructed in the early 1940's with Post No. 6 only used on an as-needed basis. The gate remained locked when not in use. The AOC is undeveloped and no buildings currently exist on this CR AOC. The anticipated future land use of this AOC is Military Training.

2.3 PHYSICAL PROPERTY CHARACTERISTICS

The topography across the site slopes approximately 10 feet from southeast to northwest towards Hinkley Creek. Tall grass grows south of the fence and Post No. 6 access gate, surrounded by denser brush and trees. The majority of the Barn No. 5 footprint, which is approximately 2,280 square feet, is covered with tall grass with the northern edge of the footprint in dense brush.

2.4 CHRONOLOGICAL PROPERTY SUMMARY

Minimal documented evidence was found regarding specific years of use for Barn No. 5 or Post No. 6 during the HRR (ECC 2012). No records of barn demolition activities were discovered. A drawing dated 1943, found during the HRR, showed the 12.5-ft pipeline easement of the SOHIO pipeline from which gasoline was released. Also found was a topographic map dated 1992 depicting the course of the pipeline in the vicinity of Post No.6. A legal document dated 1942 describing the easement contains a hand-written note that states "Buckeye Pipeline has been abandoned", dated August 15, 1986 (Vorac 1986). These documents can be found in Appendix E of the HRR (ECC 2012).

Barn No. 5 was the only structure that was built on the AOC grounds, which has since been demolished. Currently, there are no physical structures in the approximate 0.6-acre area of this AOC. The fence, which is approximately 150 feet north of the center of Newton Falls Road and runs parallel to the RVAAP property line, is the only existing structure on the AOC. One design drawing of the barn was discovered during the HRR showing two silos alongside the building and the barn entrance on the broadside of the barn.

Historical photographs from 1937, 1940, 1950, 1952, 1959, 1966, 1979, 1985, 1994, 1997, 2000, 2003, 2005, 2006, and 2009 were found during the HRR and can be viewed in Appendix O of the HRR (ECC 2012). The historical aerial photographs were analyzed to identify potential effects of the gasoline release, the relationship between the AOC and the surrounding areas, and the chronological development of the AOC. The 1937 and 1940 aerial photographs show the Barn No. 5 structure and surrounding area to be used primarily for agriculture. The May 1964

letter that documents the gasoline release states that at 10:45 pm on May 12, 1964: "They [Buckeye Pipeline Company] began to excavate for the repair. The only damage was that an area of grass was killed" (Craver 1964). The 1966 aerial photo was examined for evidence of ground disturbance but the excavation area could not be identified conclusively. It was noted that the nearest body of water is Hinkley Creek, located approximately 260 feet northwest from the center of the clearing where Barn No. 5 was once located and 330 feet northwest from the Post No. 6 gate.

No documented evidence of operations involving hazardous, toxic, and radioactive waste (HTRW) at CC RVAAP-71 Barn No. 5 Petroleum Release was found during the HRR. A review of former RVAAP underground storage tank (UST) documents from the Ohio State Fire Marshal's Office conducted by ECC in October 2011 did not identify the presence of above-ground storage tanks (ASTs) or USTs in the vicinity of the AOC.

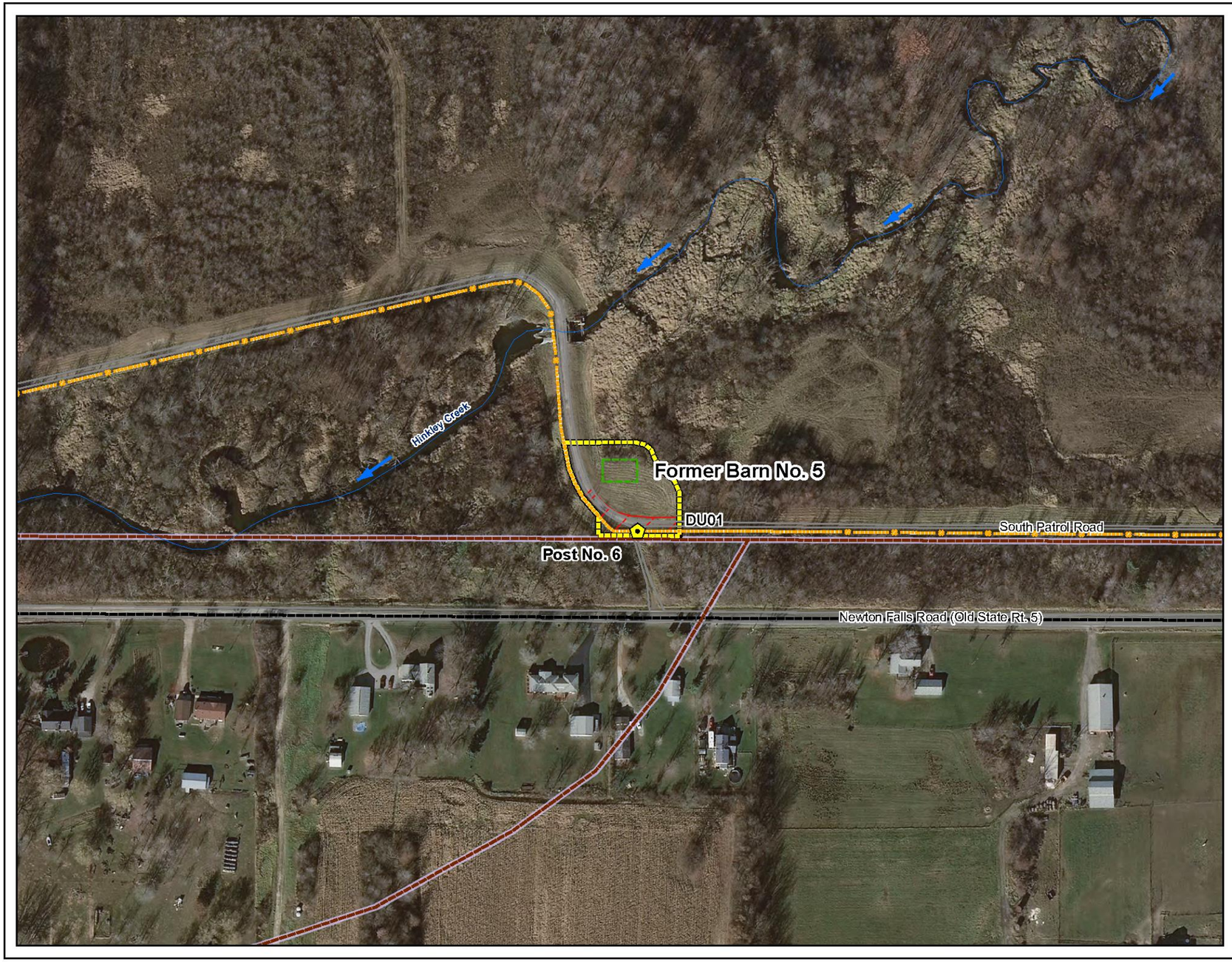
2.5 MILITARY OPERATIONS

The CC RVAAP-71 Barn No. 5 Petroleum Release AOC is currently part of Training Area D that is utilized by the OHARNG for military training. No evidence was found during the HRR that would suggest impact from former and/or current military operations or evidence of military munitions being used at the AOC.

2.6 PREVIOUS INVESTIGATIONS

An HRR was conducted by ECC in November 2011 (ECC 2012). No documented evidence of impact from former and/or current military operations at this AOC was found during the HRR. Further, no documented evidence of military munitions or operations involving HTRW was found. No presence of ASTs or USTs was discovered during the HRR. No documented evidence was discovered during the HRR of historical practices involving containerized hazardous, toxic and radioactive waste at CC RVAAP-71.

This page intentionally left blank.



LEGEND

- Post No. 6
- Creek and Stream
- Flow Direction
- Pipeline (Approx)
- Fence Line
- Facility Property Line
- CC RVAAP-71 Site Area (Approx)
- Pipeline Easement (Approx)
- Decision Unit
- Former Barn No. 5 Footprint

NOTES & SOURCES

Map Coordinates: NAD 83, UTM Zone 17N

TITLE

Figure 2-1

Site Features

CC RVAAP-71
Barn No. 5
Petroleum Release

Former Ravenna Army Ammunition Plant
Portage and Trumbull Counties, Ohio

0 100 200 Feet

N

ECC
Marlborough, Massachusetts

GIS Server
F:\Projects\Ravenna 030113\MapDocuments\SI_RPT\CC71\SI71_Fig2-1_SiteFeatures.mxd
October 2013 DWN BY: CG CHKD BY: GC

NO.
2-1

This page intentionally left blank.

3.0 HISTORICAL OR FORMER OPERATIONS

3.1 HISTORICAL WASTE SOURCES

No documented evidence of the presence of hazardous, toxic, and radioactive waste at CC RVAAP-71 Barn No. 5 Petroleum Release was found during the HRR other than the letter dated May 13, 1964 which documents that "a yellow liquid was coming out of the ground inside of our south fence near Barn No. 5" (Craver 1964). The "yellow liquid" is later identified in the letter as "SOHIO gasoline".

The letter dated May 13, 1964 (Craver 1964) documents a release of approximately 20 barrels (approximately 840 gallons) of gasoline to the subsurface, some of which surfaced inside of the facility fence near former Barn No. 5. The release occurred from a buried Standard Oil of Ohio (SOHIO) pipeline that runs parallel to the former RVAAP fence line at this location. Based on the 1964 letter, excavation was completed in order to repair the pipeline on the same day as the reported release. Historical drawings show the 12.5-foot pipeline easement on former RVAAP property at the release location that is also depicted on Figure 2-1. The pipeline has been abandoned; however, the pipeline depth has not be documented. The specific location of the pipeline leak and the subsequent repairs have not been documented. Based upon the 1964 letter referenced in the HRR (ECC 2012), the fence line along the southern portion of CC RVAAP-71 close to Barn No. 5 has been identified as the area that required further investigation.

3.2 POTENTIAL CHEMICALS OF CONCERN

The nature of the former operations at Former Barn No. 5 are summarized in Table 3-1 which includes descriptions of potential chemicals of concern (COC) associated with these activities. The COCs at this AOC are gasoline-related constituents directly associated with the documented 1964 gasoline pipeline release.

Table 3-1: Summary of Historical or Former Operations

Past Operations - Barn No. 5 Petroleum Release – CC RVAAP-71		
Operations	Reported Documentation	Evidence/Description/Potential COCs
Military Operations	None	None
Operations Involving HTRW	None	None
Historical Aerial Photographic Review – Barn No. 5 Petroleum Release – CC RVAAP-71		
Years of Photo	Notable Findings	Description
1940 - 2009	None	Not Applicable
Previous Investigations/Removal Actions – Barn No. 5 Petroleum Release – CC RVAAP-71		
Year	Type of Investigation/Action	Findings
2011	HRR	Letter dated 1964 describes a "yellow liquid coming out of the ground" later identified as "SOHIO gasoline" with estimated release of 20 barrels from a broken pipeline. Site was excavated to repair the pipeline the same day as the release.

Source: HRR (ECC 2012)

4.0 FIELD INVESTIGATION

Work conducted for this SI was performed in accordance with the *Final Site Inspection and Remedial Investigation Work Plan Addendum at Compliance Restoration Sites CC RVAAP-71 Barn No. 5 Petroleum Release and CC RVAAP-83 Former Buildings 1031 and 1039, Revision 1* (ECC 2013) and the *Facility-Wide Sampling and Analysis Plan for Environmental Investigations at the Ravenna Army Ammunition Plant, Ravenna, Ohio* (SAIC 2011a) dated February 24, 2011, unless specifically noted otherwise (Section 4.3). The samples collected for this SI are presented in Table 4-1.

4.1 SAMPLING RATIONALE

Subsurface soil sampling was conducted at the CC RVAAP-71 Barn No. 5 Petroleum Release to determine the presence of SRCs and identify COPCs as described in the Final Work Plan (ECC 2013). Table 4-2 provides the sampling rationale for each sample collected.

4.2 PRE-MOBILIZATION ACTIVITIES

Prior to the field investigation, a series of pre-mobilization activities were undertaken to ensure that all applicable requirements were met. These included obtaining any necessary notifications to the RVAAP Facility Manager, Ohio EPA, the operating contractor, and other stakeholders.

4.2.1 Site Walk and Location of Decision Unit and Direct-Push Boring Locations

ECC personnel mobilized to RVAAP on August 12, 2013 to conduct a site walk and pre-mark the location of the decision unit (DU) and direct-push boring locations within the DU at CC RVAAP-71.

4.2.1.1 Site Walk

ECC conducted a site walk at CC RVAAP-71 to assess current site conditions and to note any potential health and safety hazards which may be encountered when conducting field work.

4.2.1.2 Location of Decision Unit and Direct-Push Boring Locations

The DU and direct-push boring locations were marked using wooden stakes, high visibility paint, and flagging. The DU is located along the southern boundary of the site. Direct-push locations were located on either side of the existing chain-link fence which runs by Post No. 6. These sampling locations were selected based on information gathered as part of the HRR (ECC 2012), in particular, a letter reporting a description by Dan McMinemen who indicated “yellow liquid

was coming out of the ground inside of our south fence near Barn No. 5" (Craver 1964). Therefore, the DU location corresponds to the general area where the gasoline release from the underground pipeline was reported to have occurred (Figure 4-1). The gasoline pipeline was located outside the fence and the gasoline leak was reported to have surfaced inside the fence. Accordingly, the DU area selected spans the fence in the southern area of the AOC as the region requiring further investigation.

4.2.2 MEC and Utility Clearance Surveys

Based on HRR report findings (ECC 2012), munitions and explosives of concern (MEC) clearance was not required and therefore not conducted at Barn No. 5 Petroleum Release. No documentation of military munitions being historically located or stored on-site was discovered.

4.2.3 Site Clearing Activities

Site clearing activities were not required as the AOC is located in an area with low brush, tall grass and an access road along the southern portion of the AOC. Access was easily gained by vehicles and drilling equipment.

4.2.4 Site Security

No specific site security was needed at CC RVAAP-71. However, each work day prior to mobilizing to the site, RVAAP Range Control was notified that ECC and subcontractor personnel would be working at the CC RVAAP-71 AOC.

4.2.5 Equipment Decontamination

Prior to the beginning of intrusive activities, all down-hole direct-push drilling equipment was decontaminated using a high pressure steam cleaner and brushes. A temporary decontamination pad was constructed at a pre-designated location outside of Building 1036 and lined with plastic sheeting. The drilling equipment was then placed on a temporary steel rack within the decontamination pad and the equipment was thoroughly cleaned. Following the conclusion of the subsurface soil sampling, the drilling equipment was again cleaned using a high pressure steam cleaner before leaving the installation.

Prior to beginning subsurface soil sampling at CC RVAAP-71, all hand held sampling equipment was decontaminated at a pre-designated area within Building 1036.

Five-gallon buckets were used to contain brushes, potable water with Alconox® wash, and potable water rinse. Other decontamination fluids consisted of pesticide grade isopropyl alcohol,

a 10% nitric acid solution, and laboratory supplied deionized (DI) water contained in spray bottles. Following the Alconox® wash with brushes and potable water rinse, sampling equipment was sprayed with isopropyl alcohol, sprayed with the 10% nitric acid solution, rinsed with DI water, and then wrapped in aluminum foil. The decontamination equipment (five-gallon buckets, etc.) were placed on plastic sheeting in the designated decontamination area within Building 1036 prior to and during decontamination activities.

Sufficient sampling equipment was brought to the site to allow for sampling of the DU area without the need to decontaminate hand held equipment. The drillers' rods were decontaminated between each boring using an Alconox® wash and rinse with potable water and brushes to remove any extraneous soil from the samplers. All hand held sampling equipment was decontaminated inside Building 1036 at the end of each work day in preparation for any sampling the following day.

The decontamination fluids were containerized in a Department of Transportation (DOT) approved 55-gallon closed steel drum located within secondary containment inside Building 1036. The drum was labeled with contents, date of initial generation, and contact information. All sampling equipment was decontaminated in accordance with the procedures outlined in Section 5.5.2.8 of the Facility-Wide Sampling and Analysis Plan (FWSAP) (SAIC 2011a).

4.3 DEVIATIONS FROM THE WORK PLAN

There were no field sampling deviations from the *Final Site Inspection and Remedial Investigation Work Plan Addendum at Compliance Restoration Sites CC RVAAP-71 Barn No. 5 Petroleum Release and CC RVAAP-83 Former Buildings 1031 and 1039, Revision 1* (ECC 2013) for fieldwork conducted at CC RVAAP-71.

There was one deviation from the Sampling and Analysis Work Plan regarding the laboratory analysis of the total petroleum hydrocarbon (TPH) samples. The deviation included additional laboratory analysis in order to report the TPH gasoline range organic (GRO) and diesel range organic (DRO) results to allow comparison to the Bureau of Underground Storage Tank Regulations (BUSTR) criteria. This deviation was purposely conducted to further evaluate the GRO and DRO results with respect to BUSTR criteria which are used in the State of Ohio to effectively regulate the safe operation of underground storage tanks and ensure appropriate investigation and cleanup of releases from storage tanks. The original TPH GRO results with hydrocarbon ranges for carbon (C) C6-C10 were re-quantitated by the contract laboratory to specifically report hydrocarbon ranges which match the BUSTR criteria in order to enable direct comparison to the BUSTR carbon range of C6-C12. Likewise, the TPH DRO results with hydrocarbon ranges of C10-C28 were re-extracted and re-analyzed to report TPH DRO

hydrocarbon ranges C10-C20 and C20-C34 to specifically report hydrocarbon ranges which match the BUSTR criteria.

4.4 FIELD SAMPLING

All field activities and sampling procedures at CC RVAAP-71 were performed in accordance with Section 5.0 of the FWSAP (SAIC 2011a). Field work was comprised of collecting vertical (1 – 7 feet below ground surface (ft bgs)) and horizontal (1 – 4 and 4 – 7 ft bgs) subsurface soil ISM samples as well as one deep soil boring (7 – 13 ft bgs) sample at DU01.

On August 13 and 14, 2013, fourteen (14) soil borings were advanced to 7 ft bgs at DU01. The locations of the borings are shown on Figure 4-1. Subsurface soil ISM samples (1 - 4 ft, 4 - 7 ft, and 1 - 7 ft bgs) were collected within the DU at each of the 14 soil boring locations. A deep soil boring sample (7 – 13 ft bgs) was collected at soil boring SB9. A photoionization detector (PID) was used for the measurement of total volatile organic compounds (VOC) at each boring to facilitate discrete sampling for the purpose of VOC analysis.

The subsurface soil ISM samples and the deeper soil boring sample (7 – 13 ft bgs), were analyzed for the following analytes:

- VOCs using EPA Method SW-846, 8260C/5035
- Methyl tertiary-butyl ether (MTBE) using EPA Method SW-846, 8260C/5035
- Semi-volatile organic compounds (SVOC) using EPA Method SW-846, 8270D and 8270D selective ion monitoring (SIM)/3550
- TPH DRO using EPA Method SW-846, 8015C TPH GRO using EPA Method SW-846, 8015C/5035
- Lead using EPA Method SW-846, 6010C

In addition to the above, two vertical subsurface soil ISM samples from soil boring SB7 (Sample ID 071SB-0010M-0001-SO) and from soil boring SB11 (Sample ID 071SB-0017M-0001-SO) were analyzed for the RVAAP Full-Suite analysis which includes VOCs (with MTBE), SVOCs, polychlorinated biphenyls (PCBs), pesticides, explosives, propellants, TPH DRO, TPH GRO, and target analyte list (TAL) metals, as defined in FWQAPP Section 5.4.5 (SAIC 2011b). Table 4-1 presents a summary of samples collected at CC RVAAP-71 Barn No. 5 Petroleum Release.

Samples collected during the SI were laboratory-analyzed at CT Laboratories LLC of Baraboo, Wisconsin. Preparation and analyses for chemical parameters were performed according to the methods listed in Table 4-3. In order to compare the TPH GRO and DRO analytical results to the BUSTR criteria, the subsurface soil samples were further analyzed by CT Laboratories of Baraboo, Wisconsin, using SW-846 Method 8015C for DRO and GRO a second time to report

the specific carbon chain petroleum compounds present in the samples. The results of this additional petroleum hydrocarbon analysis are summarized in Section 5.0. The BUSTR criteria were used for screening the diesel and gasoline range hydrocarbons detected in the subsurface soil since there are no established FWCUGs for TPH GRO and TPH DRO compounds.

Quality assurance (QA) split samples were also collected separately for the USACE. The USACE QA split samples were laboratory-analyzed at Microbac Laboratories, Inc. of Marietta, Ohio. All analytical procedures were completed in accordance with applicable professional standards, USEPA requirements, government regulations and guidelines, DoD Quality Systems Manual (QSM) Version 4.2, USACE Louisville District analytical quality assurance (QA) standards, and specific project goals and requirements.

4.4.1 Subsurface Soil Sampling

Two horizontal subsurface soil ISM samples were collected at DU01; one from the 1 - 4 ft bgs interval, and one from the 4 – 7 ft bgs interval. A vertical ISM sample was collected at each of the fourteen boring locations from the 1 - 7 ft bgs interval. A deep soil boring sample was collected from one soil boring location at the 7 – 13 ft bgs interval.

Subsurface soil samples were collected using a Geoprobe® Model 6620DT direct-push drill rig. The procedures for hydraulic direct-push sampling were performed in accordance with Section 5.5.2.5.3 of the FWSAP (SAIC 2011a). Samples were collected using 5-ft long stainless steel sampling rods lined with acetate Macro-core® samplers. Each sample was collected using a dedicated liner specific for that interval. The 5-ft stainless steel sampler was advanced twice at each boring location to reach the depth of 7 ft bgs and three times at one boring location to reach the depth of 13 ft bgs. The sampler was then retrieved from the desired depth and the liner removed. The liner was cut open length-wise and the soil was immediately field-screened with a PID. Samples for headspace screening were collected at 2-ft intervals along the entire sampler using stainless steel scoopulas and placed in 8-oz glass jars. The jars were then capped with aluminum foil and a plastic lid and allowed to warm for approximately 10 minutes. The tip of the PID was then inserted into the jar through the aluminum foil and the reading recorded on the boring log. If elevated readings were noted, a VOC sample was collected using a disposable Terracore® sampler at that interval. VOC samples were collected from the deep subsurface soil boring sample prior to compositing the sample to avoid the loss of volatiles.

The liner containing the soil was photographed and soil characteristics for each interval were then logged on a soil boring log. A summary of sampling information was logged on the field log forms. Field log forms and boring logs from the site investigation are presented in Appendices B and C, respectively. Photographs are presented in Appendix H.

4.4.1.1 Horizontal Subsurface Soil ISM Sampling

Subsurface soil was collected at each of the fourteen borings from the 1 – 4 ft bgs interval to create the depth interval-specific subsurface soil ISM sample. Soil was collected by running a stainless steel scoopula along the length of the liner from 1 - 4 ft to collect a representative sample from each boring. The same procedure was performed for the 4 - 7 ft bgs interval. Sufficient soil was collected from each soil boring sample interval to generate the minimum 1 kg of soil required for an ISM sample. All sample containers were labeled and placed in a cooler with ice following collection.

4.4.1.2 Vertical ISM Soil Sampling

Fourteen vertical subsurface soil ISM samples were collected from the 1 – 7 ft bgs interval. Soil was collected by running a stainless steel scoopula along the length of the liner from 1 - 5 ft and from 5 - 7 ft to collect a representative sample. Sufficient soil was collected from the 1 - 7 ft bgs interval to generate the minimum 1 kg of soil required for an ISM sample. All sample containers were labeled and placed in a cooler with ice following collection.

4.4.1.3 Deep Soil Boring Sampling

One deep soil boring (DSB) was advanced at CC RVAAP-71 to characterize the subsurface soils to 13 ft bgs. The boring was advanced to a depth of 13 ft bgs and a sample was collected from the 7 - 13 ft bgs interval. Prior to collecting the composite sample, the VOC sample was collected prior to the compositing process. Soil for the composite portion of the sample was collected by running a stainless steel scoopula along the length of the liner from 7 - 10 ft and from 10 - 13 ft. The soil was then mixed with a stainless steel spoon in a stainless steel bowl to collect a representative sample. These were collected in accordance with sampling procedures as described in Section 5.5.2.5 in the FWSAP (SAIC 2011a) and as presented in Section 4.2 of Appendix A of the SI and RI Work Plan Addendum (ECC 2013). The sample container was labeled and placed in a cooler with ice following collection. The DSB sample at CC RVAAP-71 was collected from soil boring SB9.

4.4.2 Field QC/QA Sampling Procedures

Quality control (QC) samples were collected in accordance with Section 5.4.7 of the FWFSP (SAIC 2011c). Field duplicate samples were collected at a frequency of 10% (1 per 10 soil samples). Matrix spike/matrix spike duplicate (MS/MSD) samples were collected at a frequency of 5% (1 per 20 soil samples).

Two field duplicate samples were collected at the 1 – 7 bgs interval; one at soil boring location SB9 and one at SB12. A MS/MSD sample was collected at one soil boring location, SB1, at the 1- 7 ft bgs interval. The field duplicate and MS/MSD were derived from the same sampling point as their respective primary samples and using the same sample collection methods. The samples were then submitted for the same analyses as the primary samples (blind to the contract laboratory for the field duplicate sample). One equipment rinsate blank sample was collected from hand-tool soil collection equipment. Trip blanks accompanied all shipments containing VOC samples.

Quality assurance (QA) split samples were collected for the USACE at four soil boring locations (SB5, SB8, SB9, and SB12) and submitted to the USACE quality assurance laboratory for independent analyses. At these boring locations, the drill rig was offset approximately 6 inches from the initial boring location. The USACE QA split samples were collected from the same discrete depth interval as the primary samples and using the same sample collection methods. Two vertical subsurface soil ISM QA samples (SB5 and SB8) were collected at the 1 - 7 ft bgs interval and analyzed for TPH GRO. A vertical subsurface soil ISM QA sample from SB9 was collected at the 1 - 7 ft bgs interval and analyzed for VOCs, MTBE, SVOCs, and TPH DRO/GRO. The vertical subsurface soil ISM QA sample collected at SB12 was collected from the 1 – 7 ft bgs interval and analyzed for TPH DRO/GRO and SVOCs.

The source water blank samples were analyzed for TAL metals, explosives, propellants, herbicides, PCBs, pesticides, SVOCs, TPH DRO/GRO, hexavalent chromium, and VOCs/MTBE. A source water blank sample was collected on 13 March 2013 from the deionized (DI) water used during drilling equipment decontamination. This source water was brought on-site by the drilling subcontractor (Frontz Drilling) and originated from a private well located at the company's facility in Wooster, Ohio. Frontz Drilling has been hired as a drilling subcontractor by previous RVAAP contractors (e.g. SAIC) and has supplied potable water for decontamination purposes during numerous field events. The source water blank sample results are provided in Appendix D. The type and number of QA/QC samples are provided in Table 4-1.

4.5 SURVEYING

Campbell & Associates, Inc., of Akron, Ohio, was subcontracted by ECC to survey all soil boring locations at CC RVAAP-71. The horizontal coordinates and relative elevations of all sampling locations were determined to within 0.3 meters and 0.01 meters, respectively. Michael McMahon, an employee of Campbell & Associates, Inc. and a licensed surveyor in the State of Ohio, performed the survey. All survey data was reported in North American Datum (NAD) 1983 Universal Transverse Mercator (UTM) Zone 17 North, in meters.

4.6 INVESTIGATION DERIVED WASTE

Investigation-derived waste (IDW) materials generated during field activities included soil cuttings from subsurface soil sampling and decontamination fluids. All IDW was containerized in DOT approved 55-gallon drums, properly sealed and labeled and placed in a designated area within Building 1036. The drum containing IDW fluids was placed on a heavy duty polyethylene secondary containment pallet.

4.6.1 Collection and Containerization

All IDW was properly handled, labeled, characterized, and managed in accordance with Section 8.0 of the FWSAP (SAIC 2011a), federal and State of Ohio large-quantity generator requirements, and the RVAAP Installation Hazardous Waste Management Plan (BRACO 2009).

4.6.2 Characterization for Disposal

IDW disposal characterization samples were collected by ECC personnel on August 15, 2013. Samples were comprised of liquid IDW consisting of decontamination fluids, and solid IDW consisting of soil cuttings. IDW analysis included both liquid and solid Toxicity Characteristic Leaching Procedure (TCLP), and Reactivity, Corrosivity, and Ignitability (RCI) analysis.

4.6.3 Transportation and Disposal

On 27 November 2013, Ohio EPA approved the IDW letter report for the transport and disposal of the accumulated IDW as a result of executed SI tasks. The IDW letter report and OhioEPA approval are provided in Appendix G. On 23 December 2013, the drummed IDW was transported under a non-hazardous waste manifest by Emerald Environmental Services, Inc. for disposal at Vexor Technology in Medina, Ohio. The manifest is provided in Appendix G.

Table 4-1: Site Inspection Samples Collected

Location	Sample Location/Soil Boring	Sample ID	Matrix	Depth (ft)	Sampling Method	Date	TPH DRO	TPH GRO	VOC/MTBE	Lead	SVOC	TAL Metals	PCB	Pesticides	Explosives	Propellants	Herbicides	Hex Chrom
Subsurface Soil Analytical Program for CC RVAAP-71																		
Barn No. 5 Petroleum Release	DU01	071SB-0001M-0001-SO	SB	1-4	ISM	13-Aug-13	X	X	X	X	X							
Barn No. 5 Petroleum Release	DU01	071SB-0002M-0001-SO	SB	4-7	ISM	13-Aug-13	X	X	X	X	X							
Barn No. 5 Petroleum Release	SB1	071SB-0003M-0001-SO	SB	1-7	ISM	13-Aug-13	X	X	X	X	X							
Barn No. 5 Petroleum Release	SB1	071SB-0003M-0002-SO	SB	1-7	ISM	13-Aug-13	X	X	X	X	X							
Barn No. 5 Petroleum Release	SB2	071SB-0004M-0001-SO	SB	1-7	ISM	13-Aug-13	X	X	X	X	X							
Barn No. 5 Petroleum Release	SB3	071SB-0005M-0001-SO	SB	1-7	ISM	13-Aug-13	X	X	X	X	X							
Barn No. 5 Petroleum Release	SB4	071SB-0006M-0001-SO	SB	1-7	ISM	13-Aug-13	X	X	X	X	X							
Barn No. 5 Petroleum Release	SB5	071SB-0007M-0001-SO	SB	1-7	ISM	13-Aug-13	X	X	X	X	X							
Barn No. 5 Petroleum Release	SB5	071SB-0008M-0001-SO	SB	1-7	ISM	13-Aug-13		X										
Barn No. 5 Petroleum Release	SB6	071SB-0009M-0001-SO	SB	1-7	ISM	13-Aug-13	X	X	X	X	X							
Barn No. 5 Petroleum Release	SB7	071SB-0010M-0001-SO	SB	1-7	ISM	13-Aug-13	X	X	X	X	X	X	X	X	X	X		

Table 4-1: Site Inspection Samples Collected (Continued)

Location	Sample Location/Soil Boring	Sample ID	Matrix	Depth (ft)	Sampling Method	Date	TPH DRO	TPH GRO	VOC/MTBE	Lead	SVOC	TAL Metals	PCB	Pesticides	Explosives	Propellants	Herbicides	Hex Chrom
Subsurface Soil Analytical Program for CC RVAAP-71																		
Barn No. 5 Petroleum Release	SB8	071SB-0011M-0001-SO	SB	1-7	ISM	13-Aug-13	X	X	X	X	X							
Barn No. 5 Petroleum Release	SB8	071SB-0012M-0001-SO	SB	1-7	Grab	13-Aug-13		X										
Barn No. 5 Petroleum Release	SB9	071SB-0013M-0001-SO	SB	1-7	ISM	13-Aug-13	X	X	X	X	X							
Barn No. 5 Petroleum Release	SB9	071SB-0014M-0001-SO	SB	1-7	ISM	13-Aug-13	X	X	X	X	X							
Barn No. 5 Petroleum Release	SB9	071SB-0015M-0001-SO	SB	1-7	ISM	13-Aug-13	X	X			X							
Barn No. 5 Petroleum Release	SB9	071SB-0015M-0001-SO	SB	1-7	Grab	14-Aug-13			X									
Barn No. 5 Petroleum Release	SB10	071SB-0016M-0001-SO	SB	1-7	ISM	13-Aug-13	X	X	X	X	X							
Barn No. 5 Petroleum Release	SB11	071SB-0017M-0001-SO	SB	1-7	ISM	13-Aug-13	X	X	X	X	X	X	X	X	X	X		
Barn No. 5 Petroleum Release	SB12	071SB-0018M-0001-SO	SB	1-7	ISM	13-Aug-13	X	X	X	X	X							

Table 4-1: Site Inspection Samples Collected (Continued)

Location	Sample Location/Soil Boring	Sample ID	Matrix	Depth (ft)	Sampling Method	Date	TPH DRO	TPH GRO	VOC/MTBE	Lead	SVOC	TAL Metals	PCB	Pesticides	Explosives	Propellants	Herbicides	Hex Chrom
Subsurface Soil Analytical Program for CC RVAAP-71																		
Barn No. 5 Petroleum Release	SB12	071SB-0019M-0001-SO	SB	1-7	ISM	13-Aug-13	X	X	X	X	X							
Barn No. 5 Petroleum Release	SB12	071SB-0020M-0001-SO	SB	1-7	ISM	13-Aug-13	X	X			X							
Barn No. 5 Petroleum Release	SB13	071SB-0021M-0001-SO	SB	1-7	ISM	13-Aug-13	X	X	X	X	X							
Barn No. 5 Petroleum Release	SB14	071SB-0022M-0001-SO	SB	1-7	ISM	13-Aug-13	X	X	X	X	X							
Barn No. 5 Petroleum Release	SB9	071SB-0023-0001-SO	SB	7-13	Composite	13-Aug-13	X	X	X	X	X							
Field Quality Control - Source Water																		
NA	Source Water (ECC bottled decontamination water)	070-0057-0001-Source Water	QC	non-dedicated hand sampling tools	Grab	12-Dec-12	X	X	X	X	X	X	X	X	X	X	X	
NA	Source Water (Driller decontamination water)	079-0007-0001-Source Water	QC	Direct Push Tools	Grab	14-Mar-13	X	X	X	X	X	X	X	X	X	X	X	X
Field Quality Control - Equipment Rinsate																		
NA	Equipment Rinsate Blank	083SB-0023-0001-ER	QC	non-dedicated hand sampling tools	Grab	15-Aug-13		X	X	X	X	X	X	X	X	X		

Table 4-1: Site Inspection Samples Collected (Continued)

Location	Sample Location/Soil Boring	Sample ID	Matrix	Depth (ft)	Sampling Method	Date	TPH DRO	TPH GRO	VOC/MTBE	Lead	SVOC	TAL Metals	PCB	Pesticides	Explosives	Propellants	Herbicides	Hex Chrom
Field Quality Control - Trip Blanks																		
NA	Trip Blank	070-0060-0001-TB	QC	NA	Grab	12-Dec-12			X									
NA	Trip Blank	070SB-005-0001-TB	QC	NA	Grab	12-Dec-12		X										
NA	Trip Blank	079-0008-0001-TB	QC	NA	Grab	14-Mar-13			X									
NA	Trip Blank	079-0009-0001-TB	QC	NA	Grab	14-Mar-13		X										
NA	Trip Blank	083SB-0004-0001-TB	QC	NA	Grab	15-Aug-13			X									
NA	Trip Blank	071SB-0024-0001-TB	QA	NA	Grab	13-Aug-13		X	X									
NA	Trip Blank	071SB-0025-0001-TB	QC	NA	Grab	13-Aug-13			X									
NA	Trip Blank	071SB-0026-0001-TB	QC	NA	Grab	13-Aug-13			X									
NA	Trip Blank	071SB-0027-0001-TB	QA	NA	Grab	14-Aug-13			X									

Notes:

FD	MS/ MSD	FULL SUITE	QA

Propellants include nitroguanidine, nitrocellulose, and nitroglycerin.
ID = Identification
ISM = Incremental Sampling Methodology
DU = Decision Unit
FD = Field Duplicate
MS/MSD = Matrix Spike/Matrix Spike Duplicate
NA = Not Applicable
Hex Chrom = Hexavalent Chromium
PCB = Polychlorinated Biphenyls
SB = Soil Boring
SVOC = Semi-volatile Organic Compound
TAL = Target Analyte List
VOC = Volatile Organic Compound
ER = Equipment Rinsate
QA = Quality Assurance
QC = Quality Control
SorW = Source Water
TB = Trip Blank
TPH = Total Petroleum Hydrocarbon
GRO = Gasoline Range Organics
DRO = Diesel Range Organics
MTBE = methyl tertiary-butyl ether

Table 4-2: Subsurface Soil Samples and Rationales

Sample Type	Depth (ft bgs)	Location (DU/SB)	Sample ID	Date Sampled	Comments/Rationale
ISM	1-4	DU01	071SB-0001M-0001-SO	13-Aug-13	Characterize horizontal extent not previously sampled.
ISM	4-7	DU01	071SB-0002M-0001-SO	13-Aug-12	Characterize horizontal extent not previously sampled.
ISM	1-7	SB1	071SB-0003M-0001-SO	13-Aug-13	Characterize vertical extent not previously sampled.
ISM	1-7	SB1	071SB-0003M-0002-SO	13-Aug-13	QC. MS/MSD sample of 071SB-0003M-0001-SO.
ISM	1-7	SB2	071SB-0004M-0001-SO	13-Aug-13	Characterize vertical extent not previously sampled.
ISM	1-7	SB3	071SB-0005M-0001-SO	13-Aug-13	Characterize vertical extent not previously sampled.
ISM	1-7	SB4	071SB-0006M-0001-SO	13-Aug-13	Characterize vertical extent not previously sampled.
ISM	1-7	SB5	071SB-0007M-0001-SO	13-Aug-13	Characterize vertical extent not previously sampled.
ISM	1-7	SB5	071SB-0008M-0001-SO	13-Aug-13	QA. Split sample of 071SB-0007M-0001-SO.
ISM	1-7	SB6	071SB-0009M-0001-SO	13-Aug-13	Characterize vertical extent not previously sampled.
ISM	1-7	SB7	071SB-0010M-0001-SO	13-Aug-13	Characterize vertical extent not previously sampled. Analyzed for RVAAP full-suite analysis.
ISM	1-7	SB8	071SB-0011M-0001-SO	13-Aug-13	Characterize vertical extent not previously sampled.
ISM	1-7	SB8	071SB-0012M-0001-SO	13-Aug-13	QA. Split sample of 071SB-0011M-0001-SO.
ISM	1-7	SB9	071SB-0013M-0001-SO	13-Aug-13	Characterize vertical extent not previously sampled.
ISM	1-7	SB9	071SB-0014M-0001-SO	13-Aug-13	QC. FD sample of 071SB-0013M-0001-SO.
ISM	1-7	SB9	071SB-0015M-0001-SO	13-Aug-13	QA. Split sample of 071SB-0013M-0001-SO.
ISM	1-7	SB10	071SB-0016M-0001-SO	13-Aug-13	Characterize vertical extent not previously sampled.
ISM	1-7	SB11	071SB-0017M-0001-SO	13-Aug-13	Characterize vertical extent not previously sampled. Analyzed for RVAAP full-suite analysis.
ISM	1-7	SB12	071SB-0018M-0001-SO	13-Aug-13	Characterize vertical extent not previously sampled.
ISM	1-7	SB12	071SB-0019M-0001-SO	13-Aug-13	QC. FD sample of 071SB-0018M-0001-SO.
ISM	1-7	SB12	071SB-0020M-0001-SO	13-Aug-13	QA. Split sample of 071SB-0018M-0001-SO.
ISM	1-7	SB13	071SB-0021M-0001-SO	13-Aug-13	Characterize vertical extent not previously sampled.
ISM	1-7	SB14	071SB-0022M-0001-SO	13-Aug-13	Characterize vertical extent not previously sampled.

Table 4-2: Subsurface Soil Samples and Rationales (Continued)

Sample Type	Depth	Location (DU/SB)	Sample ID	Date Sampled	Comments/Rationale
Composite	7-13	SB9	071SB-0023-0001-SO	13-Aug-13	Characterize vertical extent not previously sampled.
Grab	NA	NA	071SB-0024-0001-TB	13-Aug-13	QA. Trip Blank.
Grab	NA	NA	071SB-0025-0001-TB	13-Aug-13	QC. Trip Blank.
Grab	NA	NA	071SB-0026-0001-TB	13-Aug-13	QC. Trip Blank.
Grab	1-7	SB9	071SB-0015M-0001-SO	14-Aug-13	QA. Split sample of 071SB-0013M-0001-SO.
Grab	NA	NA	071SB-0027-0001-TB	14-Aug-13	QA. Trip Blank.

Notes:
RVAAP = Ravenna Army Ammunition Plant
DU = Decision Unit
MS/MSD = Matrix Spike/Matrix Spike
TB = trip blank
Duplicate
FD = Field duplicate
ft bgs = Feet below ground surface
SB = Soil Boring
ISM = Incremental Sampling Methodology
ID = Identification
QC = Quality Control
QA = Quality Assurance

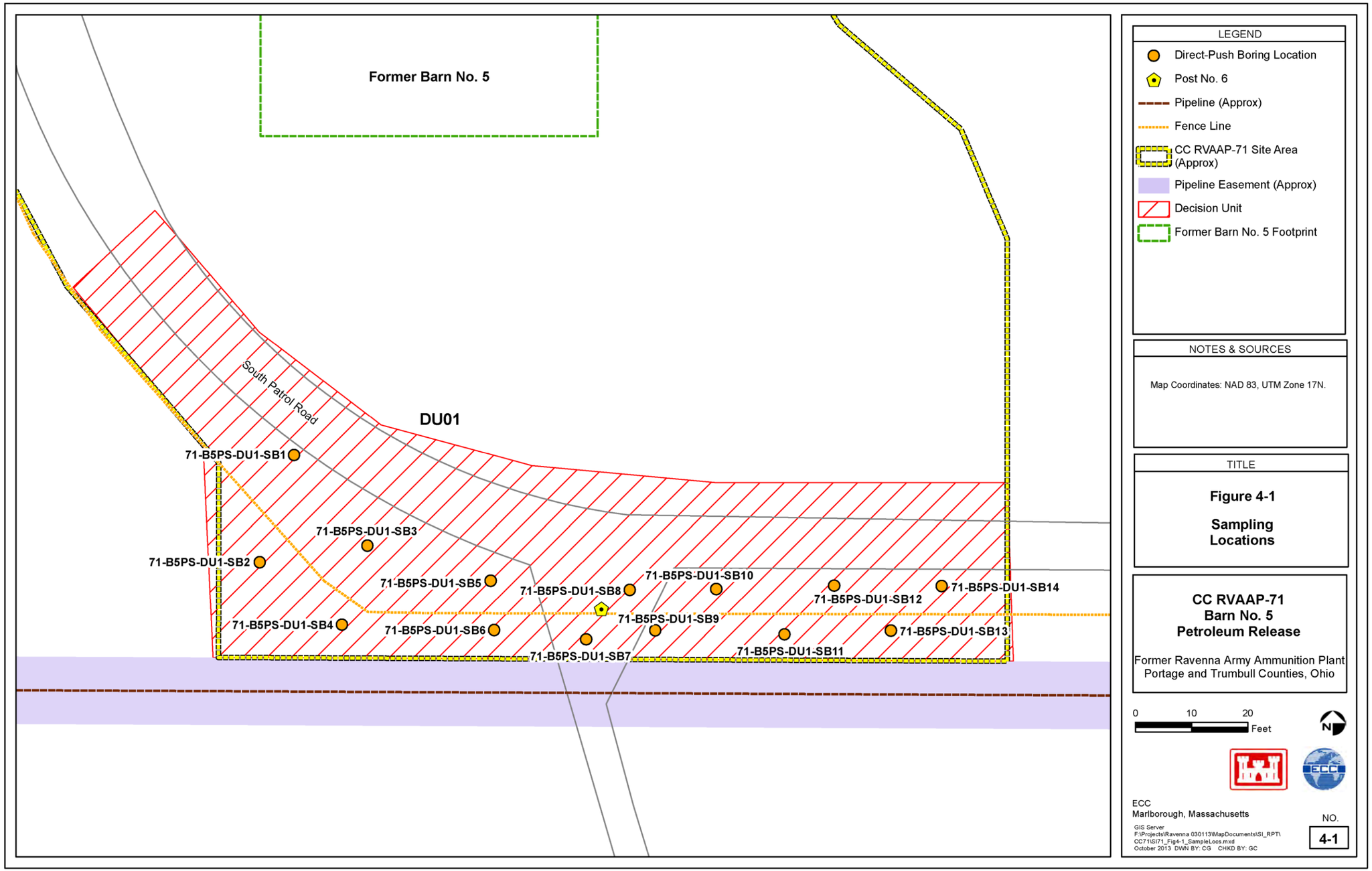
Table 4-3: Site Inspection Sample Preparation and Analytical Procedures

Parameter	Soil[1]		Aqueous	
	Preparation	Analysis	Preparation	Analysis
Propellants*	9056 Modified	9056 Modified	EPA353.2	EPA353.2
	SW8330B	SW8330B	SW8330	SW8330
			EPA9056M	EPA9056M
TAL Metals	SW3015	SW6010C	SW3050B	SW6020
	SW7471B	Mercury SW7471B	SW7470A	SW7470A
			SW3050B	SW6010C
TPH GRO	SW5035	SW8015C	SW5030B	SW8015V Modified
			SW5030B	SW8015C
TPH DRO	SW3546	SW8015C	SW3520C	SW8015D Modified
			SW3520C	SW8015C
Pesticides	SW3546	SW8081B	SW3520C	SW8081
			SW3520C	SW8081B
Explosives	SW8330B	SW8330B	SW8330A	SW8330A
			SW8330B	SW8330B
PCB	SW3540C	SW8082A	SW3520C	SW8082
			SW3520C	SW8082A
Herbicide	NA	NA	SW3510	SW8151A
VOC**	SW5035	SW8260C	SW5030B	SW8260B
SVOC***	SW3550	SW8270D/SW8270D SIM	SW3510C	SW8270C
			SW3510C	SW8270D
			SW3510C	SW8270D/SIM

Notes:

All soil samples, except for VOCs, undergo incremental sample preparation by air drying, then passed through a rotary hammer mill, and sieved.
DI = Deionized
TAL = Target Analyte List
TPH = Total Petroleum Hydrocarbon
GRO = Gasoline Range Organic
DRO = Diesel Range Organic
PAH = Polycyclic Aromatic Hydrocarbon
PCB = Polychlorinated Biphenyls
VOC = Volatile Organic Compound
SVOC = Semi-volatile Organic Compound
SIM = Selected Ion Monitoring
*Nitroglycerin and nitroguanidine reported by explosives method (SW8330B).
**Includes benzene, ethylbenzene, toluene, total xylenes, and methyl tertiary-butyl ether
***Includes polycyclic aromatic hydrocarbon using SIM mode
[1] = Soil and equipment rinsate analytical methods performed by CT Laboratories and all other aqueous methods conducted by Test America.
NA = Not analyzed
EPA = Environmental Protection Agency

This page intentionally left blank.


Former Barn No. 5
South Patrol Road
DU01
71-B5PS-DU1-SB1
71-B5PS-DU1-SB2
71-B5PS-DU1-SB3
71-B5PS-DU1-SB4
71-B5PS-DU1-SB5
71-B5PS-DU1-SB6
71-B5PS-DU1-SB7
71-B5PS-DU1-SB8
71-B5PS-DU1-SB9
71-B5PS-DU1-SB10
71-B5PS-DU1-SB11
71-B5PS-DU1-SB12
71-B5PS-DU1-SB13
71-B5PS-DU1-SB14
LEGEND
Direct-Push Boring Location
Post No. 6
Pipeline (Approx)
Fence Line
CC RVAAP-71 Site Area (Approx)
Pipeline Easement (Approx)
Decision Unit
Former Barn No. 5 Footprint
NOTES & SOURCES
Map Coordinates: NAD 83, UTM Zone 17N.
TITLE
Figure 4-1
Sampling Locations
CC RVAAP-71
Barn No. 5
Petroleum Release
Former Ravenna Army Ammunition Plant
Portage and Trumbull Counties, Ohio
0 10 20
Feet
N
ECC
Marlborough, Massachusetts
GIS Server
F:\Projects\Ravenna 030113\MapDocuments\SI_RPT\CC71\SI71_Fig4-1_SampleLocs.mxd
October 2013 DWN BY: CG CHKD BY: GC
NO.
4-1

This page intentionally left blank.

5.0 RESULTS

This section presents results of the analytical obtained during the SI and data screening process to identify SRCs indicative of potential impacts from AOC operations at the CC RVAAP-71 Barn No 5 Petroleum Release. Laboratory analytical data for the SI are provided in Appendix E.

5.1 DATA EVALUATION METHOD

The SI data collected were verified and validated in accordance with the procedures outlined in the FWSAP (SAIC 2011a). The processes used to evaluate the analytical data involved three general steps: (1) defining data aggregates; (2) data verification, reduction, and screening; and (3) data presentation. The completed data verification report is included as Appendix D and the data validation report (provided by USACE Louisville District) is provided as Appendix F of this SI Report. The data reporting convention used will be consistent with past data reporting practices to ensure comparability. Non-detect data will be reported as non-detect (ND) in the tables of detected analytes (Tables 5-2 and 5-3) and reported at the Limit of Detection (LOD) as in the data results tables in Appendix E.

5.1.1 Definition of Aggregates

The basic aggregation of data for this SI was medium-specific as per the Final Work Plan:

- Subsurface Soil Horizontal Profile (1 - 4 and 4 - 7 ft bgs)
- Subsurface Soil Boring Vertical Profile (1 - 7 ft bgs)
- Deep Soil Boring (7 - 13 ft bgs)

5.1.2 Data Verification, Reduction, and Screening

5.1.2.1 Data Verification

Data verification was performed on the subsurface soil samples. The analytical results were reported by the laboratory in accordance with the FWSAP (SAIC 2011a). Data verification is a systematic automated and manual review of all project data for compliance with the FWSAP QAPP Section 10.2.1.

Data qualifiers were initially assigned to each result based on the laboratory (i.e., CT Laboratories, LLC of Baraboo, Wisconsin) internal review criteria. These laboratory qualifiers were accepted or replaced during data verification of laboratory results against the FWSAP acceptance criteria.

Results were qualified as follows by data verification:

- "U" not detected
- "UJ" not detected, reporting limit estimated
- "J" indicates the analyte was positively identified, but the associated numerical value is an approximate concentration of the analyte in the sample or the quantitation is an estimation due to discrepancies in meeting certain analyte-specific quality control criteria
- "R" result not usable

In addition to assigning qualifiers, the verification process also selected the appropriate result to use when re-analyses or dilutions were performed. A complete discussion of verification process results is contained in the data verification report (Appendix D).

5.1.2.2 Data Validation

Independent, third-party validation of 10% of the SI data and 100% of the USACE QA laboratory data was be performed by a USACE Louisville District subcontractor and is provided as Appendix F Data Validation Report.

5.1.2.3 Data Reduction

Data reduction was not completed for this SI. Due to the limited number of samples collected for the SI, statistical analysis of the data collected at the AOC was not necessary in the data evaluation process.

5.1.2.4 Data Screening

The data were screened to identify SRCs using the processes outlined below. Figure 5-1 illustrates the screening process to identify SRCs and COPCs in accordance with the *Final Facility-Wide Cleanup Goals* for Ravenna Army Ammunition Plant (USACE 2010). All chemicals not eliminated during the screening steps were retained as SRCs. The steps involved in the SRC screening are summarized below:

- **Data quality assessment**: Data were produced, reviewed, and reported by the laboratory in accordance with specifications in the FWSAP (SAIC 2011a), and data verification of laboratory results was performed in accordance with the FWSAP (SAIC 2011a).

- **Background screening**: The maximum detected concentrations (MDC) of inorganic chemicals were compared to the RVAAP background concentrations, where established. If exceedances of background concentrations occurred, the respective inorganic chemicals were retained as SRCs. Several inorganic chemicals are screened against a background concentration of 0 mg/kg (e.g., cadmium, silver), as a value of 0 mg/kg was

denoted as background when the chemical was not detected in any of the samples collected during the background study.

- **Screening of essential human nutrients:** Chemicals that are considered essential nutrients (e.g., calcium, chloride, iodine, iron, magnesium, potassium, phosphorous, and sodium) are an integral part of the human food supply and are often added to foods as supplements. USEPA recommends these chemicals not be evaluated unless they are grossly elevated relative to background concentrations or would exhibit toxicity at the observed concentrations (USEPA 1989).

- **Frequency of detection/weight-of-evidence (WOE) screening**: Chemicals that were never detected in a given medium were eliminated as SRCs. For chemicals with at least 20 samples and a frequency of detection of less than 5%, a WOE approach was used to determine if the chemical is AOC-related. The WOE evaluated magnitude and location (clustering) of detected results and if the distribution of detected results indicated a potential source of the chemical. If the detected results for a chemical showed: (1) no clustering; (2) concentrations were not substantially elevated relative to the detection limit; and (3) the chemical did not have an evident source, the results were considered spurious, and the chemical was eliminated from further consideration. Frequency-of-detection/WOE screening was applied to the CC RVAAP-71 data set by matrix, subsurface soil, frequency of detection in relation to the underground gasoline pipeline source, and concentrations of the chemical. This screening was applied to all organic and inorganic chemicals, with the exception of explosives and propellants; all detected explosives and propellants were considered as SRCs regardless of frequency of detection.

5.1.3 Data Presentation

Data screening results for SRCs identified at CC RVAAP-71 are presented in Table 5-1. These identified SRCs were further evaluated in the screening process. Analytical results for SRCs are presented in Section 5.2. The analytical results for SRCs are also presented in data summary tables (Table 5-2 and Table 5-3) as well as in figures (Figure 5-2, Figure 5-3, and Figure 5-4). To provide an indication of the presence of contamination, concentrations of SRCs that exceed the most stringent FWCUG [target risk (TR) = 10^{-6} and/or hazard quotient (HQ) = 0.1], based on the National Guard Trainee (NGT) or Resident Receptor, are highlighted in these figures. The complete laboratory analytical data packages are included in Appendix E as well as laboratory analytical result tables with final qualifiers.

5.1.4 Data Use Evaluation

The subsurface soil sample data were evaluated as part of this SI and used to perform the AOC-specific screens and data evaluations. No previous data were used in the evaluation process. Groundwater is currently being investigated under a separate program under RVAAP-66 Facility-Wide Groundwater and was, therefore, not sampled as part of this SI.

Analytical results of the soil sampling conducted as part of this SI were initially used to determine whether the chemical was a SRC and was evaluated performing the AOC-specific screen. The reported results were used to (1) compare the reported concentrations to the background level (where established), (2) determine the frequency of detection, and (3) determine whether the chemical was an essential nutrient for each media (i.e., surface and subsurface soil). Table 5-1 presents a summary of statistics and determination of SRCs in subsurface soils at CC RVAAP-71. All of the analytical data collected during this SI were also compared to the media-specific (soil) and depth interval-specific (subsurface [greater than 1 ft bgs]) FWCUGs as well as to background levels, if established, for subsurface soils.

The FWCUGs used for data comparison are the NGT and the Resident Receptor. If no FWCUG value has been established for either receptor, detected concentrations were compared to USEPA Regional Screening Levels (RSL) (USEPA 2013). Analytical results were compared to the media-specific (soil) and depth interval-specific (subsurface) FWCUGs at the 10^{-6} cancer risk level. The cancer risk level is the excess risk of cancer from exposure to a chemical. Results were also compared to the non-carcinogenic risk HQ using the 0.1 risk value as specified in the FWSAP (SAIC 2011a).

Detected metals were considered COPCs in the event that the reported concentrations exceeded established background values as well as the FWCUG. Inorganic analytical data are presented in Table 5-3. Metals concentrations exceeding background values are presented in Figure 5-4. Concentrations equal or greater than the FWCUG are highlighted in the tables and figures. If a FWCUG has not been established, the concentration was compared to USEPA RSLs (USEPA 2013). For organic compounds, the detected concentrations were compared to the FWCUGs. The USEPA Residential and Industrial RSLs were used for comparison when there are no FWCUGs established for either the Resident Receptor or the NGT receptor. Organic analytical results are presented in Table 5-2. Organic compounds exceeding a FWCUG are highlighted in Figures 5-2 and 5-3.

Once the analytical results were compared to the FWCUGs the chemicals were considered for further screening as COPCs when the following apply:

- The chemical is site-related

- The concentration of the chemical exceeds the FWCUG (equal to 10^{-6} and/or HQ = 0.1) for either the National Guard Trainee or Resident Receptor or EPA RSL, where applicable.

5.2 HORIZONTAL SUBSURFACE SOIL ISM ANALYTICAL RESULTS

Data from CC RVAAP-71 subsurface soil samples were screened per spatial aggregate to identify SRCs representing current conditions at the site. The SRC screening process for the subsurface soil was performed for two horizontal subsurface soil ISM samples during the SI activities at DU01; one from the 1 – 4 ft bgs interval and one from the 4 – 7 ft bgs interval. A total of fourteen soil borings were advanced at DU01 to obtain the horizontal subsurface soil ISM samples. These samples were analyzed for VOCs, MTBE, SVOCs, TPH DRO, TPH GRO, and lead. Table 5-1 presents a summary of statistics and determination of SRCs in subsurface soils at CC RVAAP-71.

As summarized in Table 5-1, organic SRCs have been identified in the subsurface soils at CC RVAAP-71. Described below are the SRCs identified in the horizontal subsurface soil ISM samples.

- Seventeen SVOC PAH compounds, have been identified as SRCs as these chemicals were detected in both horizontal subsurface soil ISM samples and no background criteria have been established for these chemicals.

- TPH DRO components have been identified as SRCs as these chemicals were detected in both horizontal subsurface soil ISM samples and no background criteria have been established for these chemicals.

5.2.1 Volatile Organic Compounds

Both horizontal subsurface soil ISM samples from DU01 were submitted for VOC analysis. No VOC chemicals or gasoline-related chemicals, such as MTBE, benzene, toluene, ethylbenzene, and xylenes, were detected in either of the horizontal subsurface soil ISM samples.

5.2.2 Semi-Volatile Organic Compounds

Both horizontal subsurface soil ISM samples from DU01 were submitted for SVOC analysis. Analytical results were compared to established FWCUGs or RSLs, when applicable. SVOCs were not detected at concentrations exceeding their respective FWCUGs or RSLs in either of the horizontal subsurface soil ISM samples.

5.2.3 Lead

Both horizontal subsurface soil ISM samples from DU01 were submitted for lead analysis. Analytical results were compared to the established background criterion of 19.1 milligrams per kilogram (mg/kg). Lead was reported in the horizontal ISM samples at 10.6 mg/kg in the 1 to 4 ft bgs interval and 10.3 mg/kg in the 4 to 7 ft bgs interval sample; however, these concentrations are below the background criteria and the Residential RSL for lead. There is no established FWCUG for lead (Table 5-3).

5.2.4 TPH DRO/GRO

Both horizontal subsurface soil ISM samples from DU01 were submitted for TPH DRO/GRO analysis. The analytical results were compared to the established State of Ohio EPA BUSTR criteria as there are no established FWCUGs for these compounds. The original TPH GRO results (C6-C10) and the re-quantitated TPH GRO results (C6-C12) were both non-detect in either of the horizontal subsurface soil ISM samples. The original TPH DRO results (C10-C28) were reported at estimated concentrations of 6.3 J mg/kg to 9.5 J mg/kg in the 1 to 4 ft bgs and 4 to 7 ft bgs intervals in the horizontal ISM samples, respectively. The re-extracted and re-analyzed TPH DRO results for C10-C20 where 5.2 J mg/kg and non-detect for the 1 to 4 ft bgs and 4 to 7 ft bgs intervals, respectively. The Extended Range Organics C20-C34 was non-detect in both horizontal ISM samples. The reported TPH DRO hydrocarbon results are orders of magnitude below the BUSTR criteria (Table 5-2).

5.3 VERTICAL SUBSURFACE SOIL ISM ANALYTICAL RESULTS

Data from CC RVAAP-71 subsurface soil samples were screened to identify SRCs representing current conditions at the site. The SRC screening process for the subsurface soil was performed for fourteen vertical subsurface soil ISM samples and two field duplicate samples (at soil borings SB9 and SB12) during the SI activities at DU01. A total of fourteen soil borings (1 – 7 ft bgs) were advanced at DU01 to obtain the vertical subsurface soil ISM samples. These samples were analyzed for VOCs, MTBE, SVOCs, TPH DRO, TPH GRO, and lead. Table 5-1 presents a summary and determination of SRCs in subsurface soils at CC RVAAP-71.

As summarized in Table 5-1, several organic and inorganic SRCs have been identified in the vertical subsurface soils at CC RVAAP-71. Described below are the SRCs identified in the vertical subsurface soil ISM samples.

- One VOC (1,2-dichloroethane) was identified as an SRC, as this chemical was detected in one of the 19 vertical subsurface soil ISM samples and no background criterion has been established for this chemical.

- Seventeen PAH compounds have been identified as SRCs, as these chemicals were detected in the vertical subsurface soil ISM samples and no background criteria have been established for these chemicals.

- Both TPH DRO and TPH GRO chemicals have been identified as SRCs as these chemicals were detected in vertical subsurface soil ISM samples and no background criteria have been established for these chemicals.

- One pesticide (beta-BHC [beta-hexachlorocyclohexane]) was identified as an SRC as this chemical was detected in one vertical subsurface soil ISM sample and no background criteria has been established for this chemical. Pesticides are not, however, considered site-related chemicals associated with the reported gasoline release.

- Three metals, aluminum, antimony and cadmium, were identified as SRCs as they were detected in vertical subsurface soil ISM samples at concentrations greater than the background criteria.

5.3.1 Volatile Organic Compounds and MTBE

All vertical subsurface soil ISM samples from DU01 were submitted for VOC and MTBE analysis. MTBE was not detected in any of the vertical subsurface soil ISM samples as expected since MTBE was not used as an oxygenate to raise the octane number in gasoline produced during the 1960's. One VOC (1,2-dichloroethane) was detected in the vertical subsurface soil ISM sample from soil boring SB6 at an estimated concentration of 4.8 J micrograms per kilogram (µg/kg). A FWCUG has not been established for 1,2-dichloroethane, therefore, the analytical result was compared to the USEPA Residential RSL (USEPA 2013). The reported concentration of 1,2-dichloroethane is below the Residential RSL of 430 µg/kg (Table 5-2).

5.3.2 Semi-Volatile Organic Compounds

All vertical subsurface soil ISM samples from DU01 were submitted for SVOC analysis. Analytical results were compared to established FWCUGs or RSLs, when applicable. The results indicate that PAH compounds were detected in the vertical subsurface soil ISM samples. Only one SVOC PAH (benzo(a)pyrene) was detected at soil boring SB14 at 23.0 µg/kg which exceeds the established Resident Receptor FWCUG of 22.0 µg/kg. Literature studies indicate the concentration reported at CC RVAAP-71 of benzo(a)pyrene is indicative of a release from common anthropogenic sources such as road dust, vehicle exhaust, tire wear particles, pavement, and slag used as fill (ATSDR 1995; Bradley et. al. 1994; IEPA 2005; MassDEP 2002; Teaf et. al. 2008). No PAHs or PAH-containing materials were used at CC RVAAP-71 (gasoline release) and no burning was conducted at CC RVAAP-71. There are no CERCLA-release related

sources of PAHs at CC RVAAP-71. Various lines of evidence listed below were used to support that benzo(a)pyrene is not related to the 1964 gasoline release at CC RVAAP-71 AOC:

(1) Benzo(a)pyrene was detected in 17 of the 19 subsurface soil samples collected at CC RVAAP-71, which reported concentrations ranging from 0.29 to 23 µg/kg, and only 1 of 19 samples had a reported exceedance of the Resident Receptor FWCUG.

(2) The soil sampling location (SB14) is within 3 ft of the former asphalt pavement.

(3) The detected concentrations of benzo(a)pyrene in the horizontal ISM subsurface soil samples decrease in concentration with sampling depth, ranging from 13 µg/kg (1 - 4 ft) to 0.72 J µg/kg (4 - 7 ft). This finding suggests a probable surface source for the chemical.

(4) The detected concentration of benzo(a)pyrene at SB14 is much less than the Bureau of Underground Storage Tank Regulations (BUSTR) Class 1 Soil Action Level of 1.1 mg/kg (1,100 µg/kg), which is used for gasoline-related contamination.

(5) No other gasoline constituents, such as benzene, toluene, ethylbenzene, and total xylenes (BTEX) or TPH GRO, were reported in the subsurface soil at SB14.

5.3.2.1. Lines of Evidence for the Benzo(a)pyrene Concentration Reported in Soil

Various lines of evidence were used to support that the benzo(a)pyrene reported at one sample location is not related to the gasoline spill, which occurred in May 1964 from a subsurface gasoline pipeline where approximately 20 barrels of gasoline were released to the subsurface.

(1) Benzo(a)pyrene was detected in 17 of the 19 subsurface soil samples collected at CC RVAAP-71, which reported concentrations ranging from 0.29 to 23 µg/kg, and only 1 of 19 samples had a reported exceedance of the Resident Receptor FWCUG.

(2) The soil boring (SB14) where the highest concentration of benzo(a)pyrene was reported at CC RVAAP-71 at 23 µg/kg was located within 3 ft of a former asphalt-paved road (Figure 5-3).

(3) The vertical distribution of benzo(a)pyrene concentrations reported within the subsurface soil at soil boring SB14 range from the highest value reported in the horizontal ISM 1 - 4 ft bgs (13 µg/kg) sample to lower concentrations reported in the deeper intervals from the 4 - 7 ft (0.72 J µg/kg) and 7 - 13 ft (0.40 µg/kg) bgs. This distribution of concentrations is shown in Figures 5-2 and 5-3. This finding suggests a probable surface source for the chemical.

(4) The reported concentration of benzo(a)pyrene in soil is more indicative of PAHs found in asphalt mixes that have average concentrations ranging from 10.2 to 20.7 mg/kg (Fernandes et al. 2009).

(5) Benzo(a)pyrene is not a major constituent of gasoline. Literature values of benzo(a)pyrene concentrations in gasoline range from 0 to 6.0 µg/L (Chen 2001); therefore, the gasoline spill is unlikely to be a source of this chemical at CC RVAAP-71.

(6) The concentrations of benzo(a)pyrene were all reported at concentrations below the BUSTR Class I Soil Action Level of 1,100 µg/kg in all subsurface samples at this AOC.

(7) No BTEX or TPH-GRO compounds were reported in the subsurface soil samples collected at SB14. Gasoline range organic (GRO) compounds were reported at one sample location (SB6) at a concentration of 19 mg/kg, which is less than the BUSTR Class 1 Soil Action Level of 1,000 mg/kg. Soil boring SB6 is approximately 70 ft west of soil boring SB14.

(8) Benzo(a)pyrene concentrations reported in the subsurface soil at SB6 were also less than BUSTR Soil Action Levels and the Resident Receptor FWCUGs.

These lines of evidence support that no petroleum-related chemicals associated with the historical gasoline release were identified in the subsurface soils at this AOC.

The lines of evidence presented above indicate that benzo(a)pyrene reported at a concentration of 23 µg/kg at soil boring SB14 collected from 1 to 7 ft bgs is not related to the 1964 gasoline release. Literature studies indicate the concentration reported at CC RVAAP-71 of benzo(a)pyrene is indicative of a release from common anthropogenic sources such as road dust, vehicle exhaust, tire wear particles, pavement, and slag used as fill (ATSDR 1995; Bradley et. al. 1994; IEPA 2005; MassDEP 2002; Teaf et. al. 2008). There are no CERCLA release-related sources of benzo(a)pyrene at CC RVAAP-71. The benzo(a)pyrene reported at CC RVAAP-71 is indicative of release from common anthropogenic sources such as road dust, vehicle exhaust, tire wear particles, pavement, and/or slag used as fill material at the AOC.

5.3.3 Lead

All vertical subsurface soil ISM samples from DU01 were submitted for lead analysis. Analytical results were compared to the established background criterion of 19.1 mg/kg. Lead was not detected at concentrations exceeding the background criterion in any of the vertical subsurface soil ISM samples. The reported concentrations of lead were all below the Residential RSLs (Table 5-3).

5.3.4 TPH DRO/GRO

All vertical subsurface soil ISM samples from DU01 were submitted for TPH DRO/GRO analysis. The analytical results were compared to the State of Ohio EPA BUSTR criteria since there are no FWCUGs or RSLs for TPH DRO/GRO compounds.

In order to screen the DRO/GRO analytical results to the BUSTR criteria, the samples were further analyzed for DRO and GRO a second time in order to report the specific carbon chain ranges that match the BUSTR criteria, as shown in Table 5-2. The original TPH GRO hydrocarbon compounds (C6-C10) and the re-quantitated TPH GRO hydrocarbon compounds (C6-C12) were detected in one vertical subsurface soil ISM sample (SB6) at a concentration of 19.0 mg/kg for the carbon range C6-C12 and 8.3 mg/kg for carbon range C6-C10. Both detected concentrations of GRO are orders of magnitude below the BUSTR criteria of 1,000 mg/kg. GRO was not detected in any of the other subsurface soil samples collected at the CR site.

Estimated concentrations of TPH DRO (C10-C28) hydrocarbons were detected in vertical subsurface soil ISM samples. The reported estimated concentrations of TPH DRO ranged from 7.0 J mg/kg to 38.0 J mg/kg for the carbon range C10-C28. The re-extracted and re-analyzed TPH DRO results for the carbon range C10-C20 and the Extended Range Organics (ERO) (C20-C34), ranged between non-detect and 32 J mg/kg and are orders of magnitude less than the BUSTR criteria of 2,000 mg/kg (DRO) and 5,000 mg/kg (ERO), respectively.

Notably, the detection of GRO (19.0 mg/kg), the detection of the one VOC, 1,2-dichloroethane (4.8 J ug/kg), and the highest detection of DRO (38.0 J mg/kg) were reported in the vertical ISM sample collected from soil boring SB6 (1 - 7 ft interval). Soil boring SB6 is located to the west of the access road leading to the gate at Post No. 6. An inspection of the TPH GRO laboratory analysis chromatogram indicates that the GRO pattern is characteristic of a highly-weathered fuel which may likely be the remnants of the 1964 gasoline release.

5.3.5 RVAAP Full-Suite Sampling

Two vertical subsurface soil ISM samples from borings SB7 and SB11 were submitted for a RVAAP Full-Suite analysis which includes; VOCs, SVOCs, PCBs, Pesticides, Explosives, TPH GRO/DRO, propellants (nitroglycerine, nitroguanidine and nitrocellulose), and TAL metals.

- No VOCs, PCBs, explosives or propellant chemicals were detected in the RVAAP Full-Suite vertical subsurface soil ISM samples. Estimated concentrations of SVOCs were reported in both of the vertical ISM samples; however, the reported SVOC concentrations at soil borings SB7 and SB11 were orders of magnitude below the FWCUGs or RSLs (Table 5-3).

- One pesticide (beta-BHC [beta-hexachlorocyclohexane]) was reported at an estimated concentration of 1.7 J µg/kg in the ISM vertical subsurface sample collected from soil boring SB7. The reported concentration of beta-BHC (1.7 J µg/kg) is below the most stringent Resident Receptor FWCUG of 496 µg/kg. No other pesticides were detected at

concentrations exceeding their respective FWCUGs or RSLs in either of the vertical subsurface soil ISM samples submitted for RVAAP Full-Suite analysis.

One inorganic chemical (aluminum) was detected at an estimated concentration of 32,200 J mg/kg, which exceeds the background concentration of 19,500 mg/kg and the Resident Receptor and NGT FWCUGs of 7,380 mg/kg and 3,496 mg/kg, respectively. This elevated concentration of aluminum appears to be isolated to the SB11 boring location. This soil sample was collected within 2 ft of the rusted metal chain-link security fence, most likely coated with aluminum alloy used for corrosion protection. The various lines of evidence used to determine that the aluminum detection within this one sample is not related to the 1964 gasoline release at CC RVAAP-71 AOC include:

(1) The subsurface soil sample was collected from the subsurface soil within 2 ft of the very rusted metal security fence. This reported aluminum concentration (32,200 J mg/kg) is the highest reported aluminum concentration for all subsurface soil samples collected and analyzed at this AOC. For comparison, aluminum was analyzed in the subsurface soil collected from soil boring SB7 (1 – 7 ft interval) with a concentration of 11,900 J mg/kg, which is below the background value. Soil boring SB7 is within 40 ft of SB11, and the reported aluminum value is expected to be more representative of the site conditions.

(2) Aluminum is not a component of gasoline and, therefore, would not be associated with the 1964 gasoline release to the environment at this AOC.

(3) There is no indication that CC RVAAP-71 AOC was used for the storage of metal debris or other minerals containing aluminum, and this AOC is not a burning ground. The only reported release at this AOC was from the subsurface gasoline pipeline leak in 1964.

The concentration of aluminum reported in the one sample at SB11 is expected to be from the deterioration of the rusted metal security fence rather than the historical gasoline spill at CC RVAAP-71. Aluminum is not considered to be related to the 1964 gasoline release from the pipeline or the historical practices at CC RVAAP-71, and was not identified as a COPC.

No other TAL metals were detected at concentrations exceeding their respective FWCUGs or RSLs in either of the vertical subsurface soil ISM samples.

5.4 DEEP SUBSURFACE SOIL SAMPLE ANALYTICAL RESULTS

One deep subsurface soil sample was collected from 7 - 13 ft bgs at soil boring SB9 at DU01. The sample was analyzed for VOCs, MTBE, SVOCs, TPH DRO/GRO, and lead. Table 5-1 presents a summary of statistics and determination of SRCs in subsurface soils at CC RVAAP-71.

As summarized in Table 5-1, several organic and inorganic SRCs have been identified in the subsurface soils at CC RVAAP-71. Described below are the SRCs identified in the deep subsurface soil boring (DSB) sample.

- Twelve PAH compounds, have been identified as SRCs as these chemicals were detected in the DSB sample and no background criteria have been established for these chemicals.

- Three TPH DRO chemicals (C10-C28, C10-C20 and C20-C34 DRO hydrocarbon ranges) have been identified as SRCs as these chemicals were detected in the DSB sample and no background criteria have been established for these chemicals.

Table 5-2 and Table 5-3 provide summaries of analytical results for all detected chemicals in the CC RVAAP-71 subsurface soil samples. Complete copies of all the laboratory analytical data packages and laboratory analytical results summary tables are presented in Appendix E.

5.4.1 Volatile Organic Compounds

The DSB sample from DU01 was submitted for VOC analysis. No VOCs were detected in the DSB sample.

5.4.2 Semi-Volatile Organic Compounds

The DSB sample from DU01 was submitted for SVOC analysis. Analytical results were compared to established FWCUGs or RSLs, when applicable. SVOCs were not detected at concentrations exceeding their respective FWCUGs or RSLs in the DSB sample.

5.4.3 Lead

The DSB sample from DU01 was submitted for lead analysis. Analytical results were compared to the established background criterion. Lead was not detected at concentrations exceeding the background criterion in the DSB sample (Table 5-3).

5.4.4 TPH DRO/GRO

The DSB sample from soil boring SB9 collected at DU01 was submitted for TPH DRO/GRO analysis. The analytical results were compared to established BUSTR criteria as there are no established FWCUGs for these compounds. No TPH GRO was reported in the DSB sample collected from soil boring SB9 in either the original (C6-C10) analysis or the re-quantitated (C6-C12) results. The original TPH DRO results (C10-C28) and re-extracted, re-analyzed results

(C10-C20) reported in the DSB sample were both estimated concentrations of 28 J mg/kg. The Extended Range Organics (C20-C34) were reported at an estimated concentration of 14 J mg/kg all of which are orders of magnitude below the BUSTR criteria of 2,000 and 5,000 mg/kg, respectively (Table 5-3).

5.5 INVESTIGATION-DERIVED WASTE ANALYTICAL RESULTS

The characterized IDW streams generated during the SI, results of laboratory analyses, IDW classifications, and recommendation for disposal are summarized in a letter report included in Appendix G.

This page intentionally left blank.

Table 5-1: SRC Screening Summary for Subsurface Soil Samples

Method/Chemical	CAS Number	Freq of Detects	Min Detect	Max Detect	Average Result [(a)]	BKG Criteria[(b)]	SRC (Yes/No)	SRC Justification
Volatile Organic Compounds (µg/kg)								
1,1,1-Trichloroethane	71-55-6	0/19	None	None	None	None	No	Not Detected
1,1,2,2-Tetrachloroethane	79-34-5	0/19	None	None	None	None	No	Not Detected
1,1,2-Trichloroethane	79-00-5	0/19	None	None	None	None	No	Not Detected
1,1-Dichloroethane	75-34-3	0/19	None	None	None	None	No	Not Detected
1,1-Dichloroethene	75-35-4	0/19	None	None	None	None	No	Not Detected
1,2-Dibromoethane (EDB)	106-93-4	0/19	None	None	None	None	No	Not Detected
1,2-Dichloroethane	**107-06-2**	**1/19**	**4.8**	**4.8**	**4.8**	**None**	**Yes**	**Detected Organic**
1,2-Dichloroethene	156-59-2	0/19	None	None	None	None	No	Not Detected
1,2-Dichloropropane	78-87-5	0/19	None	None	None	None	No	Not Detected
2-Butanone (MEK)	78-93-3	0/19	None	None	None	None	No	Not Detected
2-Hexanone	591-78-6	0/19	None	None	None	None	No	Not Detected
4-Methyl-2-pentanone (MIBK)	108-10-1	0/19	None	None	None	None	No	Not Detected
Acetone	67-64-1	0/19	None	None	None	None	No	Not Detected
Benzene	71-43-2	0/19	None	None	None	None	No	Not Detected
Bromochloromethane	74-97-5	0/19	None	None	None	None	No	Not Detected
Bromodichloromethane	75-27-4	0/19	None	None	None	None	No	Not Detected
Bromoform	75-25-2	0/19	None	None	None	None	No	Not Detected
Bromomethane	74-83-9	0/19	None	None	None	None	No	Not Detected
Carbon Disulfide	75-15-0	0/19	None	None	None	None	No	Not Detected
Carbon Tetrachloride	56-23-5	0/19	None	None	None	None	No	Not Detected
Chlorobenzene	108-90-7	0/19	None	None	None	None	No	Not Detected
Chloroethane	75-00-3	0/19	None	None	None	None	No	Not Detected
Chloroform	67-66-3	0/19	None	None	None	None	No	Not Detected
Chloromethane	74-87-3	0/19	None	None	None	None	No	Not Detected
cis-1,2-Dichloroethylene	156-59-2	0/19	None	None	None	None	No	Not Detected
cis-1,3-Dichloropropene	542-75-6	0/19	None	None	None	None	No	Not Detected
Dibromochloromethane	124-48-1	0/19	None	None	None	None	No	Not Detected

Table 5-1: SRC Screening Summary for Subsurface Soil Samples (Continued)

Method/Chemical	CAS Number	Freq of Detects	Min Detect	Max Detect	Average Result [a]	BKG Criteria[b]	SRC (Yes/No)	SRC Justification
Volatile Organic Compounds (µg/kg)								
Ethylbenzene	100-41-4	0/19	None	None	None	None	No	Not Detected
m,p-Xylene	106-42-3	0/19	None	None	None	None	No	Not Detected
Methylene Chloride	75-09-2	0/19	None	None	None	None	No	Not Detected
o-Xylene	95-47-6	0/19	None	None	None	None	No	Not Detected
Styrene	100-42-5	0/19	None	None	None	None	No	Not Detected
tert-Butyl Methyl Ether (MTBE)	1634-04-4	0/19	None	None	None	None	No	Not Detected
Tetrachloroethene (PCE)	127-18-4	0/19	None	None	None	None	No	Not Detected
Toluene	108-88-3	0/19	None	None	None	None	No	Not Detected
trans-1,2-Dichloroethene	156-60-5	0/19	None	None	None	None	No	Not Detected
trans-1,3-Dichloropropene	10061-02-6	0/19	None	None	None	None	No	Not Detected
Trichloroethene (TCE)	79-01-6	0/19	None	None	None	None	No	Not Detected
Vinyl Chloride	75-01-4	0/19	None	None	None	None	No	Not Detected
Xylenes, Total	1330-20-7	0/19	None	None	None	None	No	Not Detected
Semi-Volatile Organic Compounds (µg/kg)								
2-Methylnaphthalene	**95-48-7**	**19/19**	**1.8**	**14**	**7.90**	**None**	**Yes**	**Detected Organic**
Acenaphthene	**83-32-9**	**12/19**	**0.52**	**4**	**2.26**	**None**	**Yes**	**Detected Organic**
Acenaphthylene	**208-96-8**	**3/19**	**1.6**	**4.8**	**3.20**	**None**	**Yes**	**Detected Organic**
Anthracene	**120-12-7**	**4/19**	**0.44**	**5.9**	**3.17**	**None**	**Yes**	**Detected Organic**
Benzo(a)anthracene	**56-55-3**	**2/19**	**20**	**33**	**26.50**	**None**	**Yes**	**Detected Organic**
Benzo(a)pyrene	**50-32-8**	**17/19**	**0.29**	**23**	**11.65**	**None**	**Yes**	**Detected Organic**
Benzo(b)fluoranthene	**205-99-2**	**19/19**	**1.7**	**41**	**21.35**	**None**	**Yes**	**Detected Organic**
Benzo(g,h,i)perylene	**191-24-2**	**19/19**	**0.83**	**20**	**10.42**	**None**	**Yes**	**Detected Organic**
Benzo(k)fluoranthene	**207-08-9**	**15/19**	**0.38**	**11**	**5.69**	**None**	**Yes**	**Detected Organic**
Chrysene	**218-01-9**	**19/19**	**1.5**	**23**	**12.25**	**None**	**Yes**	**Detected Organic**
Dibenz(a,h)anthracene	**53-70-3**	**8/19**	**0.36**	**5.4**	**2.88**	**None**	**Yes**	**Detected Organic**
Fluoranthene	**206-44-0**	**19/19**	**0.66**	**41**	**20.83**	**None**	**Yes**	**Detected Organic**
Fluorene	**86-73-7**	**19/19**	**0.63**	**6.3**	**3.47**	**None**	**Yes**	**Detected Organic**

Table 5-1: SRC Screening Summary for Subsurface Soil Samples (Continued)

Method/Chemical	CAS Number	Freq of Detects	Min Detect	Max Detect	Average Result [a]	BKG Criteria[b]	SRC (Yes/No)	SRC Justification
Semi-Volatile Organic Compounds (µg/kg)								
Indeno(1,2,3-c,d)Pyrene	**193-39-5**	**19/19**	**0.38**	**18**	**9.19**	**None**	**Yes**	**Detected Organic**
Naphthalene	**91-20-3**	**15/19**	**1.7**	**9.7**	**5.70**	**None**	**Yes**	**Detected Organic**
Phenanthrene	**85-01-8**	**6/19**	**6.4**	**40**	**23.20**	**None**	**Yes**	**Detected Organic**
Pyrene	**129-00-0**	**19/19**	**0.67**	**34**	**17.34**	**None**	**Yes**	**Detected Organic**
2,4-Dimethylphenol	105-67-9	0/19	None	None	None	None	No	Not Detected
2,4-Dichlorophenol	120-83-2	0/19	None	None	None	None	No	Not Detected
2,4,5-Trichlorophenol	95-95-4	0/19	None	None	None	None	No	Not Detected
2,4,6-Trichlorophenol	88-06-2	0/19	None	None	None	None	No	Not Detected
3,3'-Dichlorobenzidine	91-94-1	0/19	None	None	None	None	No	Not Detected
Phenol	108-95-2	0/19	None	None	None	None	No	Not Detected
1,4-Dichlorobenzene	106-46-7	0/19	None	None	None	None	No	Not Detected
1,3-Dichlorobenzene	541-73-1	0/19	None	None	None	None	No	Not Detected
1,2,4-Trichlorobenzene	120-82-1	0/19	None	None	None	None	No	Not Detected
3-Nitroaniline	99-09-2	0/19	None	None	None	None	No	Not Detected
2-Chloronaphthalene	91-58-7	0/19	None	None	None	None	No	Not Detected
Bis(2-chloroethoxy)methane	111-91-1	0/19	None	None	None	None	No	Not Detected
2-Nitroaniline	88-74-4	0/19	None	None	None	None	No	Not Detected
1,2-Dichlorobenzene	95-50-1	0/19	None	None	None	None	No	Not Detected
2,4-Dinitrotoluene	121-14-2	0/19	None	None	None	None	No	Not Detected
2,6-Dinitrotoluene	606-20-2	0/19	None	None	None	None	No	Not Detected
Dibenzofuran	132-64-9	0/19	None	None	None	None	No	Not Detected
Pentachlorophenol	87-86-5	0/19	None	None	None	None	No	Not Detected
4-Bromophenyl phenyl ether	101-55-3	0/19	None	None	None	None	No	Not Detected
Bis(2-chloroethyl) ether	111-44-4	0/19	None	None	None	None	No	Not Detected
4-Chlorophenyl phenyl ether	7005-72-3	0/19	None	None	None	None	No	Not Detected
2,4-Dinitrophenol	51-28-5	0/19	None	None	None	None	No	Not Detected
2-Methyl-4,6-dinitrophenol	534-52-1	0/19	None	None	None	None	No	Not Detected

Table 5-1: SRC Screening Summary for Subsurface Soil Samples (Continued)

Method/Chemical	CAS Number	Freq of Detects	Min Detect	Max Detect	Average Result [(a)]	BKG Criteria[(b)]	SRC (Yes/No)	SRC Justification
Semi-Volatile Organic Compounds (µg/kg)								
Carbazole	86-74-8	0/19	None	None	None	None	No	Not Detected
Hexachlorobenzene	118-74-1	0/19	None	None	None	None	No	Not Detected
2-Nitrophenol	88-75-5	0/19	None	None	None	None	No	Not Detected
Benzoic acid	65-85-0	0/19	None	None	None	None	No	Not Detected
4-Nitroaniline	100-01-6	0/19	None	None	None	None	No	Not Detected
Bis(2-chloroisopropyl) ether	108-60-1	0/19	None	None	None	None	No	Not Detected
Hexachloroethane	67-72-1	0/19	None	None	None	None	No	Not Detected
2-Chlorophenol	95-57-8	0/19	None	None	None	None	No	Not Detected
4-Chloro-3-methylphenol	59-50-7	0/19	None	None	None	None	No	Not Detected
4-Chloroaniline	106-47-8	0/19	None	None	None	None	No	Not Detected
4-Nitrophenol	100-02-7	0/19	None	None	None	None	No	Not Detected
2-Methylphenol	95-48-7	0/19	None	None	None	None	No	Not Detected
N-Nitrosodiphenylamine	86-30-6/122-39-4	0/19	None	None	None	None	No	Not Detected
Isophorone	78-59-1	0/19	None	None	None	None	No	Not Detected
Hexachlorocyclopentadiene	77-47-4	0/19	None	None	None	None	No	Not Detected
Di-n-octyl phthalate	117-84-0	0/19	None	None	None	None	No	Not Detected
Nitrobenzene	98-95-3	0/19	None	None	None	None	No	Not Detected
Hexachlorobutadiene	87-68-3	0/19	None	None	None	None	No	Not Detected
Dimethyl phthalate	131-11-3	0/19	None	None	None	None	No	Not Detected
Diethyl phthalate	84-66-2	0/19	None	None	None	None	No	Not Detected
4-Methylphenol	1319-77-3	0/19	None	None	None	None	No	Not Detected
N-Nitroso-di-n-propylamine	621-64-7	0/19	None	None	None	None	No	Not Detected
Butylbenzyl phthalate	85-68-7	0/19	None	None	None	None	No	Not Detected
Benzyl alcohol	100-51-6	0/19	None	None	None	None	No	Not Detected
Di-n-butyl phthalate	84-74-2	0/19	None	None	None	None	No	Not Detected

Table 5-1: SRC Screening Summary for Subsurface Soil Samples (Continued)

Method/Chemical	CAS Number	Freq of Detects	Min Detect	Max Detect	Average Result [(a)]	BKG Criteria[(b)]	SRC (Yes/No)	SRC Justification
Pesticides (µg/kg)								
Aldrin	309-00-2	0/2	None	None	None	None	No	Not Detected
alpha-BHC (alpha-Hexachlorocyclohexane)	319-84-6	0/2	None	None	None	None	No	Not Detected
alpha-Chlordane	5103-71-9	0/2	None	None	None	None	No	Not Detected
alpha-Endosulfan	959-98-8	0/2	None	None	None	None	No	Not Detected
beta-BHC (beta-Hexachlorocyclohexane)	**319-85-7**	**1/2**	**1.7**	**1.7**	**1.70**	**None**	**Yes**	**Detected Organic**
beta-Endosulfan	33213-65-9	0/2	None	None	None	None	No	Not Detected
delta-BHC (delta-Hexachlorocyclohexane)	75-99-0	0/2	None	None	None	None	No	Not Detected
Dieldrin	60-57-1	0/2	None	None	None	None	No	Not Detected
Endosulfan Sulfate	1031-07-8	0/2	None	None	None	None	No	Not Detected
Endrin	72-20-8	0/2	None	None	None	None	No	Not Detected
Endrin Aldehyde	7421-93-4	0/2	None	None	None	None	No	Not Detected
Endrin Ketone	53494-70-5	0/2	None	None	None	None	No	Not Detected
gamma-BHC (Lindane)	58-89-9	0/2	None	None	None	None	No	Not Detected
gamma-Chlordane	5566-34-7	0/2	None	None	None	None	No	Not Detected
Heptachlor	76-44-8	0/2	None	None	None	None	No	Not Detected
Heptachlor Epoxide	1024-57-3	0/2	None	None	None	None	No	Not Detected
Methoxychlor	72-43-5	0/2	None	None	None	None	No	Not Detected
p,p'-DDD	72-54-8	0/2	None	None	None	None	No	Not Detected
p,p'-DDE	72-55-9	0/2	None	None	None	None	No	Not Detected
p,p'-DDT	50-29-3	0/2	None	None	None	None	No	Not Detected
Toxaphene	8001-35-2	0/2	None	None	None	None	No	Not Detected
PCBs (µg/kg)								
PCB-1016 (Arochlor 1016)	12674-11-2	0/2	None	None	None	None	No	Not Detected
PCB-1221 (Arochlor 1221)	11104-28-2	0/2	None	None	None	None	No	Not Detected
PCB-1232 (Arochlor 1232)	11141-16-5	0/2	None	None	None	None	No	Not Detected

Table 5-1: SRC Screening Summary for Subsurface Soil Samples (Continued)

Method/Chemical	CAS Number	Freq of Detects	Min Detect	Max Detect	Average Result [a]	BKG Criteria[b]	SRC (Yes/No)	SRC Justification
PCBs (µg/kg)								
PCB-1242 (Arochlor 1242)	53469-21-9	0/2	None	None	None	None	No	Not Detected
PCB-1248 (Arochlor 1248)	12672-29-6	0/2	None	None	None	None	No	Not Detected
PCB-1254 (Arochlor 1254)	11097-69-1	0/2	None	None	None	None	No	Not Detected
PCB-1260 (Arochlor 1260)	11096-82-5	0/2	None	None	None	None	No	Not Detected
PCB-1262 (Arochlor 1262)	37324-23-5	0/2	None	None	None	None	No	Not Detected
PCB-1268 (Arochlor 1268)	11100-14-4	0/2	None	None	None	None	No	Not Detected
Explosives (mg/kg)								
1,3,5-Trinitrobenzene	99-35-4	0/2	None	None	None	None	No	Not Detected
1,3-Dinitrobenzene	99-65-0	0/2	None	None	None	None	No	Not Detected
2,4,6-Trinitrotoluene	118-96-7	0/2	None	None	None	None	No	Not Detected
2,4-Dinitrotoluene	121-14-2	0/2	None	None	None	None	No	Not Detected
2,6-Dinitrotoluene	606-20-2	0/2	None	None	None	None	No	Not Detected
2-Amino-4,6-dinitrotoluene	35572-78-2	0/2	None	None	None	None	No	Not Detected
2-Nitrotoluene	99-08-1	0/2	None	None	None	None	No	Not Detected
3,5-Dinitroaniline	618-87-1	0/2	None	None	None	None	No	Not Detected
3-Nitrotoluene	88-72-2	0/2	None	None	None	None	No	Not Detected
4-Amino-2,6-Dinitrotoluene	19406-51-0	0/2	None	None	None	None	No	Not Detected
4-Nitrotoluene	99-99-0	0/2	None	None	None	None	No	Not Detected
Hexahydro-1,3,5-Trinitro-1,3,5-Triazine (RDX)	121-82-4	0/2	None	None	None	None	No	Not Detected
Nitrobenzene	98-95-3	0/2	None	None	None	None	No	Not Detected
Octahydro-1,3,5,7-Tetranitro-1,3,5,7-Tetrazocine (HMX)	2691-41-0	0/2	None	None	None	None	No	Not Detected
Pentaerythritol Tetranitrate	78-11-5	0/2	None	None	None	None	No	Not Detected
Tetryl	479-45-8	0/2	None	None	None	None	No	Not Detected

Table 5-1: SRC Screening Summary for Subsurface Soil Samples (Continued)

Method/Chemical	CAS Number	Freq of Detects	Min Detect	Max Detect	Average Result [a]	BKG Criteria[b]	SRC (Yes/No)	SRC Justification
Propellants (mg/kg)								
Nitrocellulose	9004-70-0	0/2	None	None	None	None	No	Not Detected
Nitroglycerin	55-63-0	0/2	None	None	None	None	No	Not Detected
Nitroguanidine	556-88-7	0/2	None	None	None	None	No	Not Detected
Gasoline Range Petroleum Hydrocarbons (mg/kg)								
C6-C10 Gasoline Range Organics	**NA**	**1/19**	**8.3**	**8.3**	**8.30**	**None**	**Yes**	**Detected Organic**
C6-C12 Gasoline Range Organics	**NA**	**1/19**	**19**	**19**	**19.00**	**None**	**Yes**	**Detected Organic**
Diesel Range Petroleum Hydrocarbons (mg/kg)								
C10-C28 Diesel Range Organics	**NA**	**19/19**	**6.3**	**38**	**22.15**	**None**	**Yes**	**Detected Organic**
C10-C20 Diesel Range Organics	**NA**	**13/19**	**5.2**	**32**	**18.60**	**None**	**Yes**	**Detected Organic**
C20-C34 Extended Range Organics	**NA**	**4/19**	**7.1**	**14**	**10.55**	**None**	**Yes**	**Detected Organic**
Metals (mg/kg)								
Aluminum	**7429-90-5**	**2/2**	**11,900**	**32,200**	**22050**	**19,500**	**Yes**	**Above Background**
Antimony	**7440-36-0**	**2/2**	**1.2**	**1.4**	**1.3**	**0.96**	**Yes**	**Above Background**
Arsenic	7440-38-2	2/2	7.3	13.7	10.5	19.8	No	Below Background
Barium	7440-39-3	2/2	59.1	103	81.05	124	No	Below Background
Beryllium	7440-41-7	2/2	0.48	0.65	0.565	*0.88*	No	Below Background
Cadmium	**7440-43-9**	**2/2**	**0.66**	**2.4**	**1.53**	**0**	**Yes**	**Above Background**
Calcium**	7440-70-2	2/2	20,100	32,200	26,150	*35,500*	No	Essential Nutrient
Chromium	7440-47-3	2/2	14.6	18.4	16.5	27.2	No	Below Background
Cobalt	7440-48-4	2/2	9.5	11.5	10.5	23.2	No	Below Background
Copper	7440-50-8	2/2	18.4	19.9	19.15	32.3	No	Below Background
Iron**	7439-89-6	2/2	18,500	25,600	22,050	35,200	No	Essential Nutrient
Lead	7439-92-1	19/19	7.4	17.3	12.35	*19.1*	No	Below Background
Magnesium**	7439-95-4	2/2	6,640	7,220	6,930	*8,790*	No	Essential Nutrient
Manganese	7439-96-5	2/2	269	447	358	3,030	No	Below Background
Mercury	7439-97-6	2/2	0.0094	0.022	0.0157	0.044	No	Below Background

Table 5-1: SRC Screening Summary for Subsurface Soil Samples (Continued)

Method/Chemical	CAS Number	Freq of Detects	Min Detect	Max Detect	Average Result [a]	BKG Criteria[b]	SRC (Yes/No)	SRC Justification
Metals (mg/kg)								
Nickel	7440-02-0	2/2	23.1	32.9	28	60.7	No	Below Background
Potassium**	7440-09-7	2/2	1,350	1,640	1,495	*3,350*	No	Essential Nutrient
Selenium	7782-49-2	0/2	None	None	None	None	No	Not Detected
Silver	7440-22-4	0/2	None	None	None	None	No	Not Detected
Thallium	7440-28-0	0/2	None	None	None	None	No	Not Detected
Sodium**	7440-23-5	2/2	101	102	101.5	*145*	No	Essential Nutrient
Vanadium	7440-62-2	2/2	15.6	18.9	17.25	37.6	No	Below Background
Zinc	7440-66-6	2/2	42.8	60.6	51.7	93.3	No	Below Background

Notes:
(a) Average Result is the average of the Min Detect and the Max Detect.
(b) Background concentrations (*italicized*) published in the Final Phase II Remedial Investigation Report for Winklepeck Burning Grounds (USACE 2001).
0 = Indicates no Background has been established (value itself is not zero).
Min = Minimum
Bold indicates analyte identified as an SRC.
BKG = Background
Freq = Frequency
Max = Maximum
NA = Not Applicable
CAS = Chemical Abstract Service
SRC = Site-related chemical
mg/kg = milligrams per kilogram
FWCUG = Facility-Wide Cleanup Goal
µg/kg = micrograms per kilogram
ft bgs = feet below ground surface
** = metals are essential nutrients

Table 5-2: Organic Analytes Detected in Subsurface Soil Samples

Method/ Chemical	BKG	Facility-Wide Cleanup Goals			BUSTR	U.S. EPA RSL		Sample Type:	Primary	Primary	Primary	Primary
			Resident Receptor					Location ID:	71-B5PS-DU1-SB	71-B5PS-DU1-SB	71-B5PS-DU1-SB1	71-B5PS-DU1-SB2	71-B5PS-DU1-SB3
		National Guard Trainee	Resident Adult Farmer	Resident Child Farmer		Industrial	Residential	Field Sample ID:	071SB-0001M-0001-SO	071SB-0002M-0001-SO	071SB-0003M-0001-SO	071SB-0004M-0001-SO	071SB-0005M-0001-SO
								Lab Sample ID:	338286	338351	338353	338355	338357
								Sample Date:	08/13/2013	08/13/2013	08/13/2013	08/13/2013	08/13/2013
								Location Type:	Horizontal ISM	Horizontal ISM	Vertical ISM	Vertical ISM	Vertical ISM
								Sample Depth (ft):	1-4	4-7	1-7	1-7	1-7
Volatile Organic Compounds (µg/kg)													
1,2-Dichloroethane	None	None	None	None	NA	2,200	430		ND	ND	ND	ND	ND
Semi-Volatile Organic Compounds (µg/kg)													
2-Methylnaphthalene	None	2,384,000*	238,000*	30,600*	NA	220,000	23,000		**5.7**	**2.6**	**2.0**	**1.8**	**2.2**
Acenaphthene	None	None	None	None	NA	3,300,000	340,000		**0.89 J**	**0.65 J**	ND	ND	ND
Acenaphthylene	None	None	None	None	NA	None	None		**4.8**	ND	ND	ND	ND
Anthracene	None	None	None	None	NA	17,000,000	1,700,000		**5.9**	ND	ND	ND	ND
Benzo(a)anthracene	None	4,770	221	650	11,000	2,100	150		**20.0**	ND	ND	ND	ND
Benzo(a)pyrene	None	477	22	65	1,100	210	15		**13**	**0.72 J**	**0.42 J**	**1.0 J**	**0.36 J**
Benzo(b)fluoranthene	None	4,770	221	650	11,000	2,100	150		**25.0**	**3.9**	**2.4**	**4.4**	**1.7**
Benzo(g,h,i)perylene	None	None	None	None	NA	None	None		**13.0**	**1.9**	**1.8**	**2.0**	**0.83 J**
Benzo(k)fluoranthene	None	47,700	2,210	6,500	110,000	21,000	1,500		**4.7**	**0.58 J**	**0.66 J**	**0.70 J**	**0.38 J**
Chrysene	None	477,000	22,100	65,000	1,100,000	210,000	15,000		**13.0**	**5.4**	**4.4**	**5.6**	**1.5**
Dibenz(a,h)anthracene	None	477	22	65	1,100	210	15		**2.6**	**0.41 J**	**1.2 J**	**0.47 J**	ND
Fluoranthene	None	5,087,000*	276,000*	163,000*	NA	2,200,000	230,000		**37.0**	**2.3**	**0.68 J**	**2.8**	**1.1 J**
Fluorene	None	11,458,000*	737,000*	243,000*	NA	2,200,000	230,000		**6.3**	**1.4 J**	**0.63 J**	**0.86 J**	**1.1 J**
Indeno(1,2,3-c,d)pyrene	None	4,770	221	650	11,000	2,100	150		**11.0**	**0.91 J**	**1.0 J**	**1.3 J**	**0.52 J**
Naphthalene	None	1,541,000*	368,000*	122,000*	39,800	18,000	3,600		**5.2**	**2.6**	**1.7**	ND	**2.1**
Phenanthrene	None	None	None	None	NA	None	None		**40.0**	**7.6**	ND	ND	ND
Pyrene	None	3,815,000*	207,000*	122,000*	NA	1,700,000	170,000		**26.0**	**2.0**	**0.67 J**	**2.1**	**0.97 J**
Pesticides (µg/kg)													
beta-BHC (beta-Hexachlorocyclohexane)	None	7,420	770	496	NA	960	270		NS	NS	NS	NS	NS
Gasoline Range Organics (mg/kg)													
Gasoline Range Organics (C6-C10)[1]	None	None	None	None	NA	NA	NA		ND	ND	ND	ND	ND
Gasoline Range Organics (C6-C12)[2]	None	None	None	None	1,000	NA	NA		ND	ND	ND	ND	ND
Diesel Range Organics (mg/kg)													
Diesel Range Organics (C10-C28)[1]	None	None	None	None	NA	NA	NA		**9.5 J**	**6.3 J**	**11.0 J**	**7.0 J**	**19.0 J**
Diesel Range Organics (C10-C20)[2]	None	None	None	None	2,000	NA	NA		**5.2 J**	ND	ND	ND	ND
Extended Range Organics (C20-C34)[2]	None	None	None	None	5,000	NA	NA		ND	ND	ND	ND	ND

Table 5-2: Organic Analytes Detected in Subsurface Soil Samples (Continued)

							Sample Type:	Primary	Primary	Primary	Primary	Primary
							Location ID:	71-B5PS-DU1-SB4	71-B5PS-DU1-SB5	71-B5PS-DU1-SB6	71-B5PS-DU1-SB7	71-B5PS-DU1-SB8
							Field Sample ID:	071SB-0006M-0001-SO	071SB-0007M-0001-SO	071SB-0009M-0001-SO	071SB-0010M-0001-SO	071SB-0011M-0001-SO
							Lab Sample ID:	338359	338363	338367	338369	338371
							Sample Date:	08/13/2013	08/13/2013	08/13/2013	08/13/2013	08/13/2013
							Location Type:	Vertical ISM	Vertical ISM	Vertical ISM	Vertical ISM	Vertical ISM
							Sample Depth (ft):	1-7	1-7	1-7	1-7	1-7
Method/ Chemical	**BKG**	**Facility-Wide Cleanup Goals**			**BUSTR**	**U.S. EPA RSL**						
		National Guard Trainee	**Resident Receptor**			**Industrial**	**Residential**					
			Resident Adult Farmer	**Resident Child Farmer**								
Volatile Organic Compounds (µg/kg)												
1,2-Dichloroethane	None	None	None	None	NA	2,200	430	ND	ND	**4.8 J**	ND	ND
Semi-Volatile Organic Compounds (µg/kg)												
2-Methylnaphthalene	None	2,384,000*	238,000*	30,600*	NA	220,000	23,000	**2.5**	**4.1**	**4.7**	**2.6**	**3.2**
Acenaphthene	None	None	None	None	NA	3,300,000	340,000	**0.91 J**	**0.69 J**	**4.0**	ND	**1.1 J**
Acenaphthylene	None	None	None	None	NA	None	None	ND	ND	**1.6**	ND	ND
Anthracene	None	None	None	None	NA	17,000,000	1,700,000	ND	**0.48 J**	ND	ND	**0.44 J**
Benzo(a)anthracene	None	4,770	221	650	11,000	2,100	150	ND	ND	ND	ND	ND
Benzo(a)pyrene	None	477	22	65	1,100	210	15	**0.63 J**	**0.30 J**	ND	**0.40 J**	**0.42 J**
Benzo(b)fluoranthene	None	4,770	221	650	11,000	2,100	150	**2.6**	**2.1**	**1.7**	**2.4**	**2.3**
Benzo(g,h,i)perylene	None	None	None	None	NA	None	None	**1.1 J**	**1.1 J**	**1.1 J**	**1.2 J**	**1.3 J**
Benzo(k)fluoranthene	None	47,700	2,210	6,500	110,000	21,000	1,500	**0.54 J**	**0.43 J**	**0.38 J**	**0.42 J**	**0.38 J**
Chrysene	None	477,000	22,100	65,000	1,100,000	210,000	15,000	**3.0**	**2.3**	**1.9**	**2.1**	**2.3**
Dibenz(a,h)anthracene	None	477	22	65	1,100	210	15	ND	ND	ND	ND	ND
Fluoranthene	None	5,087,000*	276,000*	163,000*	NA	2,200,000	230,000	**3.2**	**0.81 J**	**1.4 J**	**1.3 J**	**1.0 J**
Fluorene	None	11,458,000*	737,000*	243,000*	NA	2,200,000	230,000	**1.2 J**	**0.86 J**	**4.6**	**1.2 J**	**1.3 J**
Indeno(1,2,3-c,d)pyrene	None	4,770	221	650	11,000	2,100	150	**0.70 J**	**0.50 J**	**0.39 J**	**0.66 J**	**0.59 J**
Naphthalene	None	1,541,000*	368,000*	122,000*	39,800	18,000	3,600	**2.6**	**4.0**	**8.1**	**2.6**	**2.7**
Phenanthrene	None	None	None	None	NA	None	None	ND	ND	**20.0**	ND	ND
Pyrene	None	3,815,000*	207,000*	122,000*	NA	1,700,000	170,000	**2.3**	**0.83 J**	**2.7**	**1.1 J**	**0.98 J**
Pesticides (µg/kg)												
beta-BHC (beta-Hexachlorocyclohexane)	None	7,420	770	496	NA	960	270	NS	NS	NS	**1.7 J**	NS
Gasoline Range Organics (mg/kg)												
Gasoline Range Organics (C6-C10)[1]	None	None	None	None	NA	NA	NA	ND	ND	**8.3**	ND	ND
Gasoline Range Organics (C6-C12)[2]	None	None	None	None	1,000	NA	NA	ND	ND	**19**	ND	ND
Diesel Range Organics (mg/kg)												
Diesel Range Organics (C10-C28)[1]	None	None	None	None	NA	NA	NA	**14.0 J**	**22.0 J**	**38.0 J**	**15.0 J**	**13.0 J**
Diesel Range Organics (C10-C20)[2]	None	None	None	None	2,000	NA	NA	ND	**16 J**	**32 J**	**9.2 J**	**10 J**
Extended Range Organics (C20-C34)[2]	None	None	None	None	5,000	NA	NA	ND	ND	ND	ND	ND

Table 5-2: Organic Analytes Detected in Subsurface Soil Samples (Continued)

							Sample Type:	Primary	Primary	Duplicate	Primary	Primary
							Location ID:	71-B5PS-DU1-SB9	71-B5PS-DU1-SB9	71-B5PS-DU1-SB9 (FD)	71-B5S-DU1-SB10	71-B5S-DU1-SB11
							Field Sample ID:	071SB-0013M-0001-SO	071SB-0023-0001-SO	071SB-0014M-0001-SO	071SB-0016M-0001-SO	071SB-0017M-0001-SO
							Lab Sample ID:	338377	338407	338381	338361	338375
							Sample Date:	08/13/2013	08/13/2013	08/13/2013	08/13/2013	08/13/2013
							Location Type:	Vertical ISM	Composite	Vertical ISM	Vertical ISM	Vertical ISM
							Sample Depth (ft):	1-7	7-13	1-7	1-7	1-7
Method/ Chemical	**BKG**	**Facility-Wide Cleanup Goals**			**BUSTR**	**U.S. EPA RSL**						
		National Guard Trainee	**Resident Receptor**			**Industrial**	**Residential**					
			Resident Adult Farmer	**Resident Child Farmer**								
Volatile Organic Compounds (µg/kg)												
1,2-Dichloroethane	None	None	None	None	NA	2,200	430	ND	ND	ND	ND	ND
Semi-Volatile Organic Compounds (µg/kg)												
2-Methylnaphthalene	None	2,384,000*	238,000*	30,600*	NA	220,000	23,000	**2.9**	**2.8**	**3.2**	**2.2**	**2.7**
Acenaphthene	None	None	None	None	NA	3,300,000	340,000	**1.0 J**	ND	**1.1 J**	ND	**0.52 J**
Acenaphthylene	None	None	None	None	NA	None	None	ND	ND	ND	ND	ND
Anthracene	None	None	None	None	NA	17,000,000	1,700,000	ND	ND	ND	ND	ND
Benzo(a)anthracene	None	4,770	221	650	11,000	2,100	150	ND	ND	ND	ND	ND
Benzo(a)pyrene	None	477	22	65	1,100	210	15	**0.29 J**	**0.40 J**	**0.52 J**	ND	**0.63 J**
Benzo(b)fluoranthene	None	4,770	221	650	11,000	2,100	150	**2.3**	**3.9**	**2.8**	**1.9**	**2.9**
Benzo(g,h,i)perylene	None	None	None	None	NA	None	None	**1.8**	**2.0**	**2.2**	**0.92 J**	**1.5**
Benzo(k)fluoranthene	None	47,700	2,210	6,500	110,000	21,000	1,500	ND	ND	**1.7**	ND	**0.50 J**
Chrysene	None	477,000	22,100	65,000	1,100,000	210,000	15,000	**4.3**	**14.0**	**5.1**	**2.5**	**3.5**
Dibenz(a,h)anthracene	None	477	22	65	1,100	210	15	ND	**0.45 J**	ND	ND	ND
Fluoranthene	None	5,087,000*	276,000*	163,000*	NA	2,200,000	230,000	**1.0 J**	**2.0**	**1.2 J**	**0.66 J**	**1.7**
Fluorene	None	11,458,000*	737,000*	243,000*	NA	2,200,000	230,000	**0.93 J**	**0.80 J**	**1.1 J**	**1.0 J**	**1.3 J**
Indeno(1,2,3-c,d)pyrene	None	4,770	221	650	11,000	2,100	150	**0.52 J**	**0.58 J**	**0.71 J**	**0.38 J**	**0.68 J**
Naphthalene	None	1,541,000*	368,000*	122,000*	39,800	18,000	3,600	**3.7**	**2.7**	ND	**2.1**	**2.5**
Phenanthrene	None	None	None	None	NA	None	None	ND	**13.0**	ND	ND	ND
Pyrene	None	3,815,000*	207,000*	122,000*	NA	1,700,000	170,000	**1.2 J**	**1.3 J**	**1.4 J**	**0.73 J**	**1.6**
Pesticides (µg/kg)												
beta-BHC (beta-Hexachlorocyclohexane)	None	7,420	770	496	NA	960	270	NS	NS	NS	NS	ND
Gasoline Range Organics (mg/kg)												
Gasoline Range Organics (C6-C10)[1]	None	None	None	None	NA	NA	NA	ND	ND	ND	ND	ND
Gasoline Range Organics (C6-C12)[2]	None	None	None	None	1,000	NA	NA	ND	ND	ND	ND	ND
Diesel Range Organics (mg/kg)												
Diesel Range Organics (C10-C28)[1]	None	None	None	None	NA	NA	NA	**20.0 J**	**28.0 J**	**21.0 J**	**13.0 J**	**18.0 J**
Diesel Range Organics (C10-C20)[2]	None	None	None	None	2,000	NA	NA	**10 J**	**28 J**	**24 J**	ND	**13 J**
Extended Range Organics (C20-C34)[2]	None	None	None	None	5,000	NA	NA	**8.2 J**	**14 J**	**7.1 J**	ND	ND

Table 5-2: Organic Analytes Detected in Subsurface Soil Samples (Continued)

							Sample Type:	Primary	Duplicate	Primary	Primary
							Location ID:	71-B5S-DU1-SB12	71-B5S-DU1-SB12 (FD)	71-B5S-DU1-SB13	71-B5S-DU1-SB14
							Field Sample ID:	071SB-0018M-0001-SO	071SB-0019M-0001-SO	071SB-0021M-0001-SO	071SB-0022M-0001-SO
							Lab Sample ID:	338379	338383	338373	338387
							Sample Date:	08/13/2013	08/13/2013	08/13/2013	08/13/2013
							Location Type:	Vertical ISM	Vertical ISM	Vertical ISM	Vertical ISM
							Sample Depth (ft):	1-7	1-7	1-7	1-7
Method/ Chemical	**BKG**	**Facility-Wide Cleanup Goals**			**BUSTR**	**U.S. EPA RSL**					
		National Guard Trainee	**Resident Receptor**			**Industrial**	**Residential**				
			Resident Adult Farmer	**Resident Child Farmer**							
Volatile Organic Compounds (µg/kg)											
1,2-Dichloroethane	None	None	None	None	NA	2,200	430	ND	ND	ND	ND
Semi-Volatile Organic Compounds (µg/kg)											
2-Methylnaphthalene	None	2,384,000*	238,000*	30,600*	NA	220,000	23,000	**3.0**	**3.9**	**4.5**	**14.0**
Acenaphthene	None	None	None	None	NA	3,300,000	340,000	**0.62 J**	ND	**0.66 J**	**1.4 J**
Acenaphthylene	None	None	None	None	NA	None	None	ND	ND	ND	**2.5**
Anthracene	None	None	None	None	NA	17,000,000	1,700,000	ND	ND	ND	**4.2**
Benzo(a)anthracene	None	4,770	221	650	11,000	2,100	150	ND	ND	ND	**33.0**
Benzo(a)pyrene	None	477	22	65	1,100	210	15	**0.42 J**	**0.51 J**	**0.66 J**	**23.0**
Benzo(b)fluoranthene	None	4,770	221	650	11,000	2,100	150	**2.9**	**3.2**	**3.7**	**41.0**
Benzo(g,h,i)perylene	None	None	None	None	NA	None	None	**1.5**	**2.1**	**2.5**	**20.0**
Benzo(k)fluoranthene	None	47,700	2,210	6,500	110,000	21,000	1,500	ND	**0.40 J**	**0.46 J**	**11.0**
Chrysene	None	477,000	22,100	65,000	1,100,000	210,000	15,000	**4.8**	**5.5**	**7.1**	**23.0**
Dibenz(a,h)anthracene	None	477	22	65	1,100	210	15	ND	**0.36 J**	**0.60 J**	**5.4**
Fluoranthene	None	5,087,000*	276,000*	163,000*	NA	2,200,000	230,000	**1.4 J**	**1.4 J**	**1.9**	**41.0**
Fluorene	None	11,458,000*	737,000*	243,000*	NA	2,200,000	230,000	**1.1 J**	**0.82 J**	**1.4 J**	**2.5**
Indeno(1,2,3-c,d)pyrene	None	4,770	221	650	11,000	2,100	150	**0.61 J**	**0.69 J**	**0.86 J**	**18.0**
Naphthalene	None	1,541,000*	368,000*	122,000*	39,800	18,000	3,600	ND	ND	**3.7**	**9.7**
Phenanthrene	None	None	None	None	NA	None	None	ND	ND	**6.4**	**24.0**
Pyrene	None	3,815,000*	207,000*	122,000*	NA	1,700,000	170,000	**1.4 J**	**1.4 J**	**1.9**	**34.0**
Pesticides (µg/kg)											
beta-BHC (beta-Hexachlorocyclohexane)	None	7,420	770	496	NA	960	NA	NS	NS	NS	NS
Gasoline Range Organics (mg/kg)											
Gasoline Range Organics (C6-C10)[1]	None	None	None	None	NA	NA	NA	ND	ND	ND	ND
Gasoline Range Organics (C6-C12)[2]	None	None	None	None	1,000	NA	NA	ND	ND	ND	ND
Diesel Range Organics (mg/kg)											
Diesel Range Organics (C10-C28)[1]	None	None	None	None	NA	NA	NA	**19.0 J**	**22.0 J**	**14.0 J**	**24.0 J**
Diesel Range Organics (C10-C20)[2]	None	None	None	None	2,000	NA	NA	**15 J**	**9.4 J**	**9.5 J**	**17 J**
Extended Range Organics (C20-C34)[2]	None	None	None	None	5,000	NA	NA	ND	ND	ND	**12 J**

Notes:
Yellow shading of a result indicates concentration is greater than FWCUG
All FWCUGs are carcinogenic FWCUGs (10^{-6} Risk), with the exception of the non-carcinogenic FWCUGs with an Asterisk (*) HQ = 0.1
µg/kg = micrograms per kilogram
1. The Gasoline and Diesel Range Organics (GRO/DRO) analysis was initially completed reporting the carbon chains as shown.
2. GRO results were re-quantitated and the DRO analysis was completed a second time to specifically match the GRO/DRO carbon ranges to match those of the BUSTR carbon chain ranges.
mg/kg = milligrams per kilogram
ft = feet
ISM = Incremental Sampling Methodology
BUSTR = Bureau of Underground Storage Tank Regulations (TPH Action Levels, Class I Soils. Technical Guidance Manual July 2012)
ND = Non-detected concentration reported at limit of detection (LOD)
NS = Not sampled
J = estimated
NA = Not available/Not applicable
BKG = Background criteria
FWCUG = Facility-Wide Clean Up Goal
RSL = Regional Screening Level (U.S. EPA, Nov 2013)
USEPA = United States Environmental Protection Agency

Table 5-3: Inorganic Analytes Detected in Subsurface Soil Samples

						Sample Type:	Primary	Primary	Primary	Primary	Primary	Primary	Primary
						Location ID:	71-B5PS-DU1-SB	71-B5PS-DU1-SB	71-B5PS-DU1-SB1	71-B5PS-DU1-SB2	71-B5PS-DU1-SB3	71-B5PS-DU1-SB4	71-B5PS-DU1-SB5
						Field Sample ID:	071SB-0001M-0001-SO	071SB-0002M-0001-SO	071SB-0003M-0001-SO	071SB-0004M-0001-SO	071SB-0005M-0001-SO	071SB-0006M-0001-SO	071SB-0007M-0001-SO
						Lab Sample ID:	338286	338351	338353	338355	338357	338359	338363
						Sample Date:	08/13/2013	08/13/2013	08/13/2013	08/13/2013	08/13/2013	08/13/2013	08/13/2013
						Location Type:	Horizontal ISM	Horizontal ISM	Vertical ISM	Vertical ISM	Vertical ISM	Vertical ISM	Vertical ISM
						Sample Depth (ft):	1-4	4-7	1-7	1-7	1-7	1-7	1-7
Method/Chemical	**BKG**	**Facility-Wide Cleanup Goals**			**U.S. EPA RSL**								
		National Guard Trainee	**Resident Receptor**		**Industrial**	**Residential**							
			Resident Child Farmer	**Resident Adult Farmer**									
Metals (mg/kg)													
Aluminum	19,500	3,496*	7,380*	52,923*	99,000	7,700	NR	NR	NR	NR	NR	NR	NR
Antimony	0.96	175*	2.82*	13.6*	41	3.10	NR	NR	NR	NR	NR	NR	NR
Arsenic	19.8	2.78	0.524	0.425	2.40	0.61	NR	NR	NR	NR	NR	NR	NR
Barium	124	351*	1,413*	8,966*	19,000	1,500	NR	NR	NR	NR	NR	NR	NR
Beryllium	0.88	None	None	None	200	16	NR	NR	NR	NR	NR	NR	NR
Cadmium	0	10.9	6.41*	22.3*	80.0	7.00	NR	NR	NR	NR	NR	NR	NR
Calcium**	35,500	None	None	None	None	None	NR	NR	NR	NR	NR	NR	NR
Chromium	27.2	329,763*	8,174*	19,694*	150,000	12,000	NR	NR	NR	NR	NR	NR	NR
Cobalt	23.2	7.03	131*	803	30.0	2.30	NR	NR	NR	NR	NR	NR	NR
Copper	32.3	25,368*	311*	2,714*	4,100	310	NR	NR	NR	NR	NR	NR	NR
Iron**	35,200	184,370*	2,313*	19,010*	72,000	5,500	NR	NR	NR	NR	NR	NR	NR
Lead	19.1	None	None	None	800	400	**10.6**	**10.3**	**8.9 J**	**8.6**	**8.9**	**8.3**	**10.0**
Magnesium**	8,790	None	None	None	None	None	NR	NR	NR	NR	NR	NR	NR
Manganese	3,030	35.1*	293*	1,482*	2,300	180	NR	NR	NR	NR	NR	NR	NR
Mercury	0.044	172*	2.27*	16.5*	4.30	1.00	NR	NR	NR	NR	NR	NR	NR
Nickel	60.7	12,639*	155*	1,346*	2,000	150	NR	NR	NR	NR	NR	NR	NR
Potassium**	3,350	None	None	None	None	None	NR	NR	NR	NR	NR	NR	NR
Sodium **	145	None	None	None	None	None	NR	NR	NR	NR	NR	NR	NR
Vanadium	37.6	2,304*	44.9*	156*	510	39.0	NR	NR	NR	NR	NR	NR	NR
Zinc	93.3	187,269*	2,321*	19,659*	31,000	2,300	NR	NR	NR	NR	NR	NR	NR

Table 5-3: Inorganic Analytes Detected in Subsurface Soil Samples (Continued)

						Sample Type:	Primary	Primary	Primary	Primary	Primary	Duplicate
						Location ID:	71-B5PS-DU1-SB6	71-B5PS-DU1-SB7	71-B5PS-DU1-SB8	71-B5PS-DU1-SB9	71-B5PS-DU1-SB9	71-B5PS-DU1-SB9 (FD)
						Field Sample ID:	071SB-0009M-0001-SO	071SB-0010M-0001-SO	071SB-0011M-0001-SO	071SB-0013M-0001-SO	071SB-0023-0001-SO	071SB-0014M-0001-SO
						Lab Sample ID:	338367	338369	338371	338377	338407	338381
						Sample Date:	08/13/2013	08/13/2013	08/13/2013	08/13/2013	08/13/2013	08/13/2013
						Location Type:	Vertical ISM	Vertical ISM	Vertical ISM	Vertical ISM	Vertical ISM	Vertical ISM
						Sample Depth (ft):	1-7	1-7	1-7	1-7	7-13	1-7
Method/ Chemical	**BKG**	**Facility-Wide Cleanup Goals**			**U.S. EPA RSL**							
		National Guard Trainee	**Resident Receptor**		**Industrial**	**Residential**						
			Resident Child Farmer	**Resident Adult Farmer**								
Metals (mg/kg)												
Aluminum	19,500	3,496*	7,380*	52,923*	99,000	7,700	NR	**11,900 J**	NR	NR	NR	NR
Antimony	0.96	175*	2.82*	13.6*	41	3.10	NR	**1.2 J**	NR	NR	NR	NR
Arsenic	19.8	2.78	0.524	0.425	2.40	0.61	NR	**13.7 J**	NR	NR	NR	NR
Barium	124	351*	1,413*	8,966*	19,000	1,500	NR	**103 J**	NR	NR	NR	NR
Beryllium	0.88	None	None	None	200	16	NR	**0.65 J**	NR	NR	NR	NR
Cadmium	0	10.9	6.41*	22.3*	80.0	7.00	NR	**0.66 J**	NR	NR	NR	NR
Calcium**	35,500	None	None	None	None	None	NR	**20,100 J**	NR	NR	NR	NR
Chromium	27.2	329,763*	8,174*	19,694*	150,000	12,000	NR	**18.4 J**	NR	NR	NR	NR
Cobalt	23.2	7.03	131*	803	30.0	2.30	NR	**11.5 J**	NR	NR	NR	NR
Copper	32.3	25,368*	311*	2,714*	4,100	310	NR	**18.4 J**	NR	NR	NR	NR
Iron**	35,200	184,370*	2,313*	19,010*	72,000	5,500	NR	**25,600 J**	NR	NR	NR	NR
Lead	19.1	None	None	None	800	400	**11.4**	**11.5 J**	**12.6**	**9.0**	**8.2**	**11.0**
Magnesium**	8,790	None	None	None	None	None	NR	**6,640 J**	NR	NR	NR	NR
Manganese	3,030	35.1*	293*	1,482*	2,300	180	NR	**447 J**	NR	NR	NR	NR
Mercury	0.044	172*	2.27*	16.5*	4.30	1.00	NR	**0.022**	NR	NR	NR	NR
Nickel	60.7	12,639*	155*	1,346*	2,000	150	NR	**32.9 J**	NR	NR	NR	NR
Potassium**	3,350	None	None	None	None	None	NR	**1,350 J**	NR	NR	NR	NR
Sodium **	145	None	None	None	None	None	NR	**102 J**	NR	NR	NR	NR
Vanadium	37.6	2,304*	44.9*	156*	510	39.0	NR	**18.9 J**	NR	NR	NR	NR
Zinc	93.3	187,269*	2,321*	19,659*	31,000	2,300	NR	**60.6 J**	NR	NR	NR	NR

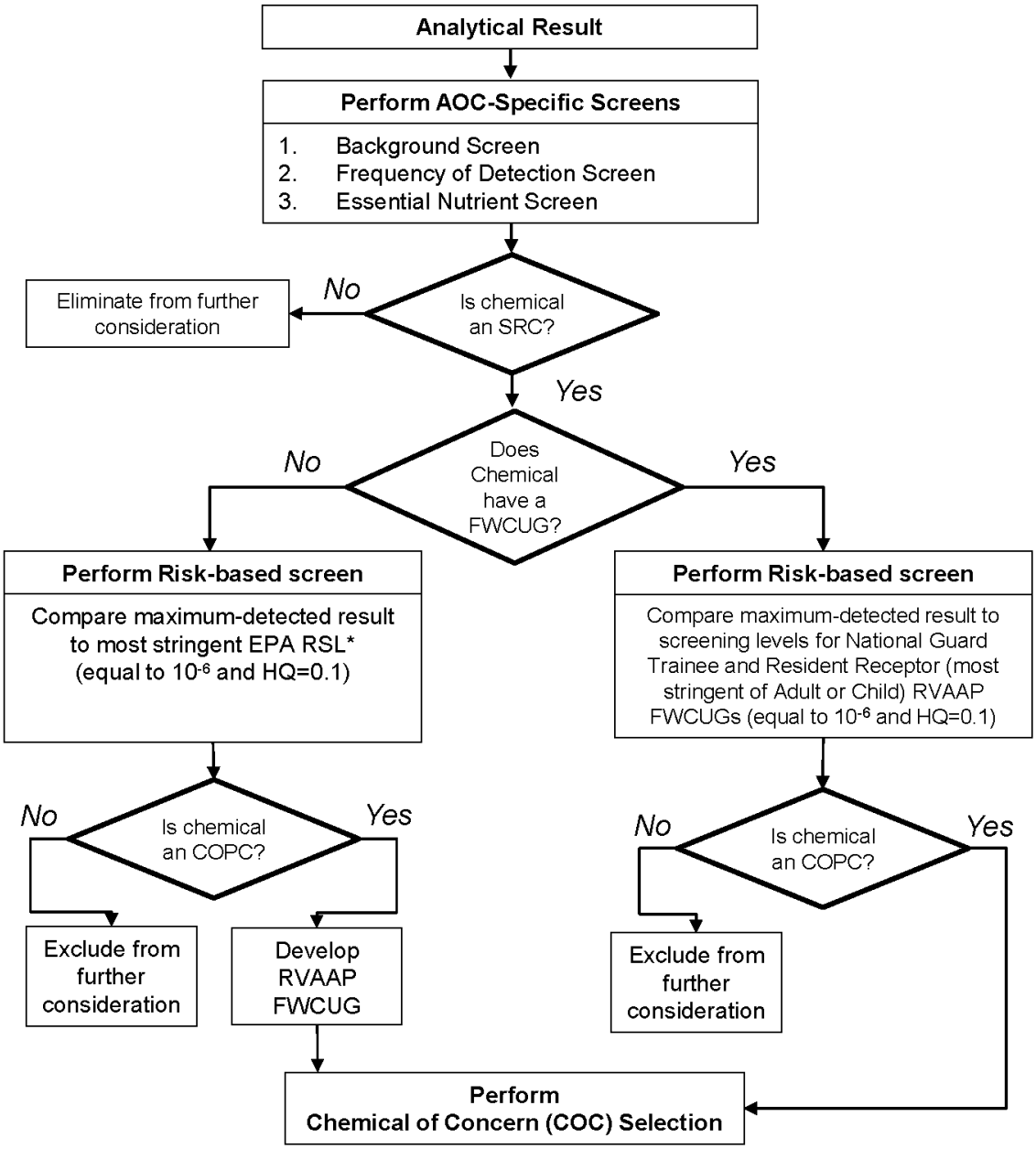
Table 5-3: Inorganic Analytes Detected in Subsurface Soil Samples (Continued)

						Sample Type:	Primary	Primary	Primary	Duplicate	Primary	Primary
						Location ID:	71-B5S-DU1-SB10	71-B5S-DU1-SB11	71-B5S-DU1-SB12	71-B5S-DU1-SB12 (FD)	71-B5S-DU1-SB13	71-B5S-DU1-SB14
						Field Sample ID:	071SB-0016M-0001-SO	071SB-0017M-0001-SO	071SB-0018M-0001-SO	071SB-0019M-0001-SO	071SB-0021M-0001-SO	071SB-0022M-0001-SO
						Lab Sample ID:	338361	338375	338379	338383	338373	338387
						Sample Date:	08/13/2013	08/13/2013	08/13/2013	08/13/2013	08/13/2013	08/13/2013
						Location Type:	Vertical ISM	Vertical ISM	Vertical ISM	Vertical ISM	Vertical ISM	Vertical ISM
						Sample Depth (ft):	1-7	1-7	1-7	1-7	1-7	1-7
Method/ Chemical	**BKG**	**Facility-Wide Cleanup Goals**			**U.S. EPA RSL**							
		National Guard Trainee	**Resident Receptors**		**Industrial**	**Residential**						
			Resident Child Farmer	**Resident Adult Farmer**								
Metals (mg/kg)												
Aluminum	19,500	3,496*	7,380*	52,923*	99,000	7,700	NR	**32,200 J**	NR	NR	NR	NR
Antimony	0.96	175*	2.82*	13.6*	41	3.10	NR	**1.4**	NR	NR	NR	NR
Arsenic	19.8	2.78	0.524	0.425	2.40	0.61	NR	**7.3 J**	NR	NR	NR	NR
Barium	124	351*	1,413*	8,966*	19,000	1,500	NR	**59.1**	NR	NR	NR	NR
Beryllium	0.88	None	None	None	200	16	NR	**0.48**	NR	NR	NR	NR
Cadmium	0	10.9	6.41*	22.3*	80.0	7.00	NR	**2.4 J**	NR	NR	NR	NR
Calcium**	35,500	None	None	None	None	None	NR	**32,200 J**	NR	NR	NR	NR
Chromium	27.2	329,763*	8,174*	19,694*	150,000	12,000	NR	**14.6**	NR	NR	NR	NR
Cobalt	23.2	7.03	131*	803	30.0	2.30	NR	**9.5 J**	NR	NR	NR	NR
Copper	32.3	25,368*	311*	2,714*	4,100	310	NR	**19.9**	NR	NR	NR	NR
Iron**	35,200	184,370*	2,313*	19,010*	72,000	5,500	NR	**18,500 J**	NR	NR	NR	NR
Lead	19.1	None	None	None	800	400	**7.4**	**7.8**	**8.8**	**8.2**	**11.9**	**17.3**
Magnesium**	8,790	None	None	None	None	None	NR	**7,220**	NR	NR	NR	NR
Manganese	3,030	35.1*	293*	1,482*	2,300	180	NR	**269**	NR	NR	NR	NR
Mercury	0.044	172*	2.27*	16.5*	4.30	1.00	NR	**0.0094**	NR	NR	NR	NR
Nickel	60.7	12,639*	155*	1,346*	2,000	150	NR	**23.1**	NR	NR	NR	NR
Potassium**	3,350	None	None	None	None	None	NR	**1,640**	NR	NR	NR	NR
Sodium **	145	None	None	None	None	None	NR	**101**	NR	NR	NR	NR
Vanadium	37.6	2,304*	44.9*	156*	510	39.0	NR	**15.6**	NR	NR	NR	NR
Zinc	93.3	187,269*	2,321*	19,659*	31,000	2,300	NR	**42.8**	NR	NR	NR	NR

Notes:
Yellow shading of a result indicates concentration is greater than a FWCUG
All FWCUGs are carcinogenic FWCUGs (10^{-6} Risk), with the exception of the FWCUGs with an Asterisk (*)
mg/kg = milligrams per kilogram
ft = feet
ID = identification
ISM = Incremental Sampling Methodology
Asterisk (*) indicates non-carcinogenic FWCUGs (HQ=0.1)
ND = Non-detected concentration reported at the Limit of Detection (LOD)
NR = Not reported
J = estimated
NA = Not available/Not applicable
BKG = Background criteria
FWCUG = Facility-Wide Cleanup Goal
RSL = Regional Screening Level (U.S. EPA, Nov 2013)
USEPA = United States Environmental Protection Agency
** Essential nutrient

This page intentionally left blank.

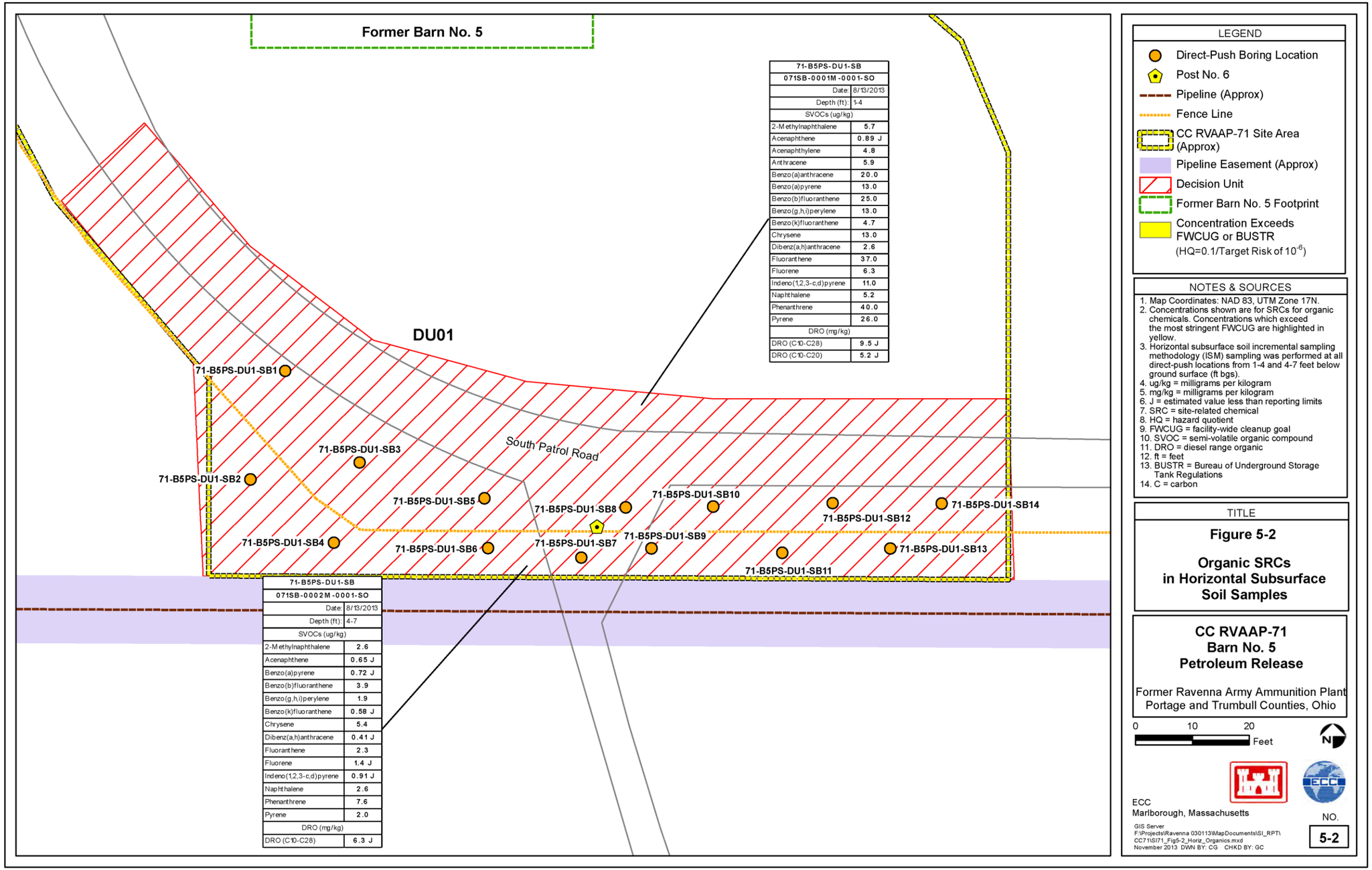
Figure 5-1: Process to Identify RVAAP Chemicals of Concern



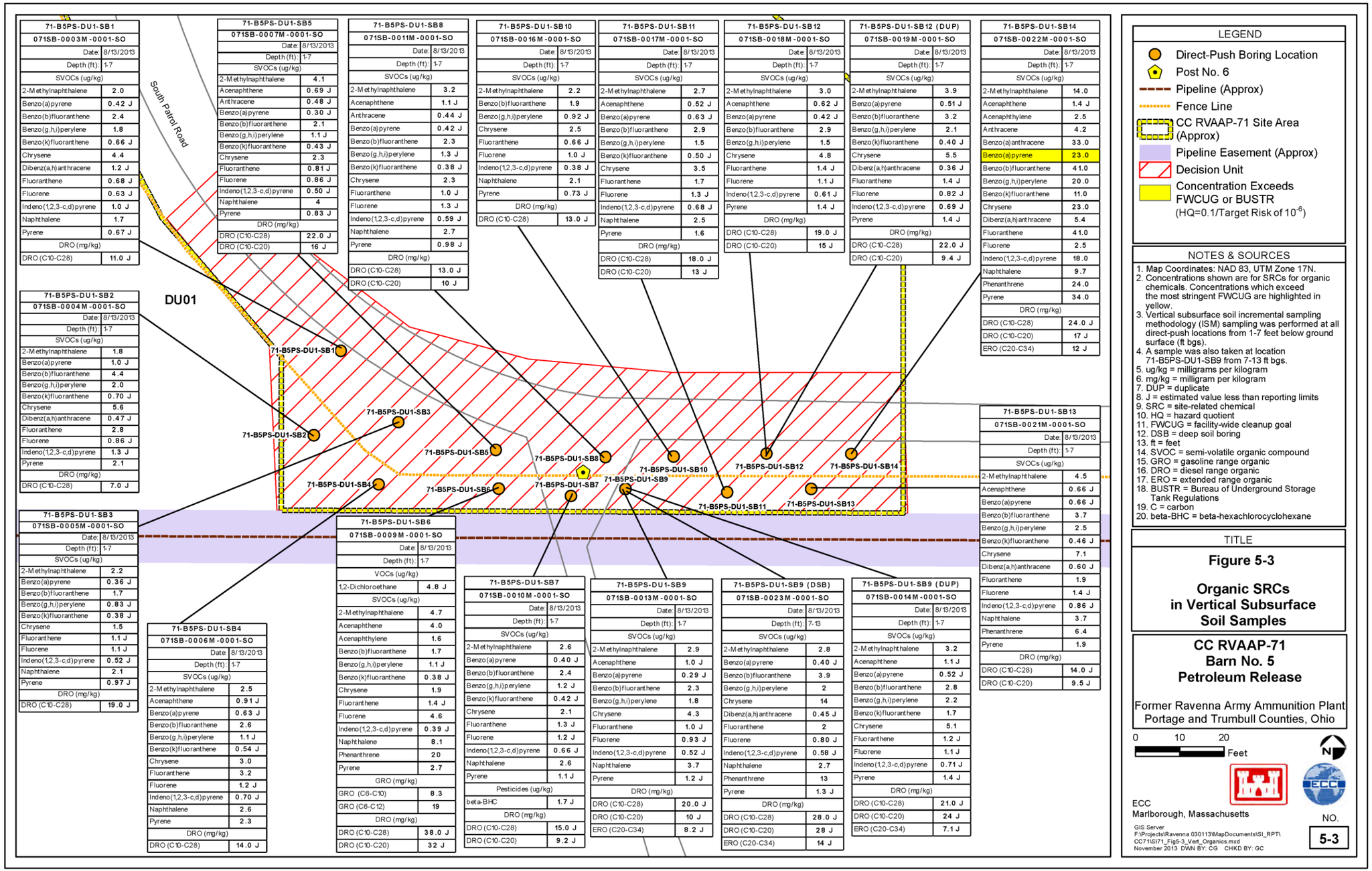
COC – Chemical of Concern
COPC – Chemical of Potential Concern
RVAAP – Ravenna Army Ammunition Plant
FWCUG – Facility-Wide Cleanup Goal
EPA – Environmental Protection Agency
HQ – Hazard Quotient
RSL – Regional Screening Level
SRC – Site-Related Chemical
AOC – Area of Concern

* The November 2013 Residential RSL is used when there is no FWCUG for the Resident Receptor.
* The November 2013 Industrial RSL is used when there is no FWCUG for the National Guard Trainee.

This page intentionally left blank.


Former Barn No. 5
DU01
South Patrol Road
71-B5PS-DU1-SB1
71-B5PS-DU1-SB2
71-B5PS-DU1-SB3
71-B5PS-DU1-SB4
71-B5PS-DU1-SB5
71-B5PS-DU1-SB6
71-B5PS-DU1-SB7
71-B5PS-DU1-SB8
71-B5PS-DU1-SB9
71-B5PS-DU1-SB10
71-B5PS-DU1-SB11
71-B5PS-DU1-SB12
71-B5PS-DU1-SB13
71-B5PS-DU1-SB14
71-B5PS-DU1-SB
071SB-0001M-0001-SO
Date 8/13/2013
Depth (ft) 1-4
SVOCs (ug/kg)
2-Methylnaphthalene 5.7
Acenaphthene 0.89 J
Acenaphthylene 4.8
Anthracene 5.9
Benzo(a)anthracene 20.0
Benzo(a)pyrene 13.0
Benzo(b)fluoranthene 25.0
Benzo(g,h,i)perylene 13.0
Benzo(k)fluoranthene 4.7
Chrysene 13.0
Dibenz(a,h)anthracene 2.6
Fluoranthene 37.0
Fluorene 6.3
Indeno(1,2,3-c,d)pyrene 11.0
Naphthalene 5.2
Phenanthrene 40.0
Pyrene 26.0
DRO (mg/kg)
DRO (C10-C28) 9.5 J
DRO (C10-C20) 5.2 J
71-B5PS-DU1-SB
071SB-0002M-0001-SO
Date 8/13/2013
Depth (ft) 4-7
SVOCs (ug/kg)
2-Methylnaphthalene 2.6
Acenaphthene 0.65 J
Benzo(a)pyrene 0.72 J
Benzo(b)fluoranthene 3.9
Benzo(g,h,i)perylene 1.9
Benzo(k)fluoranthene 0.58 J
Chrysene 5.4
Dibenz(a,h)anthracene 0.41 J
Fluoranthene 2.3
Fluorene 1.4 J
Indeno(1,2,3-c,d)pyrene 0.91 J
Naphthalene 2.6
Phenanthrene 7.6
Pyrene 2.0
DRO (mg/kg)
DRO (C10-C28) 6.3 J
LEGEND
Direct-Push Boring Location
Post No. 6
Pipeline (Approx)
Fence Line
CC RVAAP-71 Site Area (Approx)
Pipeline Easement (Approx)
Decision Unit
Former Barn No. 5 Footprint
Concentration Exceeds FWCUG or BUSTR (HQ=0.1/Target Risk of 10-6)
NOTES & SOURCES
1. Map Coordinates: NAD 83, UTM Zone 17N.
2. Concentrations shown are for SRCs for organic chemicals. Concentrations which exceed the most stringent FWCUG are highlighted in yellow.
3. Horizontal subsurface soil incremental sampling methodology (ISM) sampling was performed at all direct-push locations from 1-4 and 4-7 feet below ground surface (ft bgs).
4. ug/kg = milligrams per kilogram
5. mg/kg = milligrams per kilogram
6. J = estimated value less than reporting limits
7. SRC = site-related chemical
8. HQ = hazard quotient
9. FWCUG = facility-wide cleanup goal
10. SVOC = semi-volatile organic compound
11. DRO = diesel range organic
12. ft = feet
13. BUSTR = Bureau of Underground Storage Tank Regulations
14. C = carbon
TITLE
Figure 5-2
Organic SRCs in Horizontal Subsurface Soil Samples
CC RVAAP-71
Barn No. 5
Petroleum Release
Former Ravenna Army Ammunition Plant
Portage and Trumbull Counties, Ohio
0 10 20
Feet
N
ECC
Marlborough, Massachusetts
GIS Server
F:\Projects\Ravenna 030113\MapDocuments\SI_RPT\CC71\SI71_Fig5-2_Horiz_Organics.mxd
November 2013 DWN BY: CG CHKD BY: GC
NO.
5-2

This page intentionally left blank.



71-B5PS-DU1-SB1	
071SB-0003M-0001-SO	
Date:	8/13/2013
Depth (ft):	1-7
SVOCs (ug/kg)	
2-Methylnaphthalene	2.0
Benzo(a)pyrene	0.42 J
Benzo(b)fluoranthene	2.4
Benzo(g,h,i)perylene	1.8
Benzo(k)fluoranthene	0.66 J
Chrysene	4.4
Dibenz(a,h)anthracene	1.2 J
Fluoranthene	0.68 J
Fluorene	0.63 J
Indeno(1,2,3-c,d)pyrene	1.0 J
Naphthalene	1.7
Pyrene	0.67 J
DRO (mg/kg)	
DRO (C10-C28)	11.0 J

71-B5PS-DU1-SB2	
071SB-0004M-0001-SO	
Date:	8/13/2013
Depth (ft):	1-7
SVOCs (ug/kg)	
2-Methylnaphthalene	1.8
Benzo(a)pyrene	1.0 J
Benzo(b)fluoranthene	4.4
Benzo(g,h,i)perylene	2.0
Benzo(k)fluoranthene	0.70 J
Chrysene	5.6
Dibenz(a,h)anthracene	0.47 J
Fluoranthene	2.8
Fluorene	0.86 J
Indeno(1,2,3-c,d)pyrene	1.3 J
Pyrene	2.1
DRO (mg/kg)	
DRO (C10-C28)	7.0 J

71-B5PS-DU1-SB3	
071SB-0005M-0001-SO	
Date:	8/13/2013
Depth (ft):	1-7
SVOCs (ug/kg)	
2-Methylnaphthalene	2.2
Benzo(a)pyrene	0.36 J
Benzo(b)fluoranthene	1.7
Benzo(g,h,i)perylene	0.83 J
Benzo(k)fluoranthene	0.38 J
Chrysene	1.5
Fluoranthene	1.1 J
Fluorene	1.1 J
Indeno(1,2,3-c,d)pyrene	0.52 J
Naphthalene	2.1
Pyrene	0.97 J
DRO (mg/kg)	
DRO (C10-C28)	19.0 J

71-B5PS-DU1-SB4	
071SB-0006M-0001-SO	
Date:	8/13/2013
Depth (ft):	1-7
SVOCs (ug/kg)	
2-Methylnaphthalene	2.5
Acenaphthene	0.91 J
Benzo(a)pyrene	0.63 J
Benzo(b)fluoranthene	2.6
Benzo(g,h,i)perylene	1.1 J
Benzo(k)fluoranthene	0.54 J
Chrysene	3.0
Fluoranthene	3.2
Fluorene	1.2 J
Indeno(1,2,3-c,d)pyrene	0.70 J
Naphthalene	2.6
Pyrene	2.3
DRO (mg/kg)	
DRO (C10-C28)	14.0 J

71-B5PS-DU1-SB5	
071SB-0007M-0001-SO	
Date:	8/13/2013
Depth (ft):	1-7
SVOCs (ug/kg)	
2-Methylnaphthalene	4.1
Acenaphthene	0.69 J
Anthracene	0.48 J
Benzo(a)pyrene	0.30 J
Benzo(b)fluoranthene	2.1
Benzo(g,h,i)perylene	1.1 J
Benzo(k)fluoranthene	0.43 J
Chrysene	2.3
Fluoranthene	0.81 J
Fluorene	0.86 J
Indeno(1,2,3-c,d)pyrene	0.50 J
Naphthalene	4
Pyrene	0.83 J
DRO (mg/kg)	
DRO (C10-C28)	22.0 J
DRO (C10-C20)	16 J

71-B5PS-DU1-SB8	
071SB-0011M-0001-SO	
Date:	8/13/2013
Depth (ft):	1-7
SVOCs (ug/kg)	
2-Methylnaphthalene	3.2
Acenaphthene	1.1 J
Anthracene	0.44 J
Benzo(a)pyrene	0.42 J
Benzo(b)fluoranthene	2.3
Benzo(g,h,i)perylene	1.3 J
Benzo(k)fluoranthene	0.38 J
Chrysene	2.3
Fluoranthene	1.0 J
Fluorene	1.3 J
Indeno(1,2,3-c,d)pyrene	0.59 J
Naphthalene	2.7
Pyrene	0.98 J
DRO (mg/kg)	
DRO (C10-C28)	13.0 J
DRO (C10-C20)	10 J

71-B5PS-DU1-SB6	
071SB-0009M-0001-SO	
Date:	8/13/2013
Depth (ft):	1-7
VOCs (ug/kg)	
1,2-Dichloroethane	4.8 J
SVOCs (ug/kg)	
2-Methylnaphthalene	4.7
Acenaphthene	4.0
Acenaphthylene	1.6
Benzo(b)fluoranthene	1.7
Benzo(g,h,i)perylene	1.1 J
Benzo(k)fluoranthene	0.38 J
Chrysene	1.9
Fluoranthene	1.4 J
Fluorene	4.6
Indeno(1,2,3-c,d)pyrene	0.39 J
Naphthalene	8.1
Phenanthrene	20
Pyrene	2.7
GRO (mg/kg)	
GRO (C6-C10)	8.3
GRO (C6-C12)	19
DRO (mg/kg)	
DRO (C10-C28)	38.0 J
DRO (C10-C20)	32 J

71-B5PS-DU1-SB7	
071SB-0010M-0001-SO	
Date:	8/13/2013
Depth (ft):	1-7
SVOCs (ug/kg)	
2-Methylnaphthalene	2.6
Benzo(a)pyrene	0.40 J
Benzo(b)fluoranthene	2.4
Benzo(g,h,i)perylene	1.2 J
Benzo(k)fluoranthene	0.42 J
Chrysene	2.1
Fluoranthene	1.3 J
Fluorene	1.2 J
Indeno(1,2,3-c,d)pyrene	0.66 J
Naphthalene	2.6
Pyrene	1.1 J
Pesticides (ug/kg)	
beta-BHC	1.7 J
DRO (mg/kg)	
DRO (C10-C28)	15.0 J
DRO (C10-C20)	9.2 J

71-B5PS-DU1-SB9	
071SB-0013M-0001-SO	
Date:	8/13/2013
Depth (ft):	1-7
SVOCs (ug/kg)	
2-Methylnaphthalene	2.9
Acenaphthene	1.0 J
Benzo(a)pyrene	0.29 J
Benzo(b)fluoranthene	2.3
Benzo(g,h,i)perylene	1.8
Chrysene	4.3
Fluoranthene	1.0 J
Fluorene	0.93 J
Indeno(1,2,3-c,d)pyrene	0.52 J
Naphthalene	3.7
Pyrene	1.2 J
DRO (mg/kg)	
DRO (C10-C28)	20.0 J
DRO (C10-C20)	10 J
ERO (C20-C34)	8.2 J

71-B5PS-DU1-SB9 (DSB)	
071SB-0023M-0001-SO	
Date:	8/13/2013
Depth (ft):	7-13
SVOCs (ug/kg)	
2-Methylnaphthalene	2.8
Benzo(a)pyrene	0.40 J
Benzo(b)fluoranthene	3.9
Benzo(g,h,i)perylene	2
Chrysene	14
Dibenz(a,h)anthracene	0.45 J
Fluoranthene	2
Fluorene	0.80 J
Indeno(1,2,3-c,d)pyrene	0.58 J
Naphthalene	2.7
Phenanthrene	13
Pyrene	1.3 J
DRO (mg/kg)	
DRO (C10-C28)	28.0 J
DRO (C10-C20)	28 J
ERO (C20-C34)	14 J

71-B5PS-DU1-SB9 (DUP)	
071SB-0014M-0001-SO	
Date:	8/13/2013
Depth (ft):	1-7
SVOCs (ug/kg)	
2-Methylnaphthalene	3.2
Acenaphthene	1.1 J
Benzo(a)pyrene	0.52 J
Benzo(b)fluoranthene	2.8
Benzo(g,h,i)perylene	2.2
Benzo(k)fluoranthene	1.7
Chrysene	5.1
Fluoranthene	1.2 J
Fluorene	1.1 J
Indeno(1,2,3-c,d)pyrene	0.71 J
Pyrene	1.4 J
DRO (mg/kg)	
DRO (C10-C28)	21.0 J
DRO (C10-C20)	24 J
ERO (C20-C34)	7.1 J

71-B5PS-DU1-SB10	
071SB-0016M-0001-SO	
Date:	8/13/2013
Depth (ft):	1-7
SVOCs (ug/kg)	
2-Methylnaphthalene	2.2
Benzo(b)fluoranthene	1.9
Benzo(g,h,i)perylene	0.92 J
Chrysene	2.5
Fluoranthene	0.66 J
Fluorene	1.0 J
Indeno(1,2,3-c,d)pyrene	0.38 J
Naphthalene	2.1
Pyrene	0.73 J
DRO (mg/kg)	
DRO (C10-C28)	13.0 J

71-B5PS-DU1-SB11	
071SB-0017M-0001-SO	
Date:	8/13/2013
Depth (ft):	1-7
SVOCs (ug/kg)	
2-Methylnaphthalene	2.7
Acenaphthene	0.52 J
Benzo(a)pyrene	0.63 J
Benzo(b)fluoranthene	2.9
Benzo(g,h,i)perylene	1.5
Benzo(k)fluoranthene	0.50 J
Chrysene	3.5
Fluoranthene	1.7
Fluorene	1.3 J
Indeno(1,2,3-c,d)pyrene	0.68 J
Naphthalene	2.5
Pyrene	1.6
DRO (mg/kg)	
DRO (C10-C28)	18.0 J
DRO (C10-C20)	13 J

71-B5PS-DU1-SB12	
071SB-0018M-0001-SO	
Date:	8/13/2013
Depth (ft):	1-7
SVOCs (ug/kg)	
2-Methylnaphthalene	3.0
Acenaphthene	0.62 J
Benzo(a)pyrene	0.42 J
Benzo(b)fluoranthene	2.9
Benzo(g,h,i)perylene	1.5
Chrysene	4.8
Fluoranthene	1.4 J
Fluorene	1.1 J
Indeno(1,2,3-c,d)pyrene	0.61 J
Pyrene	1.4 J
DRO (mg/kg)	
DRO (C10-C28)	19.0 J
DRO (C10-C20)	15 J

71-B5PS-DU1-SB12 (DUP)	
071SB-0019M-0001-SO	
Date:	8/13/2013
Depth (ft):	1-7
SVOCs (ug/kg)	
2-Methylnaphthalene	3.9
Benzo(a)pyrene	0.51 J
Benzo(b)fluoranthene	3.2
Benzo(g,h,i)perylene	2.1
Benzo(k)fluoranthene	0.40 J
Chrysene	5.5
Dibenz(a,h)anthracene	0.36 J
Fluoranthene	1.4 J
Fluorene	0.82 J
Indeno(1,2,3-c,d)pyrene	0.69 J
Pyrene	1.4 J
DRO (mg/kg)	
DRO (C10-C28)	22.0 J
DRO (C10-C20)	9.4 J

71-B5PS-DU1-SB13	
071SB-0021M-0001-SO	
Date:	8/13/2013
Depth (ft):	1-7
SVOCs (ug/kg)	
2-Methylnaphthalene	4.5
Acenaphthene	0.66 J
Benzo(a)pyrene	0.66 J
Benzo(b)fluoranthene	3.7
Benzo(g,h,i)perylene	2.5
Benzo(k)fluoranthene	0.46 J
Chrysene	7.1
Dibenz(a,h)anthracene	0.60 J
Fluoranthene	1.9
Fluorene	1.4 J
Indeno(1,2,3-c,d)pyrene	0.86 J
Naphthalene	3.7
Phenanthrene	6.4
Pyrene	1.9
DRO (mg/kg)	
DRO (C10-C28)	14.0 J
DRO (C10-C20)	9.5 J

71-B5PS-DU1-SB14	
071SB-0022M-0001-SO	
Date:	8/13/2013
Depth (ft):	1-7
SVOCs (ug/kg)	
2-Methylnaphthalene	14.0
Acenaphthene	1.4 J
Acenaphthylene	2.5
Anthracene	4.2
Benzo(a)anthracene	33.0
Benzo(a)pyrene	23.0
Benzo(b)fluoranthene	41.0
Benzo(g,h,i)perylene	20.0
Benzo(k)fluoranthene	11.0
Chrysene	23.0
Dibenz(a,h)anthracene	5.4
Fluoranthene	41.0
Fluorene	2.5
Indeno(1,2,3-c,d)pyrene	18.0
Naphthalene	9.7
Phenanthrene	24.0
Pyrene	34.0
DRO (mg/kg)	
DRO (C10-C28)	24.0 J
DRO (C10-C20)	17 J
ERO (C20-C34)	12 J

LEGEND

- Direct-Push Boring Location
- Post No. 6
- Pipeline (Approx)
- Fence Line
- CC RVAAP-71 Site Area (Approx)
- Pipeline Easement (Approx)
- Decision Unit
- Concentration Exceeds FWCUG or BUSTR (HQ=0.1/Target Risk of 10^{-6})

NOTES & SOURCES

1. Map Coordinates: NAD 83, UTM Zone 17N.
2. Concentrations shown are for SRCs for organic chemicals. Concentrations which exceed the most stringent FWCUG are highlighted in yellow.
3. Vertical subsurface soil incremental sampling methodology (ISM) sampling was performed at all direct-push locations from 1-7 feet below ground surface (ft bgs).
4. A sample was also taken at location 71-B5PS-DU1-SB9 from 7-13 ft bgs.
5. ug/kg = milligrams per kilogram
6. mg/kg = milligram per kilogram
7. DUP = duplicate
8. J = estimated value less than reporting limits
9. SRC = site-related chemical
10. HQ = hazard quotient
11. FWCUG = facility-wide cleanup goal
12. DSB = deep soil boring
13. ft = feet
14. SVOC = semi-volatile organic compound
15. GRO = gasoline range organic
16. DRO = diesel range organic
17. ERO = extended range organic
18. BUSTR = Bureau of Underground Storage Tank Regulations
19. C = carbon
20. beta-BHC = beta-hexachlorocyclohexane

TITLE

Figure 5-3

Organic SRCs in Vertical Subsurface Soil Samples

CC RVAAP-71 Barn No. 5 Petroleum Release

Former Ravenna Army Ammunition Plant
Portage and Trumbull Counties, Ohio

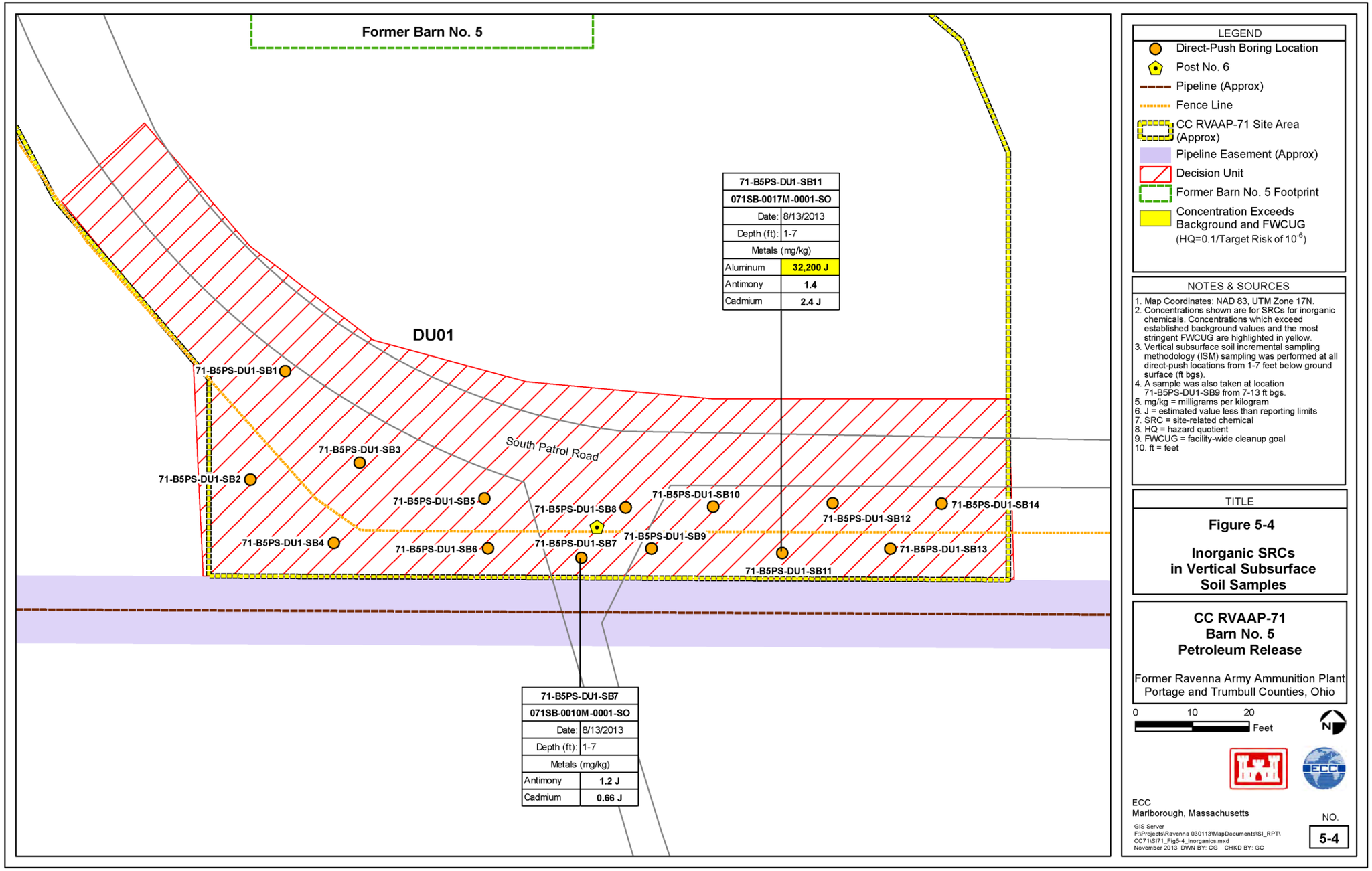
0 10 20 Feet

ECC
Marlborough, Massachusetts

GIS Server
F:\Projects\Ravenna 030113\MapDocuments\SI_RPT\CC71\SI71_Fig5-3_Vert_Organics.mxd
November 2013 DWN BY: CG CHKD BY: GC

NO. 5-3

This page intentionally left blank.


Former Barn No. 5
DU01
South Patrol Road
71-B5PS-DU1-SB1
71-B5PS-DU1-SB2
71-B5PS-DU1-SB3
71-B5PS-DU1-SB4
71-B5PS-DU1-SB5
71-B5PS-DU1-SB6
71-B5PS-DU1-SB7
71-B5PS-DU1-SB8
71-B5PS-DU1-SB9
71-B5PS-DU1-SB10
71-B5PS-DU1-SB11
71-B5PS-DU1-SB12
71-B5PS-DU1-SB13
71-B5PS-DU1-SB14
71-B5PS-DU1-SB11
071SB-0017M-0001-SO
Date: 8/13/2013
Depth (ft): 1-7
Metals (mg/kg)
Aluminum 32,200 J
Antimony 1.4
Cadmium 2.4 J
71-B5PS-DU1-SB7
071SB-0010M-0001-SO
Date: 8/13/2013
Depth (ft): 1-7
Metals (mg/kg)
Antimony 1.2 J
Cadmium 0.66 J
LEGEND
Direct-Push Boring Location
Post No. 6
Pipeline (Approx)
Fence Line
CC RVAAP-71 Site Area (Approx)
Pipeline Easement (Approx)
Decision Unit
Former Barn No. 5 Footprint
Concentration Exceeds Background and FWCUG
(HQ=0.1/Target Risk of 10-6)
NOTES & SOURCES
1. Map Coordinates: NAD 83, UTM Zone 17N.
2. Concentrations shown are for SRCs for inorganic chemicals. Concentrations which exceed established background values and the most stringent FWCUG are highlighted in yellow.
3. Vertical subsurface soil incremental sampling methodology (ISM) sampling was performed at all direct-push locations from 1-7 feet below ground surface (ft bgs).
4. A sample was also taken at location 71-B5PS-DU1-SB9 from 7-13 ft bgs.
5. mg/kg = milligrams per kilogram
6. J = estimated value less than reporting limits
7. SRC = site-related chemical
8. HQ = hazard quotient
9. FWCUG = facility-wide cleanup goal
10. ft = feet
TITLE
Figure 5-4
Inorganic SRCs in Vertical Subsurface Soil Samples
CC RVAAP-71
Barn No. 5
Petroleum Release
Former Ravenna Army Ammunition Plant
Portage and Trumbull Counties, Ohio
0 10 20
Feet
N
ECC
Marlborough, Massachusetts
GIS Server
F:\Projects\Ravenna 030113\MapDocuments\SI_RPT\CC71\SI71_Fig5-4_Inorganics.mxd
November 2013 DWN BY: CG CHKD BY: GC
NO.
5-4

This page intentionally left blank.

6.0 EXPOSURE PATHWAYS

6.1 SOIL EXPOSURE AND AIR PATHWAYS

6.1.1 Physical Conditions

The site is located within Lavery Till glacial deposits. There are two types of silty loam soils beneath the site: (1) Remsen silt loams (2-6% slopes) which comprises about 90% of the soil at CC RVAAP-71; and (2) Orrville silt loam (0-2% slopes) which is found in the northeastern and northwestern corners of the site (Figure 1-7). The inferred bedrock formation at CC RVAAP-71 is the Pennsylvanian-age Pottsville Formation, Sharon Sandstone member, informally referred to as the Sharon Conglomerate (Winslow and White 1966). The Sharon Conglomerate bedrock interface at CC RVAAP-71 is estimated to be 925-975 ft amsl, based on Ohio Department of Natural Resources (ODNR) bedrock topography contours (Figure 1-8).

6.1.2 Soil and Air Targets

Current and future human and ecological (animal and plant) receptors may come into contact with subsurface soil if contaminants are present within the DU.

Airborne contamination (e.g., windblown dust) and soil gas vapor are not considered viable migration or exposure pathways at CC RVAAP-71. Former operational areas are paved, gravel covered, or well vegetated. RVAAP is located in a humid climate, and soil moisture content is typically high, which reduces the potential for dust generation. Further, no reported organic chemicals were detected in the samples which would pose a risk to soil gas vapors.

6.1.3 Soil and Air Pathway Conclusions

The SI analytical results indicate that one metal (aluminum) and one SVOC (benzo(a)pyrene) are present in the subsurface (1 – 7 ft bgs) soils exceeding the screening criteria.

- Aluminum, was detected at a concentration (32,200 J [estimated] mg/kg) which exceeded the Resident Receptor FWCUG criteria of 7,380 mg/kg and the NGT FWCUG of 3,496 mg/kg at soil boring SB11 in the 1 - 7 ft bgs interval. The reported, estimated aluminum detection is not related to the gasoline release of 1964, and likely accumulated at this location from sources unrelated to the site.

- Benzo(a)pyrene, was detected at a concentration (23.0 µg/kg) exceeding the Resident Receptor FWCUG criteria of 22.0 µg/kg but not the NGT FWCUG of 477 µg/kg at soil boring SB14 in the 1 - 7 ft bgs interval. The one detection of benzo(a)pyrene at soil

boring SB14 does not appear to be associated with the 1964 reported gasoline release since no VOCs or TPH GRO gasoline-related compounds were reported in this ISM sample. This PAH compound may be generated from other nearby non-point sources such as runoff from paved roadways adjacent to the site. Neither of these chemicals in subsurface soils pose a direct exposure pathway for human receptors.

6.2 SURFACE WATER PATHWAY

6.2.1 Hydrological Setting

No surface water or sediment samples were collected as part of this SI as these media are not present at CC RVAAP-71. Hinkley Creek is the nearest surface water body which lies approximately 350 feet northwest from the center of the site and drains generally from north to south, eventually discharging to the Kirwan Reservoir approximately 11,000 feet southwest of the site.

6.2.2 Surface Water Targets

Surface water targets include human receptors that use surface water for potable water supply or recreation, as well as environmental (e.g., streams, wetlands, sensitive aquatic environments) and physical targets (e.g., public or private water distribution system intakes) that may be affected by potential groundwater contamination on or adjacent to the site. No perennial streams are located within CC RVAAP-71. Hinkley Creek is assumed to be connected to the groundwater in the area of the site based on the pattern of groundwater contours and therefore may be a potential receptor of the 1964 gasoline release.

6.2.3 Surface Water Pathway Conclusions

There are no perennial surface water streams or wetlands in the immediate vicinity of Former Barn No. 5. Surface water flow and sediment transport are not migration pathways for potential contamination related to CC RVAAP-71 as they are not present at the AOC.

6.3 GROUNDWATER PATHWAY

6.3.1 Hydrogeological Setting

Section 1.4.4 presents the general hydrogeological setting for the facility. The Sharon Conglomerate Unit is the primary geologic formation at the AOC. The generalized inferred groundwater flow direction of the unconfined aquifer is toward the south-southwest. The generalized inferred groundwater flow direction of the Sharon Conglomerate potentiometric

surface is towards the northeast. The inferred unconfined aquifer potentiometric surface is approximately 1,075-ft amsl at the site with groundwater flow in the northwest direction towards Hinkley Creek. Based on the review of the geographic information systems (GIS) ground surface contours and the potentiometric surface contours, the depth to groundwater in the general site area is estimated at approximately 15 ft bgs. No water was encountered at CC RVAAP-71 during drilling activities at any of the soil boring locations which indicates that the groundwater is likely deeper than 13 ft bgs in the vicinity of the AOC.

6.3.2 Groundwater Targets

Groundwater targets include human receptors that use groundwater for potable water supply, as well as environmental receptors (e.g., livestock, fish farms) and physical targets (e.g., springs) that may be affected by potential groundwater contamination on or adjacent to the site. There are no public, livestock, or commercial groundwater supply wells within RVAAP. Groundwater in the vicinity of CC RVAAP-71 is not currently used by the Army and OHARNG. Future use of groundwater has not been specifically designated in this area; therefore, future human receptors may be potentially exposed to groundwater.

6.3.3 Groundwater Pathway Conclusion

No groundwater samples were collected as part of this SI since the groundwater associated with CC RVAAP-71 is being evaluated under the RVAAP-66 Facility-Wide Groundwater.

This page intentionally left blank.

7.0 SUMMARY OF RESULTS AND CONCLUSIONS

This SI Report presents the site and operational history, a summary of the previous historical records review results, and the results of field investigations completed for this SI at CC RVAAP-71 Barn No. 5 Petroleum Release. This SI included the sampling of subsurface soil only, since due to the nature of the gasoline release from a buried pipeline, surface soils were not impacted and therefore not investigated. Further, no surface water or sediments are present at the site and groundwater is being investigated separately under RVAAP-66. This section provides a summary of the findings and conclusions of the SI at CC RVAAP-71 Barn No. 5 Petroleum Release.

7.1 SUMMARY OF RESULTS

A summary of the SI results for CC RVAAP-71 Barn No. 5 Petroleum Release are as follows:

- SRCs were identified in the subsurface soils sampled based upon the background screen, frequency of detection screen and essential nutrient screen.

- The following SRCs were identified in this SI: one VOC; seventeen SVOCs including PAH compounds; one pesticide; two TPH GRO carbon chain compounds; three TPH DRO carbon chain compounds; and three metals.

- The identified SRCs were further evaluated and used to perform a risk-based screen and compared against their respective FWCUG for the Resident Receptor and the National Guard Trainee and the State of Ohio BUSTR criteria (only TPH DRO and TPH GRO carbon chain compounds).

- COPCs were identified using the most stringent of the FWCUGs at the 1.0×10^{-6} risk level or the HQ = 0.1 in the subsurface soils collected at the CC RVAAP-71 Barn No. 5 Petroleum Release.

- One SVOC (benzo(a)pyrene) was identified at soil boring SB14 in the 1 - 7 ft bgs interval at a concentration of 23.0 µg/kg exceeding the Resident Receptor FWCUG at 22.0 µg/kg. The reported concentration (23.0 µg/kg) exceeds the Resident Receptor FWCUG by 1.0 µg/kg and is below the National Guard Trainee FWCUG of 477 µg/kg. Benzo(a)pyrene is not considered to be associated with the 1964 gasoline release and was not considered to be a contaminant related to the gasoline release, as the chemical was not detected in conjunction with any other gasoline-related chemicals reported in any of the other subsurface soils. Therefore benzo(a)pyrene is not identified as a COPC at CC RVAAP-71.

- One metal (aluminum) was detected in soil boring SB11 in the 1 - 7 ft bgs interval at a concentration of 32,200 J (estimated) mg/kg which exceeds the background criteria of 19,500 mg/kg and the Resident Receptor and National Ground Guard Trainee FWCUGs of 7,380 mg/kg and 3,496 mg/kg, respectively. Aluminum is not considered to be related to the 1964 gasoline release from the pipeline nor the historical practices at CC RVAAP-71 and was not identified as a COPC.

- Since TPH GRO and TPH DRO have no established FWCUGs, the BUSTR criteria were used for screening these organic compounds. No TPH GRO or TPH DRO carbon chain compounds were reported exceeding the BUSTR criteria. Therefore, no TPH GRO or TPH DRO carbon chain compounds were identified as COPCs at CC RVAAP-71.

7.2 CONCLUSIONS

The conclusions of this SI are as follows:

- Subsurface soil was evaluated at CC RVAAP-71 Barn No. 5 Petroleum Release to a maximum depth of 13 ft bgs.

- A total of twenty-seven SRCs were identified consisting of one VOC, seventeen SVOC PAHs, three metals, one pesticide and five TPH GRO/DRO carbon chain compounds.

- Only two of the twenty-seven SRCs exceeded FWCUGs as presented below.

    1. Benzo(a)pyrene was reported at a concentration exceeding the Resident Receptor FWCUG by 1.0 µg/kg at boring location SB14 in the 1 - 7 ft bgs interval.

    2. Aluminum was reported at a concentration exceeding the Resident Receptor and National Guard Trainee FWCUGs of 7,380 mg/kg and 3,496 mg/kg, respectively at soil boring SB11 in the 1 - 7 ft bgs interval.

- No SRCs, other than benzo(a)pyrene and aluminum were reported exceeding the Resident Receptor or National Guard Trainee FWCUG in any of the samples collected at CC RVAAP-71 Barn No. 5 Petroleum Release.

- There were no BUSTR exceedances of gasoline-constituents related with the 1964 gasoline release reported in any of the subsurface soil samples collected at CC RVAAP-71 Barn No. 5 Petroleum Release.

- The two SRCs that exceeded FWCUGs are not considered to be chemicals related to the gasoline release or historical practices at CC RVAAP-71. Therefore, no COPCs were identified in the subsurface soil sampled at CC RVAAP-71 Barn No. 5 Petroleum Release.

- Groundwater associated with CC RVAAP-71 is currently being addressed separately under RVAAP-66 Facility-Wide Groundwater.

The results of this SI indicated that NFA is warranted at CC RVAAP-71 Barn No. 5 Petroleum Release AOC.

This page intentionally left blank.

8.0 REFERENCES

Army National Guard-ILE Cleanup, US Army (ARNG), 2014. Final Technical Memorandum: Land Uses and Revised Risk Assessment Process for the Ravenna Army Ammunition Plant (RVAAP) Installation Restoration Program, Portage /Trumbull Counties, Ohio (*Tech Memo)* Memorandum between ARNG-ILE Cleanup and the Ohio Environmental Protection Agency. February.

Agency for Toxic Substances and Disease Registry (ATSDR). 1995. Toxicological Profile for Polycyclic Aromatic Hydrocarbons. U.S. Department of Health and Human Ser vices. August.

Base Realignment and Closure Office (BRACO), 2009. *Installation Hazardous Waste Management Plan.* August.

Bradley, L.J.N., B.H. McGee, and S.L. Allen. 1994. Background Levels of Polycyclic Aromatic Hydrocarbons and Selected Metals in New England Urban Soils, Journal of Soil Contamination.

Chen, S.J. et al. 2001. PAHs and Aerosol Carbons in the Exhaust of Gasoline Powered Engine. Aerosol and Air Quality Research, Vol. 1, No. 1, pages 57-67.

Cox, C.A. and G.C. (Cox-Colvin). 1996. Evaluation of Background Metal Concentrations in Ohio Soils. Submitted to the Ohio Environmental Protection Agency. Cox-Colvin & Associates, Inc. Environmental Services. June.

Craver, C.F. 1964. Buckeye Pipe Line Break. May.

Environmental Chemical Corporation (ECC), 2012. *Final Historical Records Review Report for CC RVAAP-71 Barn No. 5 Petroleum Release and CC-RVAAP-83 Former Buildings 1031 and 1039 (Revision 0), Ravenna Army Ammunition Plant Ravenna, Ohio.* May.

ECC, 2013. *Final Site Inspection and Remedial Investigation Work Plan Addendum at Compliance Restoration Sites CC RVAAP-71 Barn No. 5 Petroleum Release and CC RVAAP-83 Former Buildings 1031 and 1039 (Revision 1). Ravenna Army Ammunition Plant, Ravenna, Ohio*. June.

Environmental Quality Management (EQM), 2013. *Final Facility-Wide Groundwater Monitoring Program RVAAP-66 Facility-Wide Groundwater, Annual Report for 2012, Revision 1. Ravenna Army Ammunition Plant, Ravenna, Ohio.* October.

Fernandes, P.R.N. et al. 2009. Evaluation of Polycyclic Aromatic Hydrocarbons in Asphalt Binder Using Matrix Solid-Phase Dispersion and Gas Chromatography. Journal of Chromatographic Science, Vol. 47, pages 789-793.

Illinois Environmental Protection Agency (IEPA). 2005. Urban area polycyclic aromatic hydrocarbons study tiered approach to corrective action objectives.

Kohler, M., T. Kunniger, P. Schmid, E. Gujer, R. Crockett, and M. Wolfensberger. 2000. Inventory and Emission Factors of Creosote, Polycyclic Aromatic Hydrocarbons, and Phenols from Railroad Ties Treated with Creosote. Environmental Science and Technology. Vol. 34. pages 4766 -4772. October.

Liedos Engineering of Ohio (Leidos). 2014. Remedial Investigation Report for Soil, Sediment, and Surface Water at RVAAP-43 Load Line 10, Ravenna Army Ammunition Plant, Ravenna, Ohio. April.

Massachusetts Department of Environmental Protection (MassDEP). 2002. Background Levels of Polycyclic Aromatic Hydrocarbons and Metals in Soil. May.

Ohio Army National Guard (OHARNG), 2001. *Final Integrated Natural Resources Management Plan and Environmental Assessment for the Ravenna Training and Logistics Site and the Ravenna Army Ammunition Plant, Portage and Trumbull Counties, Ohio, Plan Period FY* 2002 – 2007. October.

Ohio Environmental Protection Agency (Ohio EPA), 2004. *Director's Final Findings and Orders for the Ravenna Army Ammunition Plant, Ravenna, Ohio*. June.

Ravenna Army Ammunition Plan (RVAAP). 2013. FY 2013 Ravenna Army Ammunition Plant Installation Action Plan. Ravenna, Ohio. November.

Rising, B. 2004. Survey of Ultra-Trace Metals in Gas Turbine Fuels. Preprints of Papers-American Chemical Society, Division of Fuel Chemistry, Vol. 49, No. 1, pages 404-406.

Science Applications International Corporation (SAIC), 2010. *Facility-Wide Heath Cleanup Goals for the Ravenna Army Ammunition Plant, Ravenna, Ohio.* March.

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

SAIC, 2011b. *Facility-Wide Quality Assurance Project Plan for Environmental Investigations at the Ravenna Army Ammunition Plant, Ravenna, Ohio.* February.

SAIC, 2011c. *Facility-Wide Field Sampling Plan for Environmental Investigations at the Ravenna Army Ammunition Plant, Ravenna, Ohio.* February.

Shacklette, H.T. and J.G. Boerngen. 1984. Element Concentrations in Soils and

Other Surficial Materials of the Conterminous United States. U.S. Geological Survey Professional Paper 1270.

Teaf, C.M., D.J. Covert, and S.R. Kother. 2008. Urban Polycyclic Aromatic Hydrocarbons: A Florida Perspective. Proceedings of the Annual International Conference on Soils, Sediments, Water and Energy: Vol. 13, Article 23.

United States Army Corps of Engineers (USACE), 1998. *Phase I Remedial Investigation Report of High-Priority Areas of Concern at the Ravenna Army Ammunition Plant, Ravenna Ohio*. 1998.

USACE, 2013. *Final Technical Memorandum for Land Uses and Facility-Wide Cleanup Goals.* September.

United States Army Toxic and Hazardous Materials Agency (USATHMA) 1978. *Installation Assessment of Ravenna Army Ammunition Plant, Records Evaluation Report No. 132*. November 1978.

United States Department of Agriculture (USDA), 2011. *Soil Map of Portage County, Version 4. Website: www.websoilsurvey.nrcs.usda.gov.* November.

United States Environmental Protection Agency (USEPA). 1989. *Risk Assessment Guidance for Superfund, Volume 1: Human Health Evaluation Manual (Part A).* December.

US EPA, 1992. *Guidance for Performing Site Inspections Under CERCLA*. Interim Final. Directive 9345.1-05. EPA540-R-92-021. September.

US EPA, 1999. Improving Site Assessment: Abbreviated Preliminary Assessments. EPA-540-F-98-037. October.

US EPA, 2006. Lead Scavengers Compendium: Overview of Properties, Occurrence, and Remedial Technologies. May.

US EPA, 2013. Regional Screening Levels. Screening Levels for Chemical Contaminants. November.

Vista Sciences Corporation (VISTA), 2012. *Submission Format Guidelines, Ravenna Army Ammunition Plant, Version 20*. March.

Winslow, J.D., and G.W. White, 1966. *Geology and Ground-water Resources of Portage County, Ohio.* Geological Survey Professional Paper 511. 1966

This page intentionally left blank