VOLUME I - TABLE OF CONTENTS

VOLUME I – FIGURES

VOLUME TABLES OF CONTENTS

VOLUME II-A - CONTENTS

VOLUME II-B - CONTENTS

VOLUME II-C - CONTENTS

VOLUME II-D - CONTENTS

VOLUME III - CONTENTS

VOLUME IV - CONTENTS

VOLUME V - CONTENTS

VOLUME V – CONTENTS (Continued)

VOLUME VI - CONTENTS

VOLUME VII - CONTENTS

VOLUME VII – CONTENTS (Continued)

VOLUME VIII - CONTENTS

VOLUME VIII – CONTENTS (Continued)

DOCUMENT DISTRIBUTION

Name/Organization	**No. of Copies**
Irv Venger Ravenna Army Ammunition Plant (RVAAP)	2 + 2 electronic
Major Meade Ohio Army National Guard (OHARNG)	1 + 1 electronic
John Jent United States Army Corps of Engineers (USACE) Louisville District	2 + 2 electronic
Mark Krivansky United States Army Environmental Command (USAEC)	1 electronic
Adam Deck United States Army Center for Health Promotion and Preventive Medicine (USACHPPM)	1 electronic
Andrew Kocher Ohio EPA	1+ 2 electronic

ABBREVIATIONS/ACRONYMS

ADR	Automated Data Review
AOC	Area of Concern
amsl	Above mean sea level
AST	Above Ground Storage Tank
ASTM	American Society for Testing and Materials
bgs	Below ground surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COPC	Chemical of Potential Concern
COPEC	Chemical of Potential Ecological Concern
°F	Degrees Fahrenheit
DOT	Department of Transportation
DQO	Data quality objective
EDD	Electronic data deliverable
EDMS	Environmental Data Management System
EZ	Exclusion Zone
ft	Feet or foot
FSAP	Final Sampling and Analysis Plan
FWERWP	Facility-Wide Ecological Risk Work Plan
FWHHRAM	Facility-Wide Human Health Risk Assessors Manual
FWSAP	Facility-Wide Sampling and Analysis Plan
GPD	Gallons per day
GPM	Gallons per minute
GPS	Global Positioning System
GSA	General Service Administration
ha	hectare
HHRS	Human Health Risk Screening
HMX	High Melting Explosive
IAW	In Accordance With
IDW	Investigation-Derived Waste
in	Inch or inches
IRP	Installation Restoration Program
JMC	Joint Munitions Command
km	kilometer

LCG	Louisville Chemistry Guidance
LDC	Laboratory Data Consultants
LDPE	Low Density Polyethylene
LL	Load Line
LPD	Liters per day
LPM	Liters per minute
MEC	Munitions and Explosives of Concern
mi	Mile or miles
MI	Multi-increment
ml	Milliliter
MKM	MKM Engineers, Inc.
mph	Miles per hour
MS/MSD	Matrix spike/matrix spike duplicate
NGVD	National Geodetic Vertical Datum
NPL	National Priority List
OhioEPA	Ohio Environmental Protection Agency
PCB	Polychlorinated Biphenol
PID	Photo-ionization Detector
PRG	Preliminary Remediation Goals
OHARNG	Ohio Army National Guard
OSHA	Occupational Safety and Health Administration
PAH	Polycyclic Aromatic Hydrocarbons
PRG	Preliminary Remediation Goals
QA	Quality assurance
QAPP	Quality Assurance Project Plan
QC	Quality control
RCRA	Resource Conservation and Recovery Act
RDX	Royal Demolition Explosive
RI	Remedial Investigation
RRSE	Relative-Risk Site Evaluation
RVAAP	Ravenna Army Ammunition Plant
SAIC	Science Applications International Corporation
SAP	Sampling and Analysis Plan
SOP	Standard Operating Procedures
sq ft	Square feet

SRC	site-related chemicals
SSHO	Site Safety Health Officer
SSHP	Site-Specific Safety and Health Plan
STL	Severn Trent Laboratory
SVOC	Semi-Volatile Organic Compound
SZ	Support zone
TCLP	Toxicity Characteristic Leaching Procedure
TNT	Trinitrotoluene
TPH-DRO	Total Petroleum Hydrocarbons – Diesel Range Organics
TPH-GRO	Total Petroleum Hydrocarbons – Gasoline Range Organics
TSCA	Toxic Substance Control Act
TSS	Totally Suspended Solids
USACE	U.S. Army Corps of Engineers – Louisville District
USACHPPM	U.S. Army Center for Health Promotion and Preventative Medicine
USATHAMA	U.S. Army Toxic and Hazardous Materials Agency
USEPA	U.S. Environmental Protection Agency
UST	Underground storage tank
UTL	Upper tolerance limit
UXO	Unexploded ordnance
VOC	Volatile Organic Compound
WP	Work Plan
yd	Yard

EXECUTIVE SUMMARY

This report documents the results of characterization activities undertaken at 14 Ravenna Army Ammunition Plant (RVAAP) Areas of Concern (AOCs). The characterization activities were conducted for the U.S. Army Corps of Engineers, Louisville District (USACE) under General Services Administrator (GSA) Contract No. GS-10F-0542N. The 14 AOCs are located at the U.S. Army Joint Munitions Command's (JMC) RVAAP facility which is located near Ravenna, Ohio. The Characterization was performed in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, following work plans reviewed and approved by the Ohio Environmental Protection Agency (Ohio EPA).

The overall purpose of this report is to describe the characterization activities completed at 14 AOCs at RVAAP, identify human health chemicals of potential concern (COPCs) and chemicals of potential ecological concern (COPECs) for further assessment, and to define the horizontal extent of contamination. The specific objectives of the characterization effort are:

- Collect characterization data using multi-increment (MI) sampling to provide data for future risk assessments that may be conducted;
- Develop and/or update Conceptual Site Models to identify the key elements that should be considered in future actions;
- Assess AOC-specific physical characteristics;
- Assess potential sources of contamination;
- Allow initial assessment of the nature and lateral extent of soil, sediment, surface and groundwater contamination (the depth of contamination was not evaluated for this characterization effort); and
- Conduct a preliminary human health and ecological screening for each of the 12 AOCs where no risk assessments have been conducted previously. (Risk Assessments have been completed for two AOCs – Load Line 12 and NACA Test Area therefore, risk screening was not conducted for these sites.)

This characterization report was produced to fulfill the requirements of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) at RVAAP. This information will be used to provide information and analytical data to support future environmental work and remedial decision making for the 14 AOCs characterized.

PAST INVESTIGATIONS

Several previous assessments, evaluations and investigations have been conducted on the AOCs addressed during this characterization effort. Previous site-wide investigations, from which information was used in the planning for this characterization effort, are as follows:

- 1978 Installation Assessment of Ravenna Army Ammunition Plant (U.S. Army Toxic and Hazardous Materials Agency [USATHAMA] 1978);

- 1989 Preliminary Review and Visual Site Inspection conducted as a part of Resource Conservation and Recovery Act (RCRA) Facility Assessment conducted by the USEPA. (Jacobs Engineering Group, Inc. 1989);
- 1994 Preliminary Assessment Screening of the Boundary Load Line Areas (U.S. Army Environmental Hygiene Agency [USAEHA] 1994);
- 1996 Preliminary Assessment for the Ravenna Army Ammunition Plant (USACE 1996);
- 1996 Relative Risk Site Evaluation, Ravenna Army Ammunition Plant (U.S. Army Center for Health Promotion and Preventative Medicine [USACHPPM] 1996);
- 1998 Relative Risk Site Evaluation for Newly Added Sites at the Ravenna Army Ammunition Plant (USACHPPM 1998); and
- 1998 Phase I Remedial Investigation for High-Priority Areas of Concern at the Ravenna Army Ammunition Plant (SAIC 1998).

Specific information for each of the 14 AOCs from the above listed documents is detailed in each site-specific section of this report.

NATURE OF CONTAMINATION

Within each AOC-specific report, Section 4.0 summarizes all analytical results obtained from the environmental sampling conducted during this characterization effort. The results are organized by media and a table is presented in each AOC-specific report, outlining the number of samples collected and the number of analytical results that exceeded either the RVAAP background criteria or Region 9 Preliminary Remediation Goals (PRGs). Residential soil and tap water Region 9 PRG values were used for soil/sediment and water, respectively. The evaluation completed is a preliminary comparison and is not intended to be used alone for making risk management decisions.

C-Block Quarry (RVAAP-06)

The characterization effort for C-Block Quarry evaluated the nature of potential contamination in:

- Surface soil (0-1 ft),
- Sediment,
- Surface water, and
- Groundwater.

A summary of the analytical results are presented and briefly discussed below.

Surface Soil (0-1 ft)

- Only one explosive (2,4,6-TNT) exceeded the Region 9 residential PRG at one sample location.
- PCBs, VOCs, semi-volatile organic compounds (SVOCs) and Pesticides were below the Region 9 residential PRGs values in all samples collected.
- One propellant (Nitrocellulose) was detected at one sample location.

- Inorganics exceeded RVAAP background and/or Region IX PRG values at all surface soil sample locations.

Sediment

- Explosives, PCBs, VOCs, SVOCs, Pesticides and Propellants were below Region 9 residential PRGs.
- Inorganics exceeded RVAAP background and/or Region 9 residential PRG values at all sediment sample locations.

Surface Water

- PCBs, Explosives, Propellants and Pesticides were below the RVAAP background and Region 9 tap water PRGs.
- Methylene Chloride exceeded the Region 9 tap water PRG at one sample location.
- Bis(2-ethylhexyl)phthalate exceeded the Region 9 tap water PRG value at one sample location.
- Inorganics exceeded RVAAP background and/or Region 9 tap water PRG values at all surface water sample locations.

Groundwater

- Explosives, Propellants, PCBs, VOCs and Pesticides were below the Region 9 tap water PRGs.
- A total of five SVOCs exceeded their respective Region 9 tap water PRG values in three of the groundwater sample locations.
- Inorganics exceeded background and/or Region 9 tap water PRG values at all groundwater sample locations.

Load Line 12 (RVAAP-12)

The characterization effort for Load Line 12 evaluated the nature of potential contamination in groundwater.

A summary of the analytical results are presented and briefly discussed below.

Groundwater

- PCBs, VOCs and Pesticides were below Region 9 tap water PRG values.
- One propellant (Nitrocellulose) was detected three sample locations.
- Six SVOCs exceeded their respective Region 9 tap water PRG values in a total of four sample locations.
- Two explosive (2,4,6-TNT and RDX) exceeded their respective Region 9 tap water PRGs at one sample location.
- Inorganics exceeded RVAAP background and/or Region 9 tap water PRG values at all groundwater sample locations.

Building 1200 (RVAAP-13)

The characterization effort for Building 1200 evaluated the nature of potential contamination in:

- Surface soil (0-1 ft),
- Sediment,
- Surface water, and
- Groundwater.

A summary of the analytical results are presented and briefly discussed below.

Surface Soil (0-1 ft)

- Only one explosive (RDX) exceeded the Region 9 residential PRG at one sample location.
- PCBs, VOCs, and Pesticides were below Region 9 residential PRG values.
- One SVOC (Benzo[g,h,i]perylene) was detected at one sample location.
- One propellant (Nitrocellulose) was detected at one sample location.
- Inorganics exceeded RVAAP background and/or Region 9 residential PRG values at all surface soil sample locations.

Sediment

- Explosives, PCBs, VOCs, and Pesticides were below the Region 9 residential PRG values.
- One SVOC (Benzo[g,h,i]perylene) was detected at one sample location.
- One propellant (Nitrocellulose) was detected at one sample location.
- Inorganics exceeded RVAAP background and/or Region 9 residential PRGs at all sediment sample locations.

Surface Water

- PCBs, VOCs, SVOCs and Pesticides were below the Region 9 tap water PRG values.
- RDX exceeded the Region 9 tap water PRG value at three sample locations.
- One propellant (Nitroglycerine) exceeded the Region 9 tap water PRG at two sample locations.
- Inorganics exceeded RVAAP background and/or Region 9 tap water PRG values at all surface water sample locations.

Groundwater

- Explosives, Pesticides, PCBs, SVOCs, VOCs and Propellants were below the Region 9 tap water PRG values.
- Inorganics exceeded background and/or Region 9 tap water PRGs at three of the four groundwater sample locations.

Landfill North of Winklepeck Burning Grounds (RVAAP-19)

The characterization effort for the Landfill North of Winklepeck Burning Grounds evaluated the nature of potential contamination in:

- Surface soil (0-1 ft),
- Subsurface soil (>1 ft),
- Sediment,
- Surface water, and
- Groundwater.

A summary of the analytical results are presented and briefly discussed below.

Surface Soil (0-1 ft)

- Pesticides, PCBs, VOCs, and explosives were below the Region 9 residential PRG values.
- Only one SVOC (Benzo(a)pyrene) exceeded the Region 9 residential PRG at one sample location.
- One propellant (Nitrocellulose) was detected at two sample locations.
- Inorganics exceeded RVAAP background and/or Region 9 residential PRGs at all surface soil sample locations.

Subsurface Soil (>1 ft)

- Explosives, Pesticides, PCBs, VOCs, SVOCs and Propellants were below the Region 9 residential PRG values.
- Inorganics exceeded RVAAP background and/or Region 9 residential PRG values at all subsurface soil sample locations.

Sediment

- Explosives, Pesticides, PCBs, and VOCs were below the Region 9 residential PRG values.
- One propellant (Nitrocellulose) was detected at one sample location.
- Inorganics exceeded RVAAP background and/or Region 9 residential PRGs at all sediment sample locations.

Surface Water

- Explosives, Pesticides, PCBs, VOCs, and Propellants were below the Region 9 tap water PRG values.
- Five SVOCs exceeded their respective Region 9 tap water PRGs at one sample location.
- Inorganics exceeded RVAAP background and/or Region 9 tap water PRGs at all surface water sample locations.

Groundwater

- Explosives, Pesticides, PCBs, VOCs and Propellants were below the Region 9 tap water PRG values.
- One SVOC (Bis(2-ethylhexyl)phthalate) exceeded the Region 9 tap water PRG one sample location.
- Inorganics exceeded RVAAP background and/or Region 9 tap water PRG values at all groundwater sample locations.

Pistol Range (RVAAP-36)

The characterization effort for Pistol Range evaluated the nature of potential contamination in:

- Surface soil (0-1 ft),
- Sediment, and
- Surface water.

A summary of the analytical results are presented and briefly discussed below.

Surface Soil (0-1 ft)

- Explosives, Pesticides, PCBs, VOCs, SVOCs and Propellants were below the Region 9 residential PRG values.
- Inorganics exceeded RVAAP background and/or Region 9 residential PRGs at all surface soil sample locations.

Sediment

- Explosives, Pesticides, PCBs, VOCs, SVOCs and Propellants were below the Region 9 residential PRG values.
- Inorganics exceeded RVAAP background and/or Region 9 residential PRGs at all surface soil sample locations.

Surface Water

- One chemical (Arsenic) exceeded the Region 9 tap water PRG at the one surface water sample location at the Pistol Range.

NACA Test Range (RVAAP-38)

The characterization effort for NACA Test Range evaluated the nature of potential contamination in groundwater.

A summary of the groundwater analytical results are presented and briefly discussed below.

Groundwater

- Explosives, Pesticides, PCBs and VOCs were below the Region 9 tap water PRG values.
- One propellant (Nitrocellulose) was detected at two sample locations.
- Six SVOCs exceeded the Region 9 tap water PRGs at two sample locations.
- Inorganics exceeded RVAAP background and/or Region 9 tap water PRGs at all groundwater sample locations.

Load Line 5 (RVAAP-39)

The characterization effort for Load Line 5 evaluated the nature of potential contamination in:

- Surface soil (0-1 ft),
- Sediment,
- Surface water, and
- Groundwater.

A summary of the analytical results are presented and briefly discussed below.

Surface Soil (0-1 ft)

- Explosives, Pesticides, PCBs, VOCs, and Propellants were below the Region 9 residential PRGs values.
- Two SVOCs (Benzo(a)pyrene and Benzo[g,h,i]perylene) exceeded their Region 9 residential PRGs at two and three sample locations, respectively.
- Inorganics exceeded RVAAP background and/or Region 9 residential PRGs at all surface soil sample locations.

Sediment

- Explosives, Pesticides, PCBs, VOCs, SVOCs and Propellants were Region 9 residential PRG values.
- Inorganics exceeded RVAAP background and/or Region 9 residential PRGs at all sediment sample locations.

Surface Water

- Explosives, Pesticides, PCBs, VOCs and Propellants were below the Region 9 tap water PRG values.
- A total of six SVOCs exceeded their Region 9 residential PRGs at four sample locations.
- Inorganics exceeded RVAAP background and/or Region 9 tap water PRGs at all surface water sample locations.

Groundwater

- Explosives, Pesticides, PCBs, VOCs, SVOCs and Propellants were below the Region 9 tap water PRG values.
- Inorganics exceeded RVAAP background and/or Region 9 residential PRGs at all groundwater sample locations.

Load Line 7 (RVAAP-40)

The characterization effort for Load Line 7 evaluated the nature of potential contamination in:

- Surface soil (0-1 ft),
- Sediment,
- Surface water, and
- Groundwater.

A summary of the analytical results are presented and briefly discussed below.

Surface Soil (0-1 ft)

- Pesticides, PCBs and VOCs, were below the Region 9 residential PRG values.
- Only one explosive (RDX) exceeded the Region 9 residential PRG at one sample location.
- One propellant (Nitrocellulose) was detected at three sample locations.
- A total of five SVOCs exceeded their Region 9 residential PRGs at four sample locations.
- Inorganics exceeded RVAAP background and/or Region 9 residential PRGs at all surface soil sample locations.

Sediment

- Explosives, Pesticides, PCBs, VOCs, SVOCs, and Propellants were below the Region 9 residential PRG values.
- Inorganics exceeded RVAAP background and/or Region 9 residential PRGs at all sediment sample locations.

Surface Water

- Pesticides, PCBs, and Propellants were below the Region 9 tap water PRG values.
- One VOC (Trichloroethene) exceeded Region 9 tap water PRGs at one sample location.
- RDX exceeded the Region 9 tap water PRG value at eight sample locations.
- A total of eight SVOCs exceeded Region 9 tap water PRGs at three sample locations.
- Inorganics exceeded RVAAP background and/or Region 9 tap water PRGs at all surface water sample locations.

Groundwater

- Explosives, Pesticides, PCBs, VOCs, SVOCs, and Propellants were below the Region 9 tap water PRG values.
- Inorganics exceeded RVAAP background and/or Region 9 tap water PRGs at all groundwater sample locations.

Load Line 8 (RVAAP-41)

The characterization effort for Load Line 8 evaluated the nature of potential contamination in:

- Surface soil (0-1 ft),
- Sediment,
- Surface water, and
- Groundwater.

A summary of the analytical results are presented and briefly discussed below.

Surface Soil (0-1 ft)

- Explosives, Pesticides, PCBs and VOCs were below the Region 9 residential PRG values.
- One SVOC (Benzo(a)pyrene) was detected at two sample locations.
- One propellant (Nitrocellulose) was detected at three sample locations.
- Inorganics exceeded RVAAP background and/or Region 9 residential PRGs at all surface soil sample locations.

Sediment

- Explosives, Pesticides, PCBs, VOCs and SVOCs were below the Region 9 residential PRG values.
- One propellant (Nitrocellulose) was detected at one sample location.
- Inorganics exceeded RVAAP background and/or Region 9 residential PRGs at all sediment sample locations.

Surface Water

- Explosives, Pesticides, PCBs, VOCs, and Propellants were below the Region 9 tap water PRG values.
- A total of five SVOCs exceeded their Region 9 residential PRGs at two sample locations.
- Inorganics exceeded RVAAP background and/or Region 9 tap water PRGs at all surface water sample locations.

Groundwater

- Explosives, Pesticides, PCBs, VOCs, SVOCs, and Propellants were below the Region 9 tap water PRG values.
- Inorganics exceeded RVAAP background and/or Region 9 tap water PRGs at all groundwater sample locations.

Load Line 10 (RVAAP-43)

The characterization effort for Load Line 10 evaluated the nature of potential contamination in:

- Surface soil (0-1 ft),
- Sediment,
- Surface water, and
- Groundwater.

A summary of the analytical results are presented and briefly discussed below.

Surface Soil (0-1 ft)

- Explosives, Pesticides, PCBs, VOCs, SVOCs and Propellants were below the Region 9 residential PRG values.
- Cyanide exceeded background at thirteen sample locations.
- Inorganics exceeded RVAAP background and/or Region 9 residential PRGs at all surface soil sample locations.

Sediment

- Pesticides, PCBs, VOCs and Propellants were below the Region 9 residential PRG values.
- Only one explosive (2, 6-Dinitrotoluene) exceeded the Region 9 residential PRG at one sample location.
- A total of eight SVOCs exceeded their respective Region 9 residential PRGs at one sample location.
- Inorganics exceeded RVAAP background and/or Region 9 residential PRGs at all sediment sample locations.

Surface Water

- Explosives, Pesticides, PCBs, VOCs and Propellants were below the Region 9 tap water PRG values.
- A total of nine SVOCs exceeded their Region 9 residential PRGs at seven sample locations.
- Inorganics exceeded RVAAP background and/or Region 9 tap water PRGs at all surface water sample locations.

Groundwater

- Explosives, Pesticides, PCBs, SVOCs and Propellants were below Region 9 tap water PRG values.
- Carbon Tetrachloride exceeded the Region 9 tap water PRG at two sample locations.
- Inorganics exceeded RVAAP background values at five of the six groundwater sample locations.

Wet Storage Area (RVAAP-45)

The characterization effort for Wet Storage Area evaluated the nature of potential contamination in surface soil (0-1 ft).

A summary of the surface soil (0-1 ft) analytical results are presented and briefly discussed below.

Surface Soil (0-1 ft)

- Explosives, Pesticides, PCBs and VOCs were below the Region 9 residential PRG values.
- Five SVOCs exceeded their Region 9 residential PRGs at one sample location.
- Inorganics exceeded RVAAP background and/or Region 9 residential PRGs at all surface soil sample locations.

Buildings F-15/F-16 (RVAAP-46)

The characterization effort for Buildings F-15/F-16 evaluated the nature of potential contamination in:

- Surface soil (0-1 ft),
- Sediment, and
- Surface water.

A summary of the analytical results are presented and briefly discussed below.

Surface Soil (0-1 ft)

- Explosives, Pesticides, PCBs and VOCs were below the Region 9 residential PRG values.
- One SVOC (Benzo(a)pyrene) exceeded the Region 9 residential PRG at one sample location.
- One propellant (Nitrocellulose) was detected at two sample locations.
- Inorganics exceeded RVAAP background and/or Region 9 residential PRGs at all surface soil sample locations.

Sediment

- Explosives, Pesticides, PCBs, VOCs, SVOCs, and Propellants were below the Region 9 residential PRG values.

- Inorganics exceeded RVAAP background and/or Region 9 residential PRGs at all sediment sample locations.

Surface Water

- Explosives, Pesticides, PCBs, VOCs, SVOCs, and Propellants were below the Region 9 tap water PRG values.
- Inorganics exceeded RVAAP background and/or Region 9 tap water PRGs at one of the three surface water sample locations.

Anchor Test Area (RVAAP-48)

The characterization effort for Anchor Test Area evaluated the nature of potential contamination in:

- Surface soil (0-1 ft) , and
- Subsurface soil (>1 ft).

A summary of the analytical results are presented and briefly discussed below.

Surface Soil (0-1 ft)

- Explosives, Pesticides, PCBs, VOCs, SVOCs, and Propellants were below the Region 9 residential PRG values.
- Inorganics exceeded RVAAP background and/or Region 9 residential PRGs at all surface soil sample locations.

Subsurface Soil (>1 ft)

- Explosives, Pesticides, PCBs, VOCs, SVOCs, and Propellants were below the Region 9 residential PRG values.
- Arsenic, Iron and Manganese exceeded Region 9 residential PRGs in both subsurface soil sample locations; and Chromium exceeded RVAAP background in one of the two subsurface soil sample locations.

Atlas Scrap Yard (RVAAP-50)

The characterization effort for Atlas Scrap Yard evaluated the nature of potential contamination in:

- Surface soil (0-1 ft),
- Sediment,
- Surface water, and
- Groundwater.

A summary of the analytical results are presented and briefly discussed below.

Surface Soil (0-1 ft)

- Explosives, Pesticides, PCBs and VOCs were below the Region 9 residential PRG values.
- A total of five SVOCs exceeded their Region 9 residential PRGs at five sample locations.
- One propellant (Nitrocellulose) was detected at three sample locations.
- Inorganics exceeded background and/or Region IX PRG values at all surface soil sample locations.

Sediment

- Explosives, Pesticides, PCBs, VOCs, and Propellants were below the Region 9 residential PRG values.
- One SVOC (Benzo(a)anthracene) exceeded the Region 9 residential PRGs at one sample location.
- Inorganics exceeded background and/or Region IX PRG values at all sediment sample locations.

Surface Water

- Explosives, Pesticides, PCBs, VOCs and Propellants were below the Region 9 residential PRG values.
- A total of three SVOCs exceeded their respective Region 9 tap water PRGs at three sample locations.
- Inorganics exceeded RVAAP background and/or Region 9 tap water PRGs at all surface water sample locations.

Groundwater

- Explosives, Pesticides, PCBs, VOCs and Propellants were below the Region 9 tap water PRG values.
- Hexavalent Chromium exceeded background at five sample locations.
- Bis(2-ethylhexyl)phthalate exceeded the Region 9 tap water PRG at one sample location.
- Inorganics exceeded RVAAP background and/or Region 9 tap water PRGs at all groundwater sample locations.

HUMAN HEALTH RISK SCREENING (HHRS)

A HHRS was conducted on the analytical data from 12 of the 14 RVAAP AOCs evaluated during this characterization effort. Risk screening was not required for Load Line 12 and the NACA Test Area due to risk assessments performed during previous remedial investigations at these two sites. The methodology used in the HHRS for this characterization is based primarily on the protocol established in the Facility Wide Human Health Risk Assessors Manual (FWHHRAM) (USACE 2004). Technical direction provided during a teleconference with the USACE and Ohio EPA (10 May 2005) was also incorporated into the HHRS evaluation.

HHRS methodology for this characterization effort consists of a data evaluation for the selection of site-related chemicals (SRCs) and COPCs for environmental media as identified in Paragraph 3.5.2 of the FWHHRAM. The results of the HHRS identify the COPCs for each AOC and will be used by decision makers to identify the need for future environmental work. COPCs are identified for an environmental media when the maximum contaminant concentrations exceed EPA Region 9 screening criteria and, for inorganics, RVAAP background concentrations, as identified in paragraph 3.5.2 of the FWHHRAM. Per direction given during the 10 May 2005 teleconference, no surrogates were selected for the purposes of this characterization event. The use of surrogates for screening risk values should be evaluated in any follow on environmental site investigations. A summary of the COPCs selected for each AOC is provided below.

C-Block Quarry (RVAAP-06)

The table below lists the chemicals identified by the HHRS as COPCs for C-Block Quarry.

Table CBL-18			
Chemical of Potential Concern - All Media			
Soils	**Sediment**	**Surface Water**	**Groundwater**
Arsenic	Aluminum	Arsenic	2-methylnaphthalene
Chromium	Vanadium	Iron	Benzo(a)anthracene
Benzo(g,h,i)perylene		Manganese	Benzo(a)pyrene
Phenanthrene		Methylene Chloride	Benzo(b)fluoranthene
2,4,6-TNT		Bis(2-ethylhexyl)phthalate	Bis(2-ethylhexyl)phthalate
2-amino-4,6-dinitrotoluene			Indeno(1,2,3-cd)pyrene
4-amino-2,6-dinitrotoluene			Phenanthrene
Nitrocellulose			

Building 1200 (RVAAP-13)

The table below lists the chemicals identified by the HHRS as COPCs for Building 1200.

Table B12-18			
Chemical of Potential Concern – All Media			
Soils	**Sediment**	**Surface Water**	**Groundwater**
Aluminum	Aluminum	Manganese	Arsenic
Chromium	Benzo(g,h,i)perylene	RDX	
Iron	Nitrocellulose	Nitroglycerine	
Manganese			
Benzo(g,h,i)perylene			
RDX			
Nitrocellulose			

Landfill North of Winklepeck Burning Grounds (RVAAP-19)

The table below lists the chemicals identified by the HHRS as COPCs for Landfill North of Winklepeck Burning Grounds.

Table LNW-21			
Chemical of Potential Concern – All Media			
Soils	**Sediment**	**Surface Water**	**Groundwater**
Copper	Benzo(a)pyrene	Manganese	Arsenic
Iron	Benzo(g,h,i)perylene	Benzo(a)anthracene	Bis(2-ethylhexyl)phthalate
2-Methylnapthalene	Nitrocellulose	Benzo(a)pyrene	
Acenaphthylene		Benzo(b)fluoranthene	
Benzo(a)pyrene		Dibenzo(a,h)anthracene	
Benzo(g,h,i)perylene		Indeno(1,2,3-cd)pyrene	
Phenanthrene			
Nitrocellulose			

Pistol Range (RVAAP-36)

The table below lists the chemicals identified by the HHRS as COPCs for Pistol Range.

Table PIR-15			
Chemical of Potential Concern – All Media			
Soils	**Sediment**	**Surface Water**	**Groundwater**
Arsenic Lead	No COPCs detected	No COPCs detected	Groundwater not sampled

Load Line 5 (RVAAP-39)

The table below lists the chemicals identified by the HHRS as COPCs for Load Line 5.

Table LL5-18			
Chemical of Potential Concern – All Media			
Soils	**Sediment**	**Surface Water**	**Groundwater**
Aluminum Chromium Iron Manganese Mercury 2-Methylnapthalene Acenapthylene Benzo(a)pyrene Benzo(g,h,i)perylene Phenanthrene	Arsenic Cadmium Chromium Copper Iron Lead Vanadium	Benzo(a)anthracene Benzo(a)pyrene Benzo(b)fluoranthene Benzo(g,h,i)perylene Bis(2-ethylhexyl)phthalate Dibenzo(a,h)anthracene Indeno(1,2,3-cd)pyrene Nitrate	Arsenic Manganese

Load Line 7 (RVAAP-40)

The table below lists the chemicals identified by the HHRS as COPCs for Load Line 7.

Table LL7-18			
Chemical of Potential Concern – All Media			
Soils	**Sediment**	**Surface Water**	**Groundwater**
Aluminum	Aluminum	Manganese	Iron
Arsenic	Cadmium	Antimony	Manganese
Chromium	Iron	Trichloroethene	Arsenic
Iron	Lead	1,4-dichlorobenzene	
Manganese		Benzo(a)anthracene	
Silver		Benzo(a)pyrene	
2-methylnaphthalene		Benzo(b)flouranthene	
Benzo(a)anthracene		Benzo(g,h,i)perylene	
Benzo(a)pyrene		Benzo(k)flouranthene	
Benzo(b)flouranthene			
Benzo(g,h,i) perylene			
Dibenzo(a,h)anthracene			
Indeno(1,2,3-cd)pyrene			
Phenanthere			
2-amino-4,6-dinitrotoluene			
RDX			
Nitrocellulose			

Load Line 8 (RVAAP-41)

The table below lists the chemicals identified by the HHRS as COPCs for Load Line 8.

Table LL8-18			
Chemical of Potential Concern – All Media			
Soils	**Sediment**	**Surface Water**	**Groundwater**
Chromium	Arsenic	Manganese	Manganese
Iron	Barium	Benzo(a)pyrene	
Manganese	Iron	Benzo(b)fluoranthene	
2-Methylnaphthalene	Manganese	Benzo(g,h,i)perylene	
Acenaphthalene	Vanadium	Bis(2-ethylhexyl)phthalate	
Benzo(a)pyrene	Benzo(g,h,i)perylene	Dibenzo(a,h)anthracene	
Benzo(g,h,i)perylene	2-Amino-4,6-dinitrotoluene	Indeno(1,2,3-cd)pyrene	
Phenanthrene	Nitrocellulose	Nitrate	
Nitrocellulose			

Load Line 10 (RVAAP-43)

The table below lists the chemicals identified by the HHRS as COPCs for Load Line 10.

Table L10-18			
Chemical of Potential Concern – All Media			
Soils	**Sediment**	**Surface Water**	**Groundwater**
Arsenic	Arsenic	Chromium	Carbon Tetrachloride
Aluminum	Aluminum	Arsenic	Phenanthrene
Benzo(g,h,i)perylene	Barium	Benzo(b)fluoranthene	
Lead	Cadmium	Chrysene	
Chromium	Chromium	Phenanthrene	
Iron	Copper	Iron	
2-methylnaphthalene	Iron	Acenaphthylene	
Phenanthrene	Lead	Benzo(ghi)perylene	
	Vanadium	Dibenzo(a,h)anthracene	
	Antimony	2-Amino-4,6-dinitrotoluene	
	2-Methylnaphthalene	Lead	
	Acenaphthylene	Benzo(a)anthracene	
	Benzo(a)anthracene	Benzo(k)fluoranthene	
	Benzo(a)pyrene	Indeno(1,2,3-cd)pyrene	
	Benzo(b)fluoranthene	4-Amino-2,6-dinitrotoluene	
	Benzo(ghi)perylene	Antimony	
	Benzo(k)fluoranthene	Benzo(a)pyrene	
	Dibenzo(a,h)anthracene	Bis(2-ethylhexyl)phthalate	
	Dibenzofuran	Pentachlorophenol	
	Indeno(1,2,3-cd)pyrene		
	Naphthalene		
	Phenanthrene		
	2,6-Dinitrotoluene		
	2-Amino-4,6-dinitrotoluene		
	4-Amino-2,6-dinitrotoluene		

Wet Storage Area (RVAAP-45)

The table below lists the chemicals identified by the HHRS as COPCs for Wet Storage Area.

Table WSA-7				
Chemical of Potential Concern – All Media				
Soils		**Sediment**	**Surface Water**	**Groundwater**
Arsenic Iron 2-Methylnaphthalene Acenaphthalene Benzo(a)anthracene Benzo(a)pyrene	Benzo(b)fluoranthene Benzo(g,h,i)perylene Dibenzo(a,h)anthracene Indeno(1,2,3-cd)pyrene Phenanthrene Nitrocellulose	No COPCs detected	No COPCs detected	Groundwater not sampled

Buildings F-15/F-16 (RVAAP-46)

The table below lists the chemicals identified by the HHRS as COPCs for Buildings F-15/F-16.

Table F-15/F-16 -15			
Chemical of Potential Concern – All Media			
Soils	**Sediment**	**Surface Water**	**Groundwater**
Arsenic Chromium Iron Thallium 2-Methylnapthalene Benzo(a)pyrene Benzo(g,h,i)perylene Phenanthrene Nitrocellulose	No COPCs detected	Manganese Arsenic 4-Amino-2,6-dinitrotoluene	Groundwater not sampled

Anchor Test Area (RVAAP-48)

The table below lists the chemicals identified by the HHRS as COPCs for Anchor Test Area.

Table ATA-10			
Chemical of Potential Concern – All Media			
Soils	**Sediment**	**Surface Water**	**Groundwater**
Arsenic Chromium Manganese	No COPCs detected	No COPCs detected	Groundwater not sampled

Atlas Scrap Yard (RVAAP-50)

The table below lists the chemicals identified by the HHRS as COPCs for Atlas Scrap Yard.

Table ASY-18			
Chemical of Potential Concern – Soils			
Soils	**Sediment**	**Surface Water**	**Groundwater**
Aluminum	Aluminum	Benzo(a)pyrene	Arsenic
Iron	Iron	2-amino-4,6-dinitrotoluene	Bis(2-ethylhexyl)phthalate
Acenaphthylene	Benzo(a)anthracene	Benzo(b)fluoranthene	
Benzo(ghi)perylene	Arsenic	Indeno(1,2,3-cd)pyrene	
2-amino-4,6-dinitrotoluene	Manganese	Phenanthrene	
Arsenic	2-amino-4,6-dinitrotoluene		
Lead	Barium		
Benzo(a)anthracene	Vanadium		
Dibenzo(ah)anthracene	Cobalt		
Cadmium	Mercury		
Manganese			
Benzo(a)pyrene			
Indeno(1,2,3-cd)pyrene			
Chromium			
2-methylnaphthalene			
Benzo(b)fluoranthene			
Phenanthrene			

ECOLOGICAL RISK SCREENING (ERS)

The goal of this ecological risk screening is to determine COPECs for 12 of the 14 RVAAP AOCs addressed by this characterization effort. Risk screening was not required for Load Line 12 and the NACA Test Area due to risk assessments performed during previous remedial investigations at these two sites. This ecological risk screening provides information to scientists and managers to direct them in future remedial decisions pertaining to each AOC. The ecological risk screening methodology follows the guidance presented in the RVAAP Facility Wide Ecological Risk Work Plan (FWERWP) (USACE, 2003d) and Guidance for Conducting Ecological Risk Assessments (Ohio EPA, 2003).

This ecological risk screening consists of the first two of the six steps listed in Figure III of the RVAAP FWERWP. These two steps identify the evaluation procedures which are used to determine AOC-related COPECs. First, the maximum value of each detected analyte for each sampling matrix at an AOC is compared to its respective facility-wide background concentration. If an analyte concentration is above the respective facility-wide background concentration, the analyte's maximum concentration is compared to an additional screening value, as determined by the hierarchy of screening values. The hierarchy of screening values is based on the guidance found in the FWERWP for each environmental media sampled. A summary of the COPECs selected for each AOC follows.

C-Block Quarry (RVAAP-06)

The table below lists the chemicals identified by the ERS as COPECs for C-Block Quarry.

Table CBL-19			
Chemicals of Potential Ecological Concern– All Media			
Soils	**Sediment**	**Surface Water**	**Groundwater**
Arsenic Chromium Copper Lead Mercury 2,4,6-TNT 2-amino-4,6-dinitrotoluene 4-amino-2,6-dinitrotoluene Nitrocellulose	Beryllium Acetone	Iron Manganese Hexavalent Chromium Mercury Acetone Benzoic Acid Benzyl Alcohol	Groundwater not evaluated for ERS

Building 1200 (RVAAP-13)

The table below lists the chemicals identified by the ERS as COPECs for Building 1200.

Table B12-19

Chemical of Potential Ecological Concern – All Media

Soils	Sediment	Surface Water	Groundwater
Aluminum	Beryllium	Iron	Groundwater not evaluated for ERS
Barium	Mercury	Manganese	
Chromium	Gamma-BHC	Mercury	
Copper	Acetone	Acetone	
Iron	Nitrocellulose	Benzoic Acid	
Lead		Benzyl alcohol	
Manganese			
Selenium			
Zinc			
Mercury			
2,4,6-TNT			
HMX			
RDX			
Nitrocellulose			

Landfill North of Winklepeck Burning Grounds (RVAAP-19)

The table below lists the chemicals identified by the ERS as COPECs for Landfill North of Winklepeck Burning Grounds.

Table LNW-22				
Chemical of Potential Ecological Concern – All Media				
Soils		**Sediment**	**Surface Water**	**Groundwater**
Chromium Copper Iron Lead Silver Zinc	Mercury Beta-BHC Benzoic acid Carbazole Dibenzofuran Nitrocellulose	Nitrocellulose	Manganese Mercury Benzo(a)anthracene Benzo(a)pyrene Benzo(b)fluoranthene Benzo(k)fluoranthene Chrysene Dibenzo(a,h)anthracene Indeno(1,2,3-cd)pyrene	Groundwater not evaluated for ERS

Pistol Range (RVAAP-36)

The table below lists the chemicals identified by the ERS as COPECs for Pistol Range.

Table PIR-16			
Chemical of Potential Ecological Concern – All Media			
Soils	**Sediment**	**Surface Water**	**Groundwater**
Arsenic Chromium Copper Lead Zinc Mercury Nitroglycerin	No COPECs detected	No COPECs detected	Groundwater not evaluated for ERS

Load Line 5 (RVAAP-39)

The table below lists the chemicals identified by the ERS as COPECs for Load Line 5.

Chemical of Potential Ecological Concern – All Media			
Soils	**Sediment**	**Surface Water**	**Groundwater**
Aluminum Chromium Iron Lead Manganese Nickel Selenium Zinc Mercury Aroclor 1254 Carbazole Dibenzofuran 4-Nitrotoluene Nitrate	Arsenic Barium Cadmium Chromium Copper Iron Lead Nickel Selenium Zinc Antimony Mercury Nitrate	Iron Selenium Mercury Benzo(a)anthracene Benzo(a)pyrene Benzo(b)fluoranthene Benzo(g,h,i)perylene Benzo(k)fluoranthene Chrysene Dibenzo(a,h)anthracene indeno(1,2,3-cd)pyrene Nitrate	Groundwater not evaluated for ERS

Load Line 7 (RVAAP-40)

The table below lists the chemicals identified by the ERS as COPECs for Load Line 7.

Table LL7-20

Chemical of Potential Ecological Concern – All Media

Soils	Sediment	Surface Water	Groundwater
Aluminum	Beryllium	Copper	Groundwater not evaluated for ERS
Arsenic	Cadmium	Iron	
Chromium	Copper	Manganese	
Copper	Lead	Zinc	
Iron	Selenium	Lead	
Lead	Zinc	Mercury	
Mangenese	Nitrate	Anthracene	
Silver		Benzo(a)anthracene	
Zinc		Benzo(a)pyrene	
Mercury		Benzo(b)fluoranthene	
Aroclor-1254		Benzo(g,h,i)perylene	
4-methylphenol		Benzo(k)fluoranthene	
Benzo(a)pyrene		Chrysene	
Carbazole		Dibenzo(a,h)anthracene	
Dibenzofuran		Indeno(1,2,3-cd)pyrene	
Naphthalene		HMX	
2,4,6-TNT		Nitrate(as N(N03-N)	
2,6-dinitrotoluene			
2-amino-4,6-dinitrotoluene			
2-nitrotoluene			
3-nitrotoluene			
HMX			
RDX			
Nitrocellulose			
Nitroglycerine			
Nitrate(as N(N03-N)			

Load Line 8 (RVAAP-41)

The table below lists the chemicals identified by the ERS as COPECs for Load Line 8.

Table LL8-19			
Chemicals of Potential Ecological Concern – All Media			
Soils	**Sediment**	**Surface Water**	**Groundwater**
Chromium	Arsenic	Copper	Groundwater not evaluated for ERS
Copper	Barium	Iron	
Iron	Beryllium	Manganese	
Lead	Cadmium	Selenium	
Manganese	Copper	Benzo(a)pyrene	
Zinc	Iron	Benzo(b)fluoranthene	
Mercury	Lead	Benzo(g,h,i)perylene	
Beta-BHC	Manganese	Benzo(k)fluoranthene	
Arochlor 1254	Silver	Benzoic Acid	
Dibenzofuran	Selenium	Benzyl Alcohol	
Tetryl	Mercury	Dibenzo(a,h)anthracene	
Nitrocellulose	4,4'-DDD	Indeno(1,2,3-cd)pyrene	
	4,4'-DDE	Nitrate	
	4,4'-DDT		
	2-Amino-4,6-dinitrotoluene		
	Nitrocellulose		

Load Line 10 (RVAAP-43)

The table below lists the chemicals identified by the ERS as COPECs for Load Line 10.

Table L10-19

Chemical of Potential Ecological Concern – All Media

Soils	Sediment		Surface Water	Groundwater
Aluminum	Arsenic	Benzo(a)anthracene	Aluminum	Groundwater not evaluated for ERS
Arsenic	Barium	Benzo(a)pyrene	Cadmium	
Iron	Beryllium	Benzo(b)fluoranthene	Copper	
Lead	Cadmium	Benzo(ghi)perylene	Iron	
Nickel	Chromium	Benzo(k)fluoranthene	Selenium	
Selenium	Copper	Carbazole	Zinc	
Zinc	Iron	Chrysene	Lead	
Mercury	Lead	Dibenzo(a,h)anthracene	Arsenic	
Chromium	Nickel	Dibenzofuran	Mercury	
Dibenzofuran	Selenium	Fluoranthene	Acenaphthylene	
2,6-Dinitrotoluene	Silver	Fluorene	Anthracene	
	Zinc	Indeno(1,2,3-cd)pyrene	Benzo(a)anthracene	
	Antimony	Naphthalene	Benzo(a)pyrene	
	Mercury	Phenanthrene	Benzo(b)fluoranthene	
	4,4-DDD	Pyrene	Benzo(ghi)perylene	
	4,4-DDE	Total PAHs	Benzo(k)fluoranthene	
	4,4-DDT	2,6-Dinitrotoluene	Carbazole	
	Alpha-chlordane	2-Amino-4,6-dinitrotoluene	Chrysene	
	Dieldrin	4-Amino-2,6-dinitrotoluene	Dibenzo(a,h)anthracene	
	Endosulfan I	Tetryl	Di-n-butyl Phthalate	
	Gamma-chlordane	Nitroguanidine	Fluoranthene	
	2-Methylnaphthalene		Indeno(1,2,3-cd)pyrene	
	Acenaphthene		n-Nitrosodiphenylamine	
	Acenaphthylene		Pentachlorophenol	
	Anthracene		Pyrene	

Wet Storage Area (RVAAP-45)

The table below lists the chemicals identified by the ERS as COPECs for Wet Storage Area.

Table WSA-8				
Chemical of Potential Ecological Concern – All Media				
Soils		**Sediment**	**Surface Water**	**Groundwater**
Arsenic Chromium Iron Lead Nickel Zinc Mercury	Beta-BHC Benzo(a)anthracene Benzo(a)pyrene Carbazole Chrysene Dibenzofuran 3-Nitrotoluene Nitrocellulose	Not Collected	Not Collected	Groundwater not evaluated for ERS

Buildings F-15/F-16 (RVAAP-46)

The table below lists the chemicals identified by the ERS as COPECs for Buildings F-15/F-16.

Table F-15/F-16 -16			
Chemical of Potential Ecological Concern – All Media			
Soils	**Sediment**	**Surface Water**	**Groundwater**
Arsenic Copper Chromium Iron Lead Selenium Zinc Mercury 4,4-DDT Aroclor 1260 Carbazole Dibenzofuran Naphthalene Nitrocellulose Nitroglycerin	Beryllium	Iron Manganese Acetone	Groundwater not evaluated for ERS

Anchor Test Area (RVAAP-48)

The table below lists the chemicals identified by the ERS as COPECs for Anchor Test Area.

Table ATA-11			
Chemical of Potential Ecological Concern – All Media			
Soils	**Sediment**	**Surface Water**	**Groundwater**
Arsenic Chromium Manganese Mercury	Not Collected	Not Collected	Groundwater not evaluated for ERS.

Atlas Scrap Yard (RVAAP-50)

The table below lists the chemicals identified by the ERS as COPECs for Atlas Scrap Yard.

Table ASY-19			
Chemical of Potential Ecological Concern – All Media			
Soils	**Sediment**	**Surface Water**	**Groundwater**
Aluminum Arsenic Barium Cadmium Chromium Copper Iron Lead Manganese Nickel Selenium Silver Zinc Mercury Arcolor 1260 4-methylphenol Benzo(a)pyrene Bis(2-ethylhexyl)phthalate Butylbenzyl phthalate Dibenzofuran Naphthalene 2-amino-4,6-dinitrotoluene 2-nitrotoluene 3-nitrotoluene Nitrocellulose	Arsenic Barium Beryllium Cadmium Cobalt Copper Iron Lead Manganese Nickel Selenium Silver Vanadium Mercury Acetone Benzo(a)anthracene Chrysene Pyrene Total PAHs 2-amino-4,6-dinitrotoluene	Selenium Anthracene Benzo(a)pyrene Benzo(b)fluoranthene Benzo(k)fluoranthene Carbazole Chrysene Indeno(1,2,3-cd)pyrene	Groundwater not evaluated for ERS

CONCLUSIONS

Based on the COPCs and COPECs presented in the AOC specific sections, a full risk evaluation should be considered in the overall risk management decisions that are made for these sites. This characterization did not include a vertical investigation component. Future investigations will be required to evaluate subsurface conditions at all of the 14 AOCs.

1.0 INTRODUCTION

This report documents the results of characterization activities undertaken at 14 Ravenna Army Ammunition Plant (RVAAP) Areas of Concern (AOCs). The characterization activities were conducted for the U.S. Army Corps of Engineers, Louisville District (USACE) under General Services Administrator (GSA) Contract No. GS-10F-0542N. The 14 AOCs are located at the RVAAP facility, which is located near Ravenna, Ohio (Figure1-1). The Characterization was performed in accordance with (IAW) the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, following work plans reviewed and approved by the Ohio Environmental Protection Agency (Ohio EPA).

This document summarizes the results of the activities conducted during the period of October 2004 through May 2005 to characterize 14 RVAAP AOCs. The document is organized into three segments:

Volume I summarizes information about the RVAAP facility that is common for all 14 AOCs, such as the facility description and history. It also describes sampling approaches and field procedures that were implemented to collect the characterization data.

Volume II contains AOC-specific characterization summary reports and sampling results.

Volumes III through VIII contain the document appendices.

1.1 PURPOSE AND SCOPE

The purpose of this report is to document the characterization activities conducted at 14 AOCs at the RVAAP. This report includes the data collected for all applicable media to evaluate risk and assist in the planning of future investigative activities. The goal for these 14 AOCs is to transfer ownership to the Ohio Army National Guard, and to ensure protection of human health and the environment. To meet this goal, additional investigation activities and remedial actions are required to complete the characterization of the 14 AOCs.

The characterization effort includes the following 14 AOCs:

- C-Block Quarry (CBL)
- Load Line 12 (L12)
- Building 1200 (B12)
- Landfill North of Winklepeck Burning Grounds (LNW)
- Pistol Range (PIR)
- NACA Test Area (NTA)
- Load Line 5 (LL5)
- Load Line 7 (LL7)

- Load Line 8 (LL8)
- Load Line 10 (L10)
- Wet Storage (WSA)
- Buildings F-15/F-16 (F-15/16)
- Anchor Test Area (ATA)
- Atlas Scrap Yard (ASY)

The characterization effort for the 14 AOCs was undertaken to accomplish the following:

- Collect characterization data using multi-increment (MI) sampling to provide data for future risk assessments that may be conducted;
- Develop and/or update Conceptual Site Models to identify the key elements that should be considered in future actions;
- Assess AOC-specific physical characteristics;
- Assess potential sources of contamination;
- Allow initial assessment of the nature and lateral extent of soil, sediment, surface and groundwater contamination (the depth of contamination was not evaluated for this characterization effort); and
- Conduct a preliminary human health and ecological screening for each of the 12 AOCs where no risk assessments have been conducted previously. Risk Assessments have been completed for two AOCs –
- Load Line 12 and NACA Test Area. Therefore, risk screening was not conducted for these sites.

The investigation approach to the Characterization at the 14 AOCs involved a combination of field and laboratory activities to characterize the 14 AOCs. Field investigation techniques included surface soil (0-1ft) samples; multi-increment (MI) and discrete MI sediment samples; surface water and sediment samples from sewer/sump locations; soil boring and sampling, surface water; monitoring well installation and development; groundwater sampling; sample and monitoring well location survey; and aquifer testing. The rationale for each AOC-specific sampling plan was biased based on historical information including past usage, past investigations, ecological settings, climatic conditions, and geological and hydrologic characteristics. The field program was conducted in general accordance with the revised (USACE, 2001a) and the Final Sampling and Analysis Plan Addendum FSAP for the characterization of 14 RVAAP AOCs (MKM, 2004).

1.2 BACKGROUND INFORMATION

This section briefly describes the RVAAP facility, the historical activities that occurred there, previous investigations, and the regulatory guidance followed when conducting the characterization effort.

1.2.1 General Facility Description and History

Until 1999, the RVAAP was identified as a 21,419-acre installation. The Ohio Army National Guard (OHARNG) resurveyed the property boundary, finishing in 2003, and the actual total acreage was found to be 21,683.289 acres. As of February 2006, a total of 20,403 acres of the former 21,683-acre RVAAP have been transferred to the United States Property and Fiscal Officer (USP&FO) for Ohio for use as an OHARNG training site. Currently, RVAAP consists of 1,280 acres in several distinct parcels scattered throughout the confines of the OHARNG's Ravenna Training and Logistics Site (RTLS). RVAAP's remaining parcels of land are located completely within the RTLS, and are completely enclosed by the RTLS perimeter fence.

The RTLS is located in northeastern Ohio within Portage and Trumbull Counties, approximately 4.8 kilometers (km) (3 miles) east/northeast of the City of Ravenna and approximately 1.6 km (1 mile) northwest of the Village of Newton Falls. The RVAAP portions of the property are completely located within Portage County. The RTLS (inclusive of RVAAP) is a parcel of property approximately 17.7 km (11 miles) long and 5.6 km (3.5 Miles) wide. The facility is bounded by State Route 5, the Michael J. Kirwan Reservoir, and the CSX System Railroad on the south; Garrett, McCormick, and Berry Roads on the west; the Norfolk Southern Railroad on the north; and State Route 534 on the east.

The RTLS is surrounded by several communities: Windham on the north, Garrettsville 9.6 km (6 miles) to the northwest; Village of Newton Falls 1.6 km (1 mile) to the southeast; Charlestown to the southwest, and Wayland 4.8 km (3 miles) to the south. RTLS did not exist when the RVAAP was operational, and the entire 21,683-acre parcel was a government-owned, contractor-operated (GOCO) industrial facility. The RVAAP Installation Restoration Program (IRP) encompasses investigation and clean up of past activities over the entire 21,683 acres of the former RVAAP, so references to the RVAAP in this document consider the historical extent of the RVAAP, inclusive of the combined acreages of the current RTLS and RVAAP, unless otherwise specifically stated.

1.2.2 Previous Investigations

Several previous assessments, evaluations and investigations have been conducted on the AOCs addressed in this characterization effort. Previous site-wide investigations, from which information was used in the planning for this characterization effort are as follows:

- 1978 *Installation Assessment of Ravenna Army Ammunition Plant* (U.S. Army Toxic and Hazardous Materials Agency [USATHAMA] 1978);
- 1989 Preliminary Review and Visual Site Inspection conducted as a part of Resource Conservation and Recovery Act (RCRA) Facility Assessment conducted by the USEPA. (Jacobs Engineering Group, Inc. 1989);
- 1994 Preliminary Assessment Screening of the Boundary Load Line Areas (U.S. Army Environmental Hygiene Agency [USAEHA] 1994).
- 1996 Preliminary Assessment for the Ravenna Army Ammunition Plant (USACE 1996);

- 1996 *Relative Risk Site Evaluation (RRSE), Ravenna Army Ammunition Plant* (U.S. Army Center for Health Promotion and Preventative Medicine [USACHPPM] 1996);
- 1998 Relative Risk Site Evaluation for Newly Added Sites at the Ravenna Army Ammunition Plant (USACHPPM 1998); and
- 1998 Phase I Remedial Investigation (RI) for High-Priority Areas of Concern at the Ravenna Army Ammunition Plant (SAIC 1998);

Additionally, previous AOC-specific investigations are listed in Section 1.2.2 of each site-specific report, provided in Volume II.

1.2.3 Authorities and Responsibilities

The approach used to address environmental conditions at RVAAP is regulatory based on the frameworks established by CERCLA, Resource Conservation an Recovery Act, Toxic Substance Control Act (TSCA) and applicable State environmental regulations. CERCLA activities are funded under the Installation Restoration Program (IRP). The Ohio EPA is the lead environmental regulatory agency in the oversight of environmental activities at RVAAP.

- National Environmental Policy Act (NEPA)- 1969
  *42 USC Paragraphs 4321-4370a
  **CFR 1500-1508)
- Comprehensive Environmental Response, Compensation, and Liable Act
  USC Paragraphs 9601-9675
  40 CFR 300,302
- Emergency Planning and Community Right-to-Know Act
  42 USC Paragraphs 11001-11050
  CFR 355
- Toxic Substances Control Act
  USC Paragraphs 2601-2671
  40 CFR 702-799
- Clean Water Act
  33 USC Paragraphs 1251-1387
  33 CFR 320-330
- Safe Drinking Water Act
  42 USC Paragraphs 300f-300j-26
  CFR 141-149
- Clean Air Act
  USC 7401-7626
  40 CFR 50-52
- Endangered Species Act
  16 USC Paragraphs 1531-1544
- Executive Order 12580- designates the Department of Defense as the lead agency with the responsibility for responding to any releases from DoD facilities.

- Ohio Revised Code 3745: Environmental Protection Agency
- Ohio Administrative Code 3745-27-13: Authorization to Engage in Filling, Grading, Excavating, Building, Drilling, or Mining on Land Where a Hazardous Waste Facility or Solid Waste Facility Was Operated
- (Ohio EPA) Director's Final Findings and Orders, June 10, 2004
- Facility-Wide Sampling and Analysis Plan (FWSAP) for Environmental Investigations at the RVAAP, March 2001
- Facility-Wide Safety and Health Plan for Environmental Investigations at the RVAAP, March 2001
- Final Environmental Information Management Plan for RVAAP, March 2001

*USC = United States Code
** CFR = Code of Federal Regulation

1.2.4 Regulatory Status of AOCs

While the AOCs addressed by this characterization effort are inactive, none of the 14 AOCs has achieved response complete status. Additional environmental investigations may be required for vertical and possibly horizontal delineation of contaminants of concern.

2.0 ENVIRONMENTAL SETTINGS AT RVAAP

This section describes the physical characteristics of RVAAP and its adjacent environment that are factors in interpreting the potential contaminant transport pathways, receptor populations, and exposure scenarios with respect to the evaluation of human health and ecological risks.

2.1 SURFACE FEATURES

The topography of the RVAAP is characterized by gently undulating contours that decrease in elevation from a topographic high in the far western portion of the facility of approximately 1220 feet above mean sea level (ft amsl) to lows in far eastern portion of the facility of approximately 930 ft amsl.

USACE mapped the installation topography in February, 1998 using a 5.1-cm (2-ft) contour interval with an accuracy of 0.51 mm (0.02 foot). USACE based the topographic information on aerial photographs taken during spring 1997. The USACE survey is the basis for the topographical information illustrated in figures found in this characterization report.

2.2 METEOROLOGY AND CLIMATE

The general climate of the RVAAP 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. The following climatological data was obtained from the National Weather Service Office (NWS 1995) at the Youngstown-Warren Regional Airport located in Trumbull County and are based on a 30-year average.

Total annual rainfall in the RVAAP area is approximately 37.3 inches (in), with the highest monthly average occurring in July (4.07 in) and the lowest monthly average occurring in February (2.03 in). Average annual snowfall totals approximately 56.2 inches with the highest monthly average occurring in January (12.9 in). It should be noted that due to the influence of lake-effect snowfall events associated with Lake Erie (located approximately 35 miles to the northwest of RVAAP), snowfall totals vary widely throughout northeastern Ohio. The average annual daily temperature in the RVAAP area is 48.3 degrees Fahrenheit (ºF), with an average daily high temperature of 57.7 ºF and an average daily low temperature of 38.7ºF. The record high temperature of 100ºF occurred in July 1988, and the record low temperature of minus 22ºF occurred in January 1994.

The prevailing wind direction at RVAAP is from the southwest, with the highest average wind speed occurring in January (11.6 miles per hour [mph]) and the lowest average wind speed occurring in August (7.4 mph). Thunderstorms occur on approximately 35 days per year and are most abundant from April through August. The RVAAP area is susceptible to tornadoes; minor structural damage to several buildings on the facility occurred as the result of a tornado in 1985.

2.3 SURFACE WATER HYDROLOGY

The entire RVAAP facility is situated within the Mahoning River Basin, with the West Branch of the Mahoning River representing the major 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 M.J. Kirwan Reservoir, which is located to the south of State Route 5. The West Branch flows out of the reservoir along the southern facility boundary before joining the Mahoning River east of the RVAAP.

The western and northern portions of the RVAAP 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 facility's hills. Three primary water courses drain RVAAP: (1) the South Fork of Eagle Creek; (2) Sand Creek; and (3) Hinkley Creek. These water courses have many associated tributaries. Sand Creek, with a drainage area of 36 sq km (13.9 sq mi), flows generally in a northeast direction to its confluence with the South Fork of Eagle Creek. In turn, the South Fork of Eagle Creek then continues in a northerly direction for 4.3 km (2.7 miles) to its confluence with Eagle Creek. The drainage area of the South Fork of Eagle Creek is 67.8 sq km (26.2 sq mi), including the area drained by Sand Creek. Hinkley Creek originates just southeast of the intersection between State Routes 88 and 303 to the north of the facility. Hinkley Creek, with a drainage area of 28.5 sq km (11.0 sq mi), flows in a southerly direction through the facility to its confluence with the West Branch of the Mahoning River south of the facility.

Approximately 50 ponds are scattered throughout the facility. Many were built 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. None of the ponds within the installation are used as a water supply source. Storm water runoff is controlled primarily by natural drainage except in facility operations areas where an extensive storm sewer network helps to direct runoff to drainage ditches and settling ponds. In addition, the storm sewer system was one of the primary drainage mechanisms for process effluent during the period that production facilities were in operation.

2.4 GEOLOGY

This section describes the glacial deposits and bedrock found at RVAAP.

2.4.1 Glacial Deposits

RVAAP is located within the Glacial Allegheny Plateau physiographic region (White,1982) of Ohio (Figure 2-1). Pennsylvanian bedrock is overlain by Wisconsinian-Age glacial deposits. Two glacial advances during the Wisconsin Age of the Pleistocene Epoch resulted in the deposition of glacial till over the entire RVAAP installation. The first glacial advance deposited the Lavery Till over the facility. The Lavery Till is found in the western part of the installation and the younger Hiram Till consists mostly of clay and silt with a few cobbles and sporadic boulders. The second glacial advance deposited the Hiram Till over the eastern two-thirds of the facility only. The Hiram Till consists of 12 percent sand, 41 percent silt, and 47 percent illite and chlorite clay minerals, and ranges in depth from 1.5 to 4.6 m (5 to 15 ft) below ground surface (bgs). The Hiram Till has the highest clay content of tills in northeastern Ohio (White, 1982). Unweathered Hiram Till is dark gray and turns a dark brown when exposed to the atmosphere. The Hiram Till overlies thin beds of sandy outwash material in the far northeastern corner of the facility. Soil associated with the Hiram Till at RVAAP includes the Mahoning silt loam complex. The thickness of the glacial deposits varies across the installation. Other RVAAP documents have stated that a buried valley may cut across part of the installation. However, no presence of the valley has been discovered during investigation activities to date. Field observations indicate that overall till thickness is less than 0.6 m (2 ft) in some areas of the RVAAP facility. The reduced till thickness may be due to natural erosion or construction grading operations and is not necessarily the result of deposition.

Subsurface lithology at RVAAP consists mostly of clay to sand-rich silt tills with interbedded sands scattered throughout. These deposits are generally firm, low to moderately plastic, and tend to hold water where encountered. Deposits with higher concentrations of sand and gravel generally control the elevation of the shallow water table zone, and bioturbation has been observed to act as a conduit for the local shallow water table at various locations. Cross-sections of the subsurface illustrate the lateral distribution and variation of these discontinuous glaciated sediments.

2.4.2 Sedimentary Rocks

The bedrock geology of RVAAP consists of Carboniferous Age sedimentary rocks that lie stratigraphically beneath the glacial deposits of the Lavery and Hiram tills. The oldest bedrock within the facility is the Cuyahoga Group of the Mississippian Age. Three members comprise this formation: (1) the Orangeville Shale, (2) the Sharpsville Sandstone, and (3) the Meadville Shale. The Cuyahoga outcrops in the far northeastern corner of the facility and generally consists of a blue-gray silty shale with interbedded sandstone. The regional dip of the Cuyahoga strata is between 1.5 and 3.0 m (5 and 10 ft) per mile to the south. The remainder of the facility is underlain by bedrock associated with the Pottsville Formation of Pennsylvanian Age. The Pottsville Formation, which lies unconformably on an erosional surface of the Cuyahoga Group, is divided into four members: (1) the Sharon, (2) the Connoquenessing Sandstone, (3) the Mercer, and (4) the Homewood Sandstone. The Sharon Member consists of two individual units: the Sharon Conglomerate and the Sharon Shale.

The Sharon Conglomerate is porous, coarse-grained, gray-white sandstone that often exhibits thin layers of milky white quartz pebbles. The Sharon Conglomerate also has locally occurring thin shale lenses in the upper portion of the unit. Due to the differences in lithology between the

Sharon Conglomerate and the underlying shales of the Cuyahoga Group, the contact between the Pottsville and Cuyahoga Groups usually is quite distinct. The Sharon Shale overlies the Sharon Conglomerate and consists of sandy, gray-black, fissile shale with some plant fragments and thin flagstone beds. Sharon sandstones are exposed on the ground surface at Load Line 1 and the former Ramsdell Quarry. The Connoquenessing Sandstone member of the Pottsville Group unconformably overlies the Sharon Member and is a medium- to coarse-grained, gray-white sandstone with more feldspar and clay than the Sharon Conglomerate. Thin interbeds and partings of sandy shale also are common in the Connoquenessing. The Mercer member of Pottsville Group overlies the Connoquenessing and 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 Member of the Pottsville Group unconformably overlies the Mercer member and consists of coarse-grained crossbedded sandstones that contain discontinuous shale lenses. The Connoquenessing, Mercer, and Homewood members are present only in the western half of the RVAAP facility. The Sharon Conglomerate unit is the upper bedrock surface in most of the eastern half. The regional dip of the Pottsville Group strata is between 1.5 and 3.5 m per 1.6 km (5 and 10 ft per mi) to the south.

2.5 SOIL

According to the Soil Survey of Portage County, Ohio (USDA, 1978) RVAAP soils are described as being nearly level to gently sloping, and are poor to moderately well drained. Four soil types are generally found across the site: Mahoning silt loam (0-2% and 2-6% slopes), Trumbull silt loam (0-2% slopes) and Ellsworth silt loam (6-12% slopes). Ellsworth silt loam is characterized by sloped soil along drainage pathways, rapid runoff and severe erosion. Deep, poorly drained soil that is nearly level along drainage pathways characterize the Trumbull silt loam, while the Mahoning silt loam is characterized by more gently sloped land with medium to rapid runoff with severe seasonal wetness and slow permeability.

2.6 HYDROGEOLOGY

This section describes the unconsolidated sediments and bedrock characteristics found at RVAAP.

2.6.1 Unconsolidated Sediments

Saturated sands and gravels are found within the glacial outwash and buried valley sediments in Portage County. Wells drilled into these saturated zones may provide sufficient potable water for residential use.

The largest groundwater supplies within Portage County come from two buried valleys that underlie Franklin, Brimfield, and Suffield townships and Streetsboro, Shalersville, and Mantua townships, respectively. The sand and gravel within these buried valleys are favorably situated to receive recharge from surface streams and surface infiltration (precipitation). The water-bearing characteristics for the sand and gravel aquifers in the vicinity of the RVAAP installation are poorly documented. Wells that penetrate these aquifers can yield up to 6,080 liters per minute (LPM) [1,600 gallons per minute (GPM)]. However, yields from wells penetrating silty or clay till materials are significantly lower. In general, the Lavery and Hiram tills are too thin and impermeable to produce useful quantities of water.

2.6.2 Bedrock

The Sharon Conglomerate bedrock was the primary source of potable groundwater during RVAAP's active phase. Most facility production wells were completed in this unit, although some wells were completed in the overlying Sharon Shale. The highest yields were determined to come from the quartzite pebble conglomerate facies and from jointed and fractured zones. Competent bedrock was encountered during this investigation at C-Block Quarry, Building 1200, Load Line 7 and Load Line 10.

The most important bedrock sources of groundwater in the vicinity of the RVAAP facility are the sandstone/conglomerate members of the Pottsville Group. These aquifers, together with two other deeper Mississippian/Devonian sandstone aquifers, represent the most important bedrock sources of groundwater in Northeastern Ohio. The Sharon Conglomerate is the primary source of groundwater at RVAAP and maintains the most significant well yields of the Pottsville Group members with hydraulic conductivity values of from 19 to 7,600 liters per day per meter (lpd/m) [from 5 to 2,000 gallons per day per foot (gpd/ft)]. Past studies of the Sharon Conglomerate indicate that the highest yields are associated with the true conglomerate phase (coarse-grained sandstone with abundant quartzite pebble) and with joints and fractures in the bedrock; however, there is no facility-specific information available regarding variations in aquifer properties due to these factors. Where present, the overlying Sharon Shale acts as a relatively impermeable confining layer for the Sharon Conglomerate. Several flowing artesian production wells have been noted at the facility. The Connoquenessing Sandstone and the Homewood Sandstone are the remaining aquifers of the Pottsville Group and exhibit hydraulic conductivities that vary from 19 to 1,140 lpd/m (from 5 to 300 gpd/ft) and from 19 to 760 lpd/m (from 5 to 200 gpd/ft), respectively. Well yields in the Connoquenessing and Homewood sandstones, although lower than the Sharon Conglomerate, are high enough to provide significant quantities of water. Several wells at the RVAAP facility have penetrated both the Sharon Conglomerate and the Connoquenessing Sandstone and reportedly produced water from both units. In general, hydraulic conductivities in the shales of the Sharon and Mercer members of the Pottsville Group are low and result in insignificant groundwater yields. The primary porosity of the shales is likely secondary, owing to joints and fractures in the bedrock; however, there is no facility-specific information available regarding the occurrence of joints and fractures in these units.

2.6.3 Current Groundwater Utilization

Production wells scattered throughout the facility provided necessary sanitary and process water for historical RVAAP operations. By 1992, all process production wells had been abandoned.

Currently, only two groundwater production wells remain in operation. These wells, located in the central portion of the facility, provide sanitary water and potable water to on-site personnel. The two water supply wells are located in the administration area. One is located immediately west of Bldg 1034 (between the parking lot and George Rd). The other is located in the field behind (west side) Bldg 1039. Both wells are set in the Pennsylvanian Pottsville Group and Mississippian Cuyahoga Group Sandstones. Residential groundwater use in the surrounding area is similar to that for RVAAP, with the Sharon Sandstone acting as the major producing aquifer in the area. The Connoquenessing Sandstone and the Homewood Sandstone also provide limited groundwater resources, primarily near the western half of the RVAAP facility. Many of the local residential wells surrounding RVAAP are completed in the unconsolidated glacial material.

2.7 DEMOGRAPHY AND LAND USE

The population centers closest to RVAAP include the city of Ravenna, (population 11,771) located approximately 3.2 km (2 mi) from the western installation boundary in Portage County, and the city of Newton Falls (population 5,002), located approximately 1.6 km (1 mi) from the southeastern installation boundary in Trumbull County. According to the 2000 Census, the total populations of Portage and Trumbull counties were 152,061 and 225,116, respectively. Larger towns near RVAAP include Akron (25 mi to the west-southwest) and Youngstown (30 mi to the east-southeast).

The RVAAP installation is located in a rural area, and is not close to any major industrial or other developed areas. Based on data from the United States Census Bureau (1992) and the Portage County Soil and Water Conservation District Resources Inventory (1985), approximately 55 percent of Portage County, in which a majority of RVAAP acreage is located, consists of either woodland or farmland acreage. The Michael J. Kirwan Reservoir (also known as the West Branch Reservoir) is the closest major recreational area and is located south of State Route 5, nearest to the western half of RVAAP.

2.8 ECOLOGY

Before the government acquired the property in the 1940's, much of the land at RVAAP was cleared for agricultural use. Over 80 percent of RVAAP is now forest. In the remaining 20 percent of the facility, the limited field cover growth is the result of earlier agricultural practices that left these sites with poor top soil that still limits forest regeneration. Several thousand acres of agricultural fields were planted with trees during the 1950s and 1960s, but in areas with poor topsoil, these plantings did not take well. Some of these fields were also leased for cattle grazing during the same period, which subsequently delayed in their reversion to forest. Selected areas of the installation are routinely brush hogged, such as areas used for OHARNG training and the current administration area adjacent to Post 1.

Portions of the RVAAP facility satisfy the regulatory definition of jurisdictional wetland. Wetland areas at RVAAP include seasonally saturated wetlands, wet fields and forested wetlands.

Most of these wetland areas exist because of poorly drained and hydric soil; however, some wetland areas are associated with anthropogenic settling ponds and drainage areas. Many of the wetland areas are the result of natural drainage or beaver activity. Beaver impoundments contribute to wetland diversification on the site. The potential for impacts on wetland areas at RVAAP is real due to the amount of process effluent discharged to settling ponds and the natural drainage of the area in the past.

The flora and fauna presented at RVAAP are varied and widespread. A total of 18 plant communities have been identified on facility property including marsh, swamp and forest communities. Twelve plant species listed as Ohio State Potentially Threatened have been identified at RVAAP. These include:

- Gray Birch, *Betula populifolio;*
- Butternut, *Juglans cinerea;*
- Northern Rose Azalea, *Rhododendron nudiflorum var. roseum;*
- Hobblebush, *Viburnum alnifolium;*
- Long Beech Fern, *Phegopteris connectilis (Thelypteris phegopteris);*
- Straw Sedge, *Carex staminea;*
- Water Avens, *Geum rivale*
- Tall St. John's Wort, *Hypercium majus;*
- Swamp Oats, *Sphenopholis pensylvanica;*
- Shinning Ladies'-tresses, *Spiranthes lucida;*
- Arbor Vitea, *Thuja occidentalis; and*
- American Chestnut, *Castanea dentate.*

A complete list of all rare species (plant and animal) found on RVAAP is provided in Appendix B.

Various animals have been identified on installation property, including 35 species of mammals, 211 species of birds, and 45 species of fish. Animal species listed as Ohio State Endangered (1999 inventory) include the Northern Harrier, Golden-winger warbler, Yellow-bellied Sapsucker, Mountain Brook Lamprey, Graceful Underwing, Tufted Moisture-loving moss, American Bittern, Bobcat, Osprey, Narrow-necked Pohl's moss, Sandbill crane, and the Trumpeter Swan. Several animal species present at RVAAP are also listed as Ohio State Special Concern.

These include:

- Pygmy Shrew, *Sorex hovi;*
- Star-nosed Mole, *Condylura cristata;*
- Woodland jumping mouse, *Napaeozapus insignis;*
- Sharp-shinned hawk, *Accipiter striatus;*

- Marsh wren, *Cistothorus palustris;*
- Henslow's sparrow, *Ammodramus henslowii;*
- Cerulean warbler, *Dendroica cerulean;*
- Prothonotary warbler, *Protonotaria citrea;*
- Bobolink, *Dolichonyx oryzivorus;*
- Northern bobwhite, *Colinus virginianus;*
- Common Moorhen, *Gallinua chloropus;*
- Great egret, *Casmerodius albus (migrant);*
- Sora, *Porzana Carolina;*
- Virginia Rail, *Rallus limicola;*
- Creek heelsplitter, *Lasmigona compressa;*
- Eastern Box Turtle, *Terrapene carolina;*
- Four-toed salamander, *Hemidctylium scutatum;*
- Mayfly, *Stenonema ithica;*
- Moth, *Apamea mixta;*
- Moth, *Brachylomia algens; and*
- Sedge wren, *Cistothorus.*

Restricted land use and sound forest management practices have preserved and enabled large forest tracts to mature. Habitat conversion at RVAAP has focused on restoration of the forests that covered the area prior to its being cleared for agriculture. The reversion of these agricultural fields to mature forest provides a diversity of habitats from old field through several successional stages. Overall, the trend towards forest cover enhances the area for use by forest species, both plant and animal.

Future remedial activities will require consideration of these species to ensure detrimental effects on threatened or endangered RVAAP flora and fauna do not occur. There are no federal, state or local parks or protected areas on RVAAP facility property.

3.0 RVAAP 14 AOC CHARACTERIZATION

This section describes the field and analytical methods implemented during the characterization activities. The field and analytical programs were conducted in accordance with the RVAAP Facility Wide Sampling and Analysis Plan (USACE, 2001), the RVAAP 14 AOCs FWSAP Addendum (MKM, 2004), and the Work Plan for the RVAAP 14 AOCs (MKM, 2004). Investigation objectives and sampling methods and procedures are briefly discussed in this section. Specific information on sample locations, numbers of samples, analysis conducted and sampling rationale is presented in the AOC-specific sections of this report.

3.1 FIELD ACTIVITIES

Field activities, which were conducted from August 2004 through February 2005, included:

- Mowing/clearing sampling areas and access routes;
- Conducting a munitions and explosives of concern (MEC) avoidance screen before field activities were initiated;
- Staking sampling locations and grid corners;
- Conducting a geophysical survey at Atlas Scrap Yard;
- Excavating test trenches;
- Establishing work zones;
- Establishing temporary decontamination areas;
- Training project personnel (i.e. sampling technicians and sample processing technicians) on project specific procedures;
- Collecting multi-increment (MI) surface soil (0-1ft) samples;
- Collecting MI subsurface soil samples (5 increments composite per sample) at Anchor Test Area,
- Collecting discrete surface soil (0-1ft) samples;
- Collecting MI sediment samples;
- Collecting discrete sewer/sump surface water samples;
- Collecting discrete sewer/sump sediment samples;
- Collecting subsurface soil samples (Geoprobe);
- Collecting surface water samples;
- Installing and developing monitoring wells;
- Collecting geotechnical samples from the borings (Shelby Tubes);
- Conducting in-situ permeability testing (slug tests);
- Collecting groundwater samples from monitoring wells;
- Collecting water levels measurements;
- Surveying sampling and monitoring well locations;
- Processing MI surface soil (0-1ft) samples, MI sediment samples, MI subsurface soil samples, and discrete surface soil (0-1ft) samples; and
- Packing and shipping samples.

The following sections summarize the activities conducted during the characterization effort. A photographic log of the characterization activities is provided in Volume III, Appendix C.

3.1.1 MEC Avoidance

Before initiating any field activities, a MEC survey was conducted at each AOC to ensure worker safety during the characterization activities. A UXO-qualified technician surveyed all areas where personnel and/or equipment might traverse. Anomalies were noted and safe pathways were established. Additionally, the MI sampling points within the grids were pre-cleared by a UXO-qualified technician. Before any boring activities were initiated, the surface of the boring location was cleared and an anomaly-free area was established for the intrusive activities. Down-hole surveying was conducted at two-foot intervals to a depth of four feet. All MEC activities were conducted as specified in the MEC Avoidance Plan found in Attachment 1 of the RVAAP 14 AOCs SAP Addendum. Appendix D contains the UXO Avoidance Summary Report. Photographs of these activities (Photo 003, 004 and 005) are located in Appendix C Photo Log.

3.1.2 Mowing/Clearing of Sample Locations

Ground level vegetation was mowed using a hydroaxe or brush hog, or hand-cleared using a chainsaw, machete and weed eater. The vegetation was cut or cleared to allow personnel and equipment to safely access the designated sampling locations. Photographs 001 and 002 located in Appendix C Photo Log are examples of these activities.

3.1.3 Staking Sampling Locations and Grid Corners

Stakes were placed at the approximate discrete surface soil (0-1 ft) sampling locations and at the groundwater monitoring well locations. MI sampling locations (grids) were delineated by staking the four corners of the targeted collection area. Using a random zig-zag pattern, a UXO-qualified technician randomly selected 32 sampling points within each grid. As the technician selected each sampling point, he used Schonstedt magnetometer to determine whether any anomalies were present. If an anomaly was identified during the pre-sampling clearance activity, the sampling location was moved (within the grid). The technician cleared 32 rather than 30 sampling points within each grid to provide contingent sampling points if refusal was met when the samples were collected.

3.1.4 Geophysical Survey

Geophysical screening, which consisted of an electromagnetic conductivity survey, was performed at Atlas Scrap Yard where Service Stations 1 and 2 had been located. The screening was conducted to locate any remaining underground storage tanks (USTs). This screening activity was performed using both EM-31 and EM-61 units. The locations of electromagnetic anomalies (if any) were flagged. The results of the geophysical screen are discussed in the Atlas Scrap Yard Report (Volume II-D). Appendix T contains the geophysical survey report for Atlas Scrap Yard.

3.1.5 Trenching

Test trenches were excavated at AOCs where drilling was conducted and no pre-existing groundwater monitoring wells had been installed. Test trenches were not excavated at Load Line 12, where existing monitoring wells and previous trenching had been completed, or at C-Block Quarry, where bedrock was found at the ground surface. The trenching activities provided information about the soil stratification profile, depth to groundwater, and depth to bedrock. Trenching was conducted as directed in Section 4.4.2.4.2 of the FWSAP as outlined below, although no samples were collected during the trenching operations. In addition, standard operating procedures (SOP-34) for trenching are included in Appendix C of the Site-Specific Safety and Health Plan (SSHP) addendum for the RVAAP 14 AOCs (MKM, 2004).

- Using a wheeled backhoe (John Deer 310 Extendahoe), soil was removed to a maximum depth of 12 ft.
- Soil was removed in 2 to 3 ft lifts and placed adjacent to the excavation.
- A geologist noted the stratigraphic profile of the soils in the trench. When the trench reached a depth that inhibited profiling from the surface, the backhoe brought soil to the top of the trench where the geologist assessed and profiled the stratigraphic characteristics in the excavator bucket.
- When the required information (depth to bedrock or groundwater and stratigraphic profile information) was obtained, the excavated soil was returned to the trench.
- After the soil was replaced in the trench, it was graded and compacted.
- Perimeter air monitoring was conducted using an MIE pdr-1000 Particulate Air Monitor and a Photovac Model 2020 Photoionization Detector (PID) with a 10.6 eV lamp. A daily calibration check for each PID was recorded at the beginning of the day and periodic checks were made throughout the day to ensure against instruments drift. No volatile organic compounds (VOCs) were detected during the air monitoring. Calibration logs are maintained in MKM’s project files and available for review upon request.

Trenching was halted immediately upon encountering bedrock or groundwater (water that flows at a rate greater than one gallon per minute). No suspect soils or MEC were found or removed from the trenches at any of the AOCs. Details on the trenching operations can be found in the corresponding AOC-specific reports. Photographs of these activities are found in Appendix C Photo Log (006, 007 and 008).

3.1.6 Monitoring Well Installation and Development

Two drilling methods were utilized to install the 62 groundwater monitoring wells: hollow stem auger (HSA) for unconsolidated material or air rotary for bedrock wells. All the wells were installed under the direct supervision of a qualified geologist. Sections 4.4.2.4 and 4.4.2.5 of the FWSAP describe how the HSA drilling was conducted in saturated conditions or refusal due to proximity to bedrock. When bedrock was encountered above saturated conditions the borehole was advanced in two stages. The first stage involved using an air core barrel to cut and retrieve a representative core of the bedrock formation. The core barrel was advanced to saturated conditions with enough footage below to accommodate the monitoring well. After coring operations were completed, a tri-cone rotary bit was advanced on air to establish a borehole with sufficient dimensions (borehole reamed to a minimum or 6.5 inch diameter) to accommodate monitoring well installation. Section 4.3.2.3.2 of the FWSAP describes the air rotary drilling method. Photograph 041 in Appendix C Photo Log illustrates this activity.

An eight-to-10.25 inch inside diameter, hollow-stem auger was used to advance the borehole through unconsolidated material. Upon encountering bedrock, the remainder of the drilling was conducted using the air rotary method. Monitoring wells were constructed in each borehole, following termination of drilling at the appropriate depth per Section 4.3.2.3.3 of the FWSAP. Monitoring wells were constructed according to the following procedures:

- A 3.05 m (10 ft) section of new, pre-cleaned 5.0 cm (2.0 inch) Schedule 40 polyvinyl chloride (PVC) 0.010 slot screen was set to straddle the static water level determined during drilling activities.
- The wells were completed to the surface using new, Schedule 40 PVC risers. The screen and risers were placed into the borehole through the drill stem augers during well construction.
- Clean Global No. 5 sand filter pack was tremied in place from the bottom of the boring to approximately 0.6 m (2 ft) above the top of the well screen.
- The filter pack was sealed with 0.6 m (2 ft) of bentonite pellets. A Type 1 Portland cement with 7% bentonite grout was tremied to complete the remainder of annular space to the surface.
- Each well was finished at the surface with a protective steel surface casing. Three steel posts were installed around each well. A sloping concrete pad was constructed around the exterior of the protective steel surface casing in accordance with the facility-wide SAP.

Materials and construction requirements for monitoring wells can be found in Section 4.3.2.2 of the FWSAP. Any field changes to the materials and procedures outlined in the FWSAP are described in the AOC-specific sections of this report. Well construction diagrams are found in Appendix H.

Before initiating well development activities, MKM requested a technical change to shorten the time between well installation and well development. MKM received verbal approval from the Ohio EPA to shorten the waiting period from 14 days to seven days. Well development was conducted as specified in the FWSAP Section 4.3.2.3.11. Development of monitoring wells was started no sooner than 48 hrs. and no later than 7 days beyond the placement of the internal mortar collar. At least five borehole volumes and five times any hydration volume were removed from each well using a submersible pump. MKM received approval to terminate development after a maximum of seven borehole volumes were removed from the monitoring well if groundwater parameters did not stabilize within 10%. Any changes in the development procedures were noted and can be found in the AOC-specific sections of this report. Well development records are provided in Appendix H. Photographs 047 through 056 (Photolog Appendix C) represent the described activities.

3.1.7 Work Zones

During drilling and trenching operations, MKM established work zones. The work zone (exclusion zone [EZ]) was delineated by yellow “DO NOT ENTER” caution tape and road cones. Due to the number of field personnel entering and leaving different AOCs during any given sampling day, roads leading to the AOC were blocked with caution tape or the AOC perimeter fence was locked. A sign-in log that tracked the whereabouts of field personnel and visitors was maintained at Building 1036.

3.1.8 Temporary Decontamination Area

A temporary field decontamination area was constructed to decontaminate the drill rigs, augers, rods, and other associated equipment and personnel. A field decontamination area was located outside the main gate of Load Line 6 in the parking area. A lined decontamination pad was constructed to capture the decontamination fluids. In addition, several IDW water and clean water above ground storage tanks (ASTs) were staged at this location. A second decontamination area, located in Building 1036, was used to decontaminate smaller sampling and processing equipment. ASTs were located behind Building 1036 to store IDW water. All sampling and drilling equipment was decontaminated as outlined in Sections 4.4.2.8 and 4.3.8 of the FWSAP. Photographs of these activities are found in Appendix C Photo Log (083 and 084).

3.1.9 Personnel Training

Before initiating field activities, MKM provided site-specific training to the project team members. The training summarized the purpose of and approach for MI sampling. This training reviewed the concepts of random sampling, emphasized the importance of accurately processing samples, and explained the importance of handling samples and equipment in a manner that avoided cross-contamination. Each crew received a checklist developed by the Field Investigation Task Manager and the QA/QC Task Manager that detailed the steps to be completed for a particular activity. A mock field exercise was held to allow staff members to become familiar with the equipment used during the investigation. Photograph 012 (Photo Log Appendix C) is an example of this activity.

All contractor/subcontractor personnel who performed in field activities participated in a project kickoff meeting. During this time, the Project Manager, SSHO, Task QA/QC Manager and Field Investigation Task Manager discussed the goals and objectives of the characterization project; reviewed details about the approved SAP, Quality Assurance Project Plant (QAPP) and SSHP and explained the importance of complying with those documents; explained the responsibilities associated with each work assignment; and reviewed the health and safety requirements of the investigation.

Unique procedural or AOC-specific aspects of the investigation were highlighted. Prior to initiating a specific field task, personnel were briefed about pertinent sections of the SAP Addendum. Photograph 011 (Photo Log Appendix C) portrays the activity. The briefing also reviewed the health and safety requirements for the task.

Daily task-order safety briefings were conducted during the course of the field effort. Photograph 010 in Appendix C is an example of this activity. The SSHO compiled all pertinent Occupational Safety and Health Administration (OSHA) training and medical monitoring records for the MKM and subcontractor staff involved with field activities. Copies of these records were maintained at the MKM field office.

3.1.10 Sampling Activities

Sampling crews collected soil, sediment, surface water, groundwater and geotechnical samples. The characterization field activities were performed in a well-defined and consistent manner that complied with the approved plans and the FWSAP. This approach resulted in data that is comparable between sampling locations and could be validated against all applicable QA/QC requirements. Samples were tracked within Building 1036 during sample receiving, processing and shipping through the use of log in/out sheets at each process station. This section describes the methods and procedures, or references sections of the FWSAP that describe the methods and procedures, that are applicable to the following field activities:

- MI surface soil (0-1 ft) sampling;
- MI subsurface soil sampling (> 1 ft);
- Discrete surface soil (0-1 ft) sampling;
- MI sediment sampling;
- Discrete sewer/sump water sampling;
- Discrete sewer/sump sediment sampling;
- Subsurface (Geoprobe®) soil sampling;
- Surface water sampling;
- Geotechnical sampling;
- Groundwater sampling;
- Water level measurements;
- Sampling location survey;
- MI sample processing; and
- Packing and shipping samples.

3.1.10.1 MI Surface Soil (0-1 ft)

MI surface soil (0-1ft) samples were collected as specified in Appendix O that was part of USACE's 11 May 2004 Scope of Work (found in Attachment 2 of the RVAAP 14 AOCs SAP Addendum). A table (Titled Summary of Sampling and Analysis) is provided within each AOC specific report which lists all the QA/QC samples collected (e.g., background, duplicates, field blanks, rinsate blanks and /or MS/MSD). The following procedures were used to collect MI surface soil (0-1 ft) samples:

- The corners of the MI sampling grids were surveyed and staked;
- Thirty-two (32) sampling points were randomly selected using the "drunken sailor walk" or random zigzag pattern described in Attachment 2 of the USACE scope of work, and marked with a pin flag denoting a MEC-cleared sample point;
- Surface vegetation and roots were scraped aside or removed;
- A stainless steel soil push probe was advanced using direct pressure or a slide hammer. If refusal occurred using the push probe, a paint-free carbon steel mattock was employed to obtain each aliquot.
- An aliquot of soil (0 to 1 ft bgs) was collected at 30 of the 32 sampling points and placed into a plastic-lined 5 gallon bucket. Commercially available low density polyethylene (LDPE) liners were used for sampling. All equipment blanks for MI soil samples included the plastic liners in the rinsate. No analytical results were affected by the use of the plastic liners based upon the equipment blank results. The 30 aliquots were combined to make one MI sample. One MI sample covered a drying tray to 1 inch in thickness. The actual volume varied based on grain size and organic content of the soil.

- After the last increment was collected, the plastic bag was sealed with duct tape and labeled with the sample's ID number, sampling time and date.
- MI samples were transported to Building 1036 where they were processed, packed and shipped.

Appendix C Photolog contains Photographs 013 thru 022 that depict the activities mentioned in this section.

3.1.10.2 MI Subsurface Soil Sampling

The USACE SOW specified that two subsurface MI samples be collected from the Anchor Test Area. As stated in the May 2004 SOW, agreed upon by the USACE and Ohio EPA before the request for proposal (RFP), only five aliquots were collected from the two subsurface sampling grids. Samples from a depth of 1 to 3 ft and a depth of 3 to 5 ft were collected. The following procedures were used:

- The corners of the MI sampling grids were surveyed and staked;
- Five sampling points were targeted in the sand pit area of Anchor Test Area and each point was marked with a pin flag to denote it was a MEC-cleared sampling point;
- Surface vegetation and roots were scraped aside or removed;
- Using a stainless steel bucket hand auger, a boring was advanced from 1 to 3 ft. A second bucket hand auger was used to collect soils from the 3 to 5 ft interval at the same boring location. The 0 to 1 ft interval within this grid was sampled using the surface soil (0-1 ft) MI sampling procedures;
- Five aliquots of soil were collected from the 1 to 3 ft sampling intervals and five aliquots were also collected from the 3 to 5 ft sampling intervals. The five 1 to 3 ft interval aliquots were combined to make one MI sample and the five 3 to 5 ft interval aliquots were combined to make an additional MI sample;
- After the last increment was collected, the plastic bag was sealed with duct tape and labeled with the sample ID, sample time and date; and
- MI samples were transported to Building 1036 where they were processed, packed and shipped.

3.1.10.3 Discrete Surface Soil (VOC)

A discrete surface soil (0-1 ft) VOC sample was collected as part of the full-suite MI surface soil (0-1 ft) samples. In addition, some discrete VOC samples were strategically located to characterize areas with a high probability of VOC contamination. All discrete VOC samples were collected as specified in Section 4.5.2.1.1 (bucket hand auger method) of the FWSAP or using a stainless steel push probe. For VOC samples collected as part of an MI sample, the following procedures were used:

- When collecting MI samples from a grid slated for full-suite analyses, the VOC sample was collected from the location thought to be most likely to contain volatile contaminants (i.e., outside doorway, stained soil). Random locations were selected when no other visual determination could be made.
- After the MI sample was collected, the sampling technician returned to the selected VOC sampling point.
- Using a stainless steel bucket hand auger or push probe, a boring was advanced from 0 to 1 ft.

- The soil was immediately placed into a pre-cleaned container labeled with the sample's ID number, sampling time and date.
- The filled container was placed on ice for transport to Building 1036 where the samples were packed and shipped.
- Discrete VOC samples were not processed.

3.1.10.4 MI Sediment

MI sediment samples were collected as outlined in Appendix O of the USACE SOW and Section(s) 4.5.2.2.1 and/or 4.5.2.2.2 of the FWSAP. The following procedures were used:

- If the water body was shallow enough, the corners of the MI sampling grids were marked using stakes driven into the sediment.
- Within the staked decision unit boundaries, 32 sampling points were randomly selected using a random zigzag pattern. Care was taken to start at one end of the staked area and zigzag toward the opposite side.
- An aliquot of sediment was collected at 30 of the 32 sampling points.
- If the depth of the water body was too deep to collect samples by wading in the water, the sampling team used a boat. The boundaries of the MI sampling area were staked and an aliquot of sediment was collected from 30 sampling points within those boundaries.
- The 30 aliquots were collected using either a stainless steel spoon (shallow ponds) or a hand core sampler (deeper ponds) and placed into a plastic-lined 5 gallon bucket. The 30 aliquots were combined to make one MI sample.
- After the last increment was collected, the plastic bag was sealed with duct tape and labeled with the sample's ID number, sampling time and date.
- Saturated MI sediment samples were not dried or sifted. Rather they were homogenized in their saturated state and placed in small increments into the appropriate pre-cleaned sample containers.

Depending on seasonal weather conditions, RVAAP ditches may have water in them and at other times are dry. When the sampling team collected an MI sediment sample from a ditch, they evaluated whether the ditch is dry most of the year or whether it carries or contains water most of the year. If the ditch is normally dry, the MI sample was handled as a soil sample; if the ditch is normally wet, the MI sample was handled as a sediment sample. A portion of the sediment samples were tested for grain size and total organic content. Photo Log Appendix C contains photograph 023 that depicts the activities mentioned in this section.

3.1.10.5 Discrete Sediment (VOC)

A discrete sediment VOC sample was collected as part of each full-suite MI sediment sample. All discrete VOC samples were collected as specified in Section 4.5.2.1.1 (bucket hand auger method) of the FWSAP or using a stainless steel push probe. The following procedures were used:

- When collecting MI sediment samples from a grid slated for full-suite analyses, the sampling crew evaluated the location of the 30 aliquots. The aliquot location that was most likely to have VOC contamination was noted.
- After the MI sample was collected, the sampling technician returned to the selected VOC sample point.
- Using a stainless steel bucket hand auger or push probe, a boring was advanced from 0 to 1 ft.
- The sample was immediately placed into a pre-cleaned sample container labeled with the sample's ID number, sampling time and date. The filled container was immediately placed on ice.
- Samples were transported to Building 1036 where they were packed and shipped.
- Discrete VOC samples were not processed.

3.1.10.6 Discrete Sewer/Sump Water

Sewer/sump water samples were collected from sanitary sewers and sumps as described in the USACE SOW. Sewers at the AOCs ranged in depth from 4 to 20 ft. Sumps were approximately 6 ft in depth. Due to their age, sewers at the AOCs were in poor condition and unsafe to enter using the steel rungs. Therefore, sewer and sump water samples were collected from the surface. Many of the sewers scoped for sample collection did not contain enough media to provide a sample. If an alternate sewer was present, it was sampled instead.

Samples that could not be obtained using the method presented in the approved work plan were collected using alternate sampling techniques developed by MKM and approved by the Ohio EPA via verbal or email approval. The following procedures were used:

- If the sewer or sump was deep enough, the sample was collected using a Teflon® dipper, bailer, or scoop as specified in Section 4.6.2.1.2 of the FWSAP.
- If the amount of water was insufficient for sampling using a dipper, bailer or scoop, a flexible silicone tube was lowered into the water and then the water was pumped to the surface using a peristaltic pump. The water was pumped directly into a sample container.
- The samples were placed on ice and transported to Building 1036 for packaging and shipping.

By using the alternate method, MKM collected a large percentage of sewer water samples that would have been impossible to collect using approved sampling methods. If a sample could not be obtained, it was noted on a field sampling report. Photographs of these activities (Photos 024 through 032) are located in Appendix C Photo Log.

3.1.10.7 Discrete Sewer/Sump Sediment

Sewer/sump sediment samples were collocated with the sewer/sump water samples. Sewer/sump water samples were collected before the sewer/sump sediment samples were collected. Like the water samples, sewer sediment samples were collected from the surface.

The following procedures were used:

- Sewer/sump sediment samples were collected using a long-handled Teflon® scoop or a telescoping pole with a swivel cup attachment. The sampling device was lowered from the surface and scraped along the bottom of the sewer/sump.
- The samples were placed on ice and transported to Building 1036 for packaging and shipping.

In many cases, not enough media was present or recoverable to comprise a viable sample. Many of the sewers/sumps scoped for sample collection did not contain enough media to provide a sample. If a sample could not be obtained, it was noted on a field sampling report. Photographs 033 through 035 (Photo Log Appendix C) is an example of this activity.

3.1.10.8 Subsurface Soil Sampling (Geoprobe®)

Soil boring samples were collected at the landfill located north of Winklepeck Burning Grounds using the hydraulic direct-push technology (Geoprobe®) as outlined in Section 4.4.2.1.5 of the FWSAP. Soil borings were advanced to determine the horizontal extent of the landfill and to characterize the subsurface soil. Seventeen soil borings were advanced at the AOC. The following procedures were used:

- Using a geoprobe, 2 in. by 4 ft. butyl-acetate lined split spoons were advanced into the subsurface.
- If soil was collected in the tube, a sample was collected from each two foot interval (2 to 4 ft., 4 to 6 ft. and 6 to 8 ft. bgs) to a depth of 8 ft.
- The headspace reading was recorded, as previously described in Section 3.1.5, and soil from the interval with the highest PID reading was placed into pre-cleaned sample containers and sent to the laboratory for analysis.

Photographs 036 thru 040 (Photolog Appendix C) portray the activities described.

3.1.10.9 Surface Water Sampling

Surface water samples were collected in accordance with Section 4.6.2.1.1 and 4.6.2.1.2 of the FWSAP. The procedure is outlined below:

- Water quality measurements (pH, turbidity, conductivity, dissolved oxygen content and temperature) were recorded just before each sample was collected. A hand-held bottle, a Teflon® dipper or a scoop was lowered into the surface water and allowed to fill.
- The water was containerized, the container was labeled and the sample was placed on ice.
- The samples were transported to Building 1036 for packing and shipping.

Photographs 045 and 046 (Photo Log Appendix C) are examples of the activities.

3.1.10.10 Geotechnical Sampling

Geotechnical samples were collected from a representative number of borehole locations at AOCs where groundwater wells were installed. The number of geotechnical samples collected varied from AOC to AOC.

Geotechnical samples were collected as specified in Section 4.4.2.4 of the FWSAP. The following procedures were used to collect geotechnical samples:

- Samples were collected using a hollow stem auger equipped with a Shelby (thin-walled) sampling device;
- When the sampling device was retrieved, the percent recovery was noted and the ends of the tube were sealed with wax to preserve moisture content; and
- The Shelby tube samplers were prepared for shipment to the laboratory as required by ASTM Method K1587-83.

Photographs 042 through 044 represent the activities and are included in Photo Log Appendix C.

3.1.10.11 Groundwater Sampling

Before collecting groundwater samples, each monitoring well's condition was evaluated and noted as required by Sections 4.3.2.3.11.4 and 4.3.2.3.13 of the FWSAP. Casing headspace was field screened at each well using a handheld PID as previously described in Section 3.1.5. Water level measurements were collected as specified in Section 4.3.2.6 of the FWSAP. Field water quality measurements were collected as specified in Section 4.3.3 of the FWSAP using a Horiba U-10 or U-22 water meter. Monitoring wells were purged per Section(s) 4.3.4.1 (conventional well purging) and/or 4.3.4.2 (micro-purging) of the FWSAP. Purging continued until water quality indicators such as pH, temperature, dissolved oxygen and conductivity were stabilized (three consecutive readings within 10% of each other). Samples were collected within 24 hours of purging at each monitoring well.

Either a 2-inch bailer or low-flow technology (less than 500 ml per minute of purge/sample rate) was used to collect groundwater samples. If low flow technology was appropriate, a QED Sample Pro bladder pump with an associated pump controller and flow cell was used. Low flow samples were collected using bonded LDPE and Teflon® lined tubing (1/8" x ¼" OD). Groundwater samples were collected as specified in Section 4.3.4 of the FWSAP. Samples that were to be analyzed for TAL dissolved metals were field-filtered per Section 4.3.5 of the FWSAP. Samples were immediately placed into a cooler containing ice and submitted to the laboratory under a completed chain of custody. Groundwater samples were collected from:

- Sixty-two monitoring wells installed during this characterization study;
- Fourteen existing monitoring wells at Load Line 12; and
- One existing background well at Building 1200.

Photographs 057 through 068 (Photolog Appendix C) illustrate the activities in this section.

3.1.10.12 In-Situ Permeability Testing

In-situ permeability testing (slug testing) was performed on the 62 newly-installed monitoring wells to estimate the hydraulic conductivity of the media surrounding each well screen. A transducer was used to collect the falling and rising head data. First, the rising head test was conducted by inserting a stainless steel slug into the well and recording water levels until the groundwater returned to static levels. After it was determined that the groundwater elevations had stabilized, the falling head test was conducted by removing the slug and collecting data until static conditions were achieved. Slug test data records are provided in Appendix K. Photo 061 (Photolog Appendix C) is an example of this activity.

3.1.10.13 Water Level Measurements

Static water level and total depth measurements of the monitoring wells were measured and recorded on three separate occasions. Water level measurements were collected as specified in Section 4.3.3.2 of the FWSAP. This data provides information about the groundwater flow underlying each AOC. These water level readings were collected during February, March, and May 2005. Groundwater elevation data are included in Appendix M.

3.1.11 Sampling Location Survey

Each newly-installed monitoring well, soil, surface water and sediment sampling location was surveyed as specified in Section 4.3.2.3.12 of the FWSAP.

- Monitoring well survey vertical control was within 0.01 ft accuracy and horizontal control was within 1 ft accuracy.
- Vertical datum was in 1929 National Geodetic Vertical Datum (NGVD) and Ohio State plane coordinates were in NAD83.
- Corners of multi-increment sampling grids, discrete soil/sediment locations and surface water locations were surveyed using a Trimble© Model TSCe Pro XRS sub-meter global positioning system (GPS) unit.

Monitoring well location survey data can be found in Appendix N while the soil, surface water, and sediment sampling location survey data can be found in Appendix S. Photographs 069 through 073 (Photolog Appendix C) depict the activities described.

3.1.12 MI Sample Processing

Attachment 2 (Guidance for Multi-increment Sampling) in the SAP Addendum to the FWSAP (MKM, 2004) describes the procedures that were used to process MI samples. The following clarifications/modifications to those methods were incorporated:

- After being received from the sampling crew, MI samples were placed on plastic lined aluminum trays to be air dried. All samples were air dried. No supplemental sources for drying were used for drying samples. The sample ID number was written on a label and attached to the tray.
- The trays were placed on drying racks in a small, enclosed room in Building 1036. A dehumidifier was placed in the drying room to facilitate the removal of water from the sample media. Temperature and humidity were monitored and regulated within the drying room. Temperature was maintained between 70 to 75˚F (21 to 24˚C) and humidity was maintained at approximately 25 to 35 percent.

- To meet laboratory hold times, MI samples were dried and processed for no longer than two days.
- After drying, each sample was sieved through a Number 4 screen, then through a Number 10 screen, to remove stones and residual organic material.
- Grinders, equipped with a removable stainless steel cup and blade, were used to grind samples into a fine powder. The grinders were disassembled and decontaminated after processing each sample.
- MI samples were sieved, ground and containerized under an exhaust hood to eliminate the dust inhalation hazard and to avoid cross-contamination of samples. The exhaust hoods were vented through pre-filters and HEPA filters and the air was re-circulated into Building 1036.
- VOC samples were collected as discrete samples whether or not they were part of an MI sample suite. VOC samples collected as part of an MI sample suite were collected from a discrete location within the associated grid and biased toward the most likely area of potential VOC contamination based on a visual assessment and knowledge of the processes that occurred at the AOC. VOC samples were containerized in the field and were not subjected to sample processing or air drying.

Photographs 074 through 082 (Photolog Appendix C) portray activities described.

3.1.13 Investigation-Derived Waste (IDW)

During the field activities, investigation-derived waste was generated. The accumulated soil and water was characterized and disposed. Representative composite samples of the waste materials were collected and analyzed per the requirements of the disposal facility. Soil was analyzed for explosives, propellants, PCBs, Cr +6, TPH-GRO, TPH-DRO, reactivity, corrosivity, ignitability and full toxicity characteristic leaching procedure (TCLP). Wastewater was analyzed for VOC, SVOC, explosives, TAL metals, propellants, pesticides, polychlorinated biphenols (PCBs), Cr +6, TSS, TPH-GRO, TPH-DRO, reactive cyanide and sulfide, reactivity, corrosivity, ignitability, full TCLP and TCLP percent solids. The following summarizes the RVAAP 14 AOCs waste management disposition operations:

- Excess soil cuttings, generated from soil sampling, drilling operations and sediment sampling, disposable PPE, and disposable sampling equipment and supplies were containerized in two 20 yd roll off containers and stored until disposition. Based on the analytical results of the composite sample, the soil and associated materials were determined to be non-hazardous. These materials were transported by McCutcheon Enterprises, Inc. to the McCutcheon Enterprises Biosolids Treatment Facility in Apollo, PA and disposed.
- Monitoring well installation, development, purging activities and equipment decontamination generated IDW wastewater. The IDW wastewater was stored in two 1500 gallon poly ASTs and one 6000 gallon steel AST. Based on laboratory analytical results, the wastewater was determined to be non-hazardous. The IDW wastewater was transported by McCutcheon Enterprises, Inc. to its Apollo, PA facility for disposal.

All IDW was collected, stored, sampled, analyzed, and disposed in a manner that complies with all applicable federal, state, and/or local rules, laws, and regulations. Appendix U contains copies of the chain-of-custody forms for composite waste characterization samples, the analytical reports, and manifests used to track the IDW.

3.1.14 Sample Packaging and Shipping

All samples were packaged and shipped per Section 6.0 of the FWSAP and Section 6.2 of the RVAAP 14 AOCs SAP Addendum. Samples were properly packaged for shipment and dispatched to Severn Trent Laboratories (STL) for analysis under completed chain-of-custody forms. When transferring the possession of samples, the individuals relinquishing custody and the individual receiving the samples signed their names and noted the date and time of transfer on the record. All shipments complied with applicable Department of Transportation (DOT) regulations for environmental samples. Photograph 087 (Photo Log Appendix C) is an example of this activity.

3.2 DATA ANALYSIS AND QUALITY

This section briefly describes the data quality procedures that were followed during the RVAAP 14 AOCs Characterization and the quality of the data collected.

3.2.1 Laboratory Analysis

Analytical laboratory procedures were completed in accordance with applicable professional standards, EPA requirements, government regulations and guidelines, and specific project goals and requirements. All samples collected during the investigation were analyzed by Severn Trent Laboratory, a USACE Center of Excellence-validated laboratory. With the exception of nitroguanidine and nitrocellulose analyses, all chemical analyses were performed at STL's Chicago, IL laboratory. Nitroguanideine and nitrocellulose analyses were preformed at STL's Sacramento, CA laboratory. All geotechnical parameters were performed by Prime Engineering, Inc. located in Akon, OH.

An MKM technician collected USACE's quality assurance (QA) split samples for each media. These split samples were prepared, packaged and submitted to PDC Laboratories in Peoria, IL for analysis. Laboratories supporting this work have statements of qualifications including organizational structures, QA manuals and standard operating procedures, which are available upon request.

Samples were analyzed as specified by the FWSAP for RVAAP (USACE, 2001a), the SAP Addendum for the Characterization of the RVAAP 14 AOCs (MKM, 2004), and the USACE Louisville Chemistry Guidance (LCG) (USACE 2002). The Data Quality Objectives (DQO) established for the Characterization of the RVAAP 14 AOCs comply with EPA Region V guidance. The requirements for sample collection, handling, analysis criteria, target analytes, laboratory criteria, and data validation criteria at the RVAAP 14 AOCs are consistent with EPA requirements for National Priority List (NPL) sites. DQOs for this project included analytical precision, accuracy, representativeness, completeness, comparability and sensitivity for the measurement data.

The analytical laboratories were required to strictly adhere to the SAP and LCG and to ensure quality data would be provided. The laboratory was required to perform all analyses in compliance with EPA SW-846 (EPA 1990), Test Methods for Evaluating Solid Waste, Physical/Chemical Methods analytical protocols. EPA SW-846 chemical analytical procedures were followed for the analyses of metals, VOCs, SVOCs, pesticides, PCBs, explosives, and cyanide. Laboratories were required to comply with all methods as written; recommended procedures suggested in the methods were considered requirements.

Geotechnical samples were collected and tested for the following parameters:

- Atterberg limits; specific gravity;
- Moisture content;
- Grain size;
- pH; and
- Total organic content.

All geotechnical analyses were completed according to the American Society for Testing and Materials (ASTM) methods specified in the FWSAP.

The requisite number of QA/quality control (QC) samples was obtained during the RVAAP 14 AOCs. QC samples for this project included equipment rinses, field blanks, trip blanks, field duplicates, laboratory method blanks, laboratory control samples, laboratory duplicates and matrix spike/matrix spike duplicate (MS/MSD) samples. These samples were collected to meet the following requirements:

- Laboratory method blanks and laboratory control samples were employed to determine the accuracy and precision of the analytical method as implemented by the laboratory.
- Matrix spike samples provided information about the effect of the sample matrix on the measurement methodology.
- Laboratory sample duplicates and MS/MSDs assisted in determining the analytical reproducibility and precision of the analysis for the samples of interest.
- Equipment rinseate blanks and trip blanks were submitted for analysis along with field duplicate (co-located) samples and “multi-increment QA” samples to provide a means to assess the quality of the data resulting from the field sampling program.
- Equipment rinseate blanks were used to assess the adequacy of equipment decontamination processes prior to sample collection. Photographs 085 and 086 (Photo Log Appendix C) illustrate the process described.
- Trip blanks were used to assess the potential for VOC contamination of samples due to contaminant migration during sample shipment and storage.
- Field duplicate samples were analyzed to determine multi-increment sample heterogeneity and sampling methodology reproducibility as well as multi-increment sample processing accuracy.
- Field “multi-increment QA” samples were collected and analyzed to determine the multi-increment sample reproducibility.

Using USACE-provided Automated Data Review (ADR), Version 5 software, STL provided analytical electronic data deliverables (EDDs) in ADR-ready format. The ADR software reviewed the data automatically for questionable data and qualified non-conforming data as “rejected.” This ADR-“rejected” data was then manually reviewed by Laboratory Data Consultants (LDC), Inc. to determine usability.

Additionally, analytical data report packages and ADR-ready EDDs from STL were forwarded to LDC for QA review, comparison, and validation. The QC results were evaluated and are summarized in Appendix V.

MKM will maintain the RVAAP 14 AOCs project files including all relevant records, reports, logs, field notebooks, pictures, subcontractor reports, correspondence and chain-of-custody forms. These files will remain in the custody of the MKM Project Manager until they are transferred to USACE and RVAAP.

3.2.2 Data Review, Validation, and Quality Assessment

Analytical data was produced, reviewed and reported by the laboratory as specified in the RVAAP 14 AOCs SAP, USACE LCG (Rev 5), and the laboratory's QA manual. Laboratory reports included documentation verifying compliance with sample log-in procedures, analytical holding times, and QC procedures for analyses. The laboratory reports also provide information pertaining to percent recovery attained in laboratory spike samples, calibration curves (initial and continuing), dilutions, and detection limits. The laboratory flagged suspect data if results warranted.

STL performed in-house analytical data reduction under the direction of their Project Manager and QA Officer. These individuals assessed data quality and informed MKM about any data that were considered "unacceptable" or required caution on the part of the data user in terms of its reliability. This notification allowed MKM to determine whether it was necessary to re-collection or re-analyze any samples to achieve DQOs. Data reduction, review and reporting by the laboratory were conducted as follows:

- Raw data produced by the analyst were forwarded to the analyst's supervisor.
- The supervisor reviewed the data for attainment of QC criteria as outlined in the established methods and for overall reasonableness.
- Upon acceptance of the raw data by the supervisor, a report was generated and sent to STL QA Department.
- STL QA Department and Project Manager reviewed all reports and, based on that review, produced the ADR-formatted EDDs as well as the final reports.
- STL sent the final data to MKM, who forwarded the packages to LDC for data validation.

STL prepared and retained full analytical and QC documentation for the project in electronic storage media (e.g. CD and magnetic tape) as directed by the analytical methodologies employed. STL provided the following information to MKM in each analytical data package submitted:

- Cover sheets listing the samples included in the report and narrative comments describing problems encountered, if any, in analysis;
- Tabulated results of inorganic and organic compounds identified and quantified; and
- Analytical results for QC sample spikes, sample duplicates, initial and continuing calibration verifications of standards and blanks, method blanks and laboratory control sample information.

Upon receipt, MKM compared the data packages to the chain-of-custody forms to ensure all analyses had been conducted and results were provided. Using the aforementioned ADR and Environmental Data

Management System (EDMS) software, MKM systematically verified and reviewed the data. LDC also verified "rejected" data from ADR and validated the data to ensure that the precision and accuracy of the analytical data were adequate for their intended use. The validation process minimized the potential of using false or negative results in the decision-making process and ensured that detected and non-detected compounds were accurately identified. This approach was consistent with the project DQOs and the analytical methods, and it was appropriate to use this method to determine contaminants of concern and to calculate risk.

The data validation determined that the data meets the completeness requirements for the project (90 percent complete), is usable, and that it satisfies the DQOs for this project. Data validation is presented in the QCSR, Appendix V.

3.3 DEVIATIONS FROM THE WORK PLAN

Every effort was made to complete the field activities as outlined in the approved work plan. However, in some instances, circumstances or field conditions necessitated a modification. AOC-specific changes made during the RVAAP 14 AOCs Characterization are listed in each of the respective AOC-specific reports. Changes made during the RVAAP 14 AOCs characterization are noted below.

- Many MI sample locations near buildings, rail or road beds, were covered with significant depths of gravel or ballast. To collect samples from these areas, a steel mattock was used to move the gravel or ballast to allow access to the underlying soil and associated fines. Use of the mattock was indicated on field forms.
- VOC samples were collected as part of the required 10 percent full suite analyses for all sample media. All VOC samples were collected as a discrete sample and were not subjected to sample drying or processing.
- Several sanitary sewers did not yield enough sample for adequate PID screening. In some of those cases, the sewer itself was screened. This information can be found on the field forms located in Appendix Q.
- Besides determining the grain size using the sieve method, grain size for 21 geotechnical samples was determined using hydrometer analysis.
- Initially, MKM attempted to collect sewer surface water samples using traditionally-employed equipment such as a long-handled scoop, a telescopic rod with a swivel or fixed cup, and/or a bailer lain on its side. However, in many cases, the water was too shallow or the opening to the sewer was configured in a manner that prevented the use of these commonly-used tools. When these attempts proved unsuccessful, MKM approached the regulators and suggested using a peristaltic pump equipped with silicon tubing to collect the surface water samples from the sewers. After receiving the regulators' permission, MKM collected the samples by lowering the silicone tubing, which was attached to the peristaltic pump, into the sewer and pumping the water directly into the sampling container. The pump was decontaminated after each sample and new silicone tubing was attached each time a sample was collected.
- MI wet sediments were not processed like traditional MI soil samples or MI dry sediments. If they were determined to be too wet to dry in two days, they were poured into a stainless steel bowl, mixed

with a stainless steel spoon, and then incrementally filled into the sampling containers (using a small spoon) until full. Wet sediments were not dried or processed.

- At some locations, polyethylene bailers were used in place of Teflon® bailers for basement samples. The more rigid poly bailers facilitated efficient collection of the samples.
- One of the USACE-owned Sample Pro® QED submersible pumps was equipped with accordion-style polyethylene bladder. Because this pump was supplied for use during this project, it was used during groundwater sampling rather than using Teflon® bladders. A Teflon® bladder submersible pump (MKM-owned) was also used during groundwater sampling.
- Due to the lack of visible sediment and sediment-related vegetation, several MI scoped “wet ditches” were converted in the field to surface soil (0-1 ft) MI samples. These samples are annotated in each AOC-specific section of this report.
- Through 02 November 2004, entries on the chain-of-custody forms assigned an “SS” to the end of MI soil samples rather than “SO.” These entries were amended at the lab, prior to report and data generation. All samples thereafter had the correct SO suffix for soil samples on the COC.
- ASTM Type II water was used in place of ASTM Type I water for all equipment rinses and equipment final rinses during decontamination.

Although deviations were implemented, the objectives of the RVAAP 14 AOCs Characterization were still achieved. Photograph of this activity (photograph 009) is located in Appendix C Photolog.

4.0 NATURE OF CONTAMINATION

Within each AOC-specific report, Section 4.0 summarizes all analytical results obtained from the environmental sampling conducted during this characterization effort. The results are organized by media and a table is presented in each AOC-specific report outlining the number of samples collected and the number of analytical results that exceeded either the RVAAP background criteria or Region 9 Preliminary Remediation Goals (PRGs). Residential soil and tap water Region 9 PRG values were used for soil/sediment and water respectively. The evaluation completed is a preliminary comparison and is not intended to be used alone for making risk management decisions. The risk screening, presented in Section 5.0 of each AOC-specific report, further evaluates the contaminants detected during each AOCs characterization.

Background criteria were established during the completion of the Winklepeck Phase II RI (USACE, 2001b). Naturally occurring concentrations for some inorganics in soil, sediment, surface water, and groundwater were established. When the background study was completed, several of the TAL metals were not analyzed and/or reported as non-detects. Consequently, for these constituents, the background value was established as zero. Therefore, some inorganics (in particular cyanide) are reported as exceeding background based on the comparison of the maximum concentration when in fact most of actual concentrations are low. For the purposes of this report the MI analytical results have been compared to the discrete background values for screening comparisons."

USEPA Region 9 PRGs (EPA 2004b) represent a 1×10^{-6} risk level (hazard level of 1) for carcinogenic effects and a hazard level of 0.1 for non-carcinogenic effects. These PRGs represent individual constituent concentrations but do not account for potential impacts from multiple contaminants. Although these values may or may not indicate an unacceptable risk or a situation requiring remediation, it does form a basis for initial screening to be followed by a human health risk assessment.

All positive detections in soil and sediment were screened against 1/10 residential soil PRGs for non-cancer endpoints and full PRG for cancer endpoints. These PRG values were calculated for a human receptor hypothetically exposed to chemicals in soil assuming a residential use scenario. All positive detections in groundwater or surface water were screened against tap water PRGs. These tap water PRGs were calculated for a human receptor hypothetically using groundwater or surface water as a domestic water supply.

5.0 HUMAN HEALTH AND ECOLOGICAL RISK SCREENING

This section presents the methodology of the Human Health and Ecological Risk Screening conducted to identify site related COPCs and chemicals of potential ecological concern (COPECs) and to characterize the areas of each AOC which may require additional environmental activities. This information will be used for future remedial decision making to determine possible risks to humans and the environment associated with the potential, current or future exposures to chemicals in surface and subsurface soil, groundwater, surface water, and sediment at the 14 AOCs addressed during this characterization effort. COPCs and COPECs, as determined for each AOC, are presented in Section 5.0 of each AOC-specific report. Total chromium analytical results were conservatively screened against $1/10^{th}$ of the PRG value; therefore, a screening value of 21 mg/kg was used rather than 210 mg/kg.

5.1 HUMAN HEALTH RISK SCREENING (HHRS)

The methodology used in this HHRS is based primarily on the protocol established in the Facility Wide Human Health Risk Assessors Manual (FWHHRAM) (USACE 2004). Technical direction provided during a teleconference with the USACE and Ohio EPA (10 May 2005) was also incorporated into this HHRS evaluation.

HHRS methodology for this characterization effort consists of a data evaluation for the selection of site-related chemicals (SRCs) and COPCs for environmental media as identified in Paragraph 3.5.2 of the FWHHRAM. The results of the HHRS will identify COPCs and will be used by decision makers to identify the need for future remedial activities. COPCs are those chemicals that, when evaluated by this HHRS, are determined to pose a risk to human health exceeding target risk levels for cancer and non-cancer effects and may require the development of chemical-specific remediation levels. COPCs are identified for an environmental media when the maximum contaminant concentrations exceed EPA Region 9 screening criteria and, for inorganics, RVAAP background concentrations, as identified in paragraph 3.5.2 of the FWHHRAM. No surrogates were selected for the purposes of this characterization event. However surrogates should be considered in the next step of evaluation based on conversations with Ohio EPA risk assessors. Section 5.1 of each AOC-specific report discusses the COPC selection for each AOC. The use of surrogates for screening risk values should be covered in any follow on environmental site investigations.

5.1.1 Data Collection and Evaluation

Data evaluation involves numerous activities, including sorting the data by medium, evaluating the quality of data with respect to qualifiers and codes, and selection of COPCs. This section provides an overview of sample collection and analysis activities and a data quality review that is further detailed in Sections 1.0 through 4.0. Section 5.1.3 summarizes the results of the COPC screening process.

Data for this HHRS consisted of analytical results for surface soil (0-1 ft) and subsurface soil samples collected during this characterization effort. The lab selected the most appropriate analytical result if re-analyses/dilutions were necessary and included the result in the database used to determine SRCs for this risk assessment.

Chemical analyses were performed in accordance with SW-846 methodologies. The analytical results were evaluated, using the National Functional Guidelines (USEPA, 1994a, b) to assess data usability and the laboratory's compliance with the analytical methodology. The analytical data were reviewed, validated, and evaluated using the criteria specified in the data quality objectives. All validated data (and qualifiers, as necessary) are presented in Appendices F, G, L, P, and R. All unqualified positive detections and “J” qualified detections (estimated values) were considered as detected concentrations for this HHRS. No analytical results with a “UR” qualifier (indicating a rejected non-detect result) or “R” qualifier (indicating a rejected positive detection) were included in the HHRS data set. A complete data quality summary is presented in Appendix V of this characterization report.

5.1.2 Selection of COPCs

COPCs for the AOCs are identified in two steps. SRCs are first identified for each medium and then COPCs are selected from the SRCs based on a toxicity screen. The purpose of the screening process is to eliminate chemicals for which no further risk evaluation is needed. The premise of this screening step is that risk is typically dominated by a few chemicals and that, although dozens may actually be detected, many chemicals may contribute minimally to the total risk. Section 5.1.3.1 describes the SRC selection process and Section 5.1.3.2 describes the COPC screening process.

5.1.2.1 SRC Screens

The following assumptions are used in the determination of SRCs:

- Physical chemical data (e.g., alkalinity, pH, etc.) are not considered to be SRCs (and, therefore, are not considered to be COPCs).
- Filtered metals data are used in the determination of groundwater SRCs. The filtered metals data are used because such data are typically more indicative of the truly soluble/dissolved (mobile) chemical concentrations in groundwater. All Groundwater samples analyzed were unfiltered, except for TAL Metals. Per the FWSAP all groundwater TAL Metals were filtered.
- Soil data are subdivided into two data sets based on the sampling depths for each AOC. In accordance with the FWHHRAM, the surface soil (0-1 ft) data set is comprised of data for samples collected from the 0 to 1 ft bgs interval. Subsurface soil data is comprised of all sample results for soil samples collected below 1 ft bgs. Consequently, data from the

surface soil (0-1 ft) data set are compared against the surface soil (0-1 ft) background criteria and data from the subsurface soil data set are compared against the subsurface soil background criteria.

The SRC screening process for this site characterization involves two steps: background characterization and background comparison. The background comparison was conducted to determine if the inorganics detected in the environmental media were naturally occurring or potentially site-related. Organic chemicals were not eliminated as SRCs based on background comparisons.

Background levels were characterized for each environmental media at RVAAP as discussed in Section 4.0. The background values for the RVAPP are those presented in the Phase II Remedial Investigation Report for the Winklepeck Burning Ground at Ravenna Army Ammunition Plant, Ravenna, Ohio (USACE, 2001). These values are the 95 percent upper tolerance limit (UTL) (or the maximum detected concentration if the calculated UTL exceeds the maximum detected concentration reported for the background samples) for the background dataset for each environmental media. An inorganic is selected as a potential SRC if the maximum detected concentration exceeds the RVAAP background values. This background screen applies to inorganic chemicals only.

Naturally occurring essential elements, including calcium, chloride, iodine, iron, magnesium, potassium, phosphorous, and sodium, are typically considered to be toxic at high concentrations only and are typically not selected as SRCs. As detailed in the FWHHRAM, these inorganics are an integral part of the human food supply and are often added to food as supplements. USEPA recommends that these chemicals not be evaluated as COPCs as long as they are (1) present at low concentrations (i.e., only slightly elevated above naturally occurring levels), and (2) only toxic at very high doses (i.e., much higher than those that could be associated with contact at a site). Consequently, these essential nutrients were not selected as potential SRCs at any of the AOCs.

The list of SRCs is further evaluated using the toxicity screen described in Section 5.1.3.2 to develop a list of human health COPCs. For efficiency purposes, the results of both the SRC and COPC screens are shown on the same table for each medium within each AOC-specific report.

5.1.2.2 COPC Toxicity Screen

The purpose of the COPC screening is to eliminate SRCs for which no further risk evaluation is needed. COPCs are selected for each medium investigated. COPCs for the HHRS are limited to those chemicals that exceed a selection criterion. The COPCs are defined as chemicals that are positively detected in an environmental medium at a maximum concentration exceeding screening values.

Environmental sampling results are compared to risk-based screening concentrations (RBSCs) based on USEPA Region 9 PRG (EPA 2004b). The USEPA Region 9 risk-based PRGs represent a risk level of 1x 10^{-6} for carcinogenic effects (i.e., a one-in-one million excess chance of developing cancer over a lifetime) and a hazard index level of 1.0 for non-carcinogenic effects (i.e., adverse non-carcinogenic health effects are not anticipated at or below this concentration). The USEPA Region 9 PRGs for soil were calculated for a human receptor hypothetically exposed to chemicals in soil assuming a residential land use scenario. Conservatively, soil RBSCs for non-carcinogens is further reduced to one-tenth these PRGs to account for potential cumulative non-carcinogenic effects. This reduction of the PRGs for non-carcinogenic effects is reflected in Section 4.0 of each AOC-specific report. The RBSCs for carcinogens are the full PRG values and represent the $1x10^{-6}$ cancer risk level. If RBSCs exists for a chemical for both carcinogenic and non-carcinogenic effects, the lower of the two values is used as the COPC selection criteria.

SRCs that exceed toxicity screening levels and those lacking screening levels are retained as COPCs. Chemicals that were not detected, not selected as SRCs, or were not detected at maximum concentrations exceeding toxicity screening levels were not retained as COPCs.

The COPCs are then classified as quantitative COPCs when U.S.EPA-approved toxicity information (i.e., cancer slope factors, reference doses) is available and as qualitative when no toxicity information is available.

Tables included in each AOC-specific report, present the results of COPC screening for the applicable sampling matrices. These tables include:

- Screening values (background concentrations and RBSCs);
- SRC determination; and
- COPC determination.

5.1.2.3 Screening for Lead

USEPA approved toxicity criteria (i.e., cancer slope factors, reference doses) have not been published for lead. Consequently, a calculated, toxicity-criteria-based PRG is not available for this inorganic. The lead concentrations in soil for this characterization effort are compared to lead soil screening guidance concentration of 400 mg/kg for residential soil published in OSWER Directive #9355.4-12 (EPA 1994c). This value is presented as the PRG in the U.S. EPA Region 9 table.

5.2 ECOLOGICAL RISK SCREENING

The goal of this ecological risk screening is to determine COPECs for each of the 14 AOCs addressed by this characterization effort. This ecological risk screening will provide information to scientists and managers that will direct them in future remedial decisions pertaining to each

AOC. The ecological risk screening methodology follows the guidance presented in the RVAAP Facility Wide Ecological Risk Work Plan (FWERWP) (USACE, 2003d) and Guidance for Conducting Ecological Risk Assessments (Ohio EPA, 2003).

This ecological risk screening consists of the first two of the six steps listed in Figure III of the RVAAP FWERWP. These two steps identify the evaluation procedures which are used to determine AOC related COPECs. First, the maximum value of each detected analyte for each sampling matrix at an AOC is compared its respective facility wide background concentration. If an analyte concentration is above its respective facility wide background concentration, then the analyte's maximum concentration is compared to an additional screening value, as determined by the hierarchy of screening values. The hierarchy of screening values is based on the guidance found in the FWERWP for each environmental media sampled. The hierarchy of screening values used for this ecological risk screening is separated per sample matrix and presented below.

Soil

1) Facility-wide Background Concentrations.
2) Preliminary Remediation Goals for Ecological Endpoints, Efroymson, R.A., G.W. Suter II, B.E. Sample, and D.S. Jones, August 1997, ES/ER/TM-162/R2, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831.
3) Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Soil and Litter Invertebrates and Heterotrophic Process; 1997 Revision, Efroymson, R.A., M.E. Will, and G.W. Suter II, ES/ER/TM-126/R2, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831.
4) Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Terrestrial Plants: 1997 Revision, Efroymson, R.A., M.E. Will, G.W. Suter II, and A.C. Wooten, ES/ER/TM-85/R3, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831.
5) Ecological data Quality Levels (EDQL), U.S. EPA, Region 5, Final Technical Approach for Developing EDQLs for RCRA Appendix IX Constituents and Other Significant Contaminants of Ecological Concern, April 1998.

Sediment

1) Facility-wide Background Concentrations.
2) SRV screening to be included in the follow-on document after modification funding is procured.
3) TEC values listed in: Development and Evaluation of Consensus-based Sediment Quality Guidelines for Freshwater Ecosystems, D.D. MacDonald, C.G. Ingersoll, and T.A. Berger, Arch. Environ. Contam. Toxicol. 39, 20-31 (2000).

4) Ecological data Quality Levels (EDQL), U.S. EPA, Region 5, Final Technical Approach for Developing EDQLs for RCRA Appendix IX Constituents and Other Significant Contaminants of Ecological Concern, April 1998.
5) Persistent, Bioaccumulative, and Toxic Pollutants (PBTs) listed in Section 3.3.5, paragraph C of Ohio EPA Ecological Risk Assessment Guidance, dated March 2003.

Surface Water

1) Facility-wide Background Concentrations.
2) Ohio EPA Chemical Specific Water Quality Criteria found in OAC 3745-1. Ohio River Basin Aquatic Life table, OMZM column.
3) Persistent, Bioaccumulative, and Toxic Pollutants (PBTs) listed in Section 3.3.5, paragraph C of Ohio EPA Ecological Risk Assessment Guidance, dated March 2003.

No ecological risk screening was conducted for groundwater at any of the fourteen AOCs addressed during this characterization. As identified in Section 3.2.2 of the FWERWP, groundwater is not considered an exposure medium because ecological receptors are unlikely to contact groundwater where it is encountered at a depth of greater than 5 ft bgs.

Section 5.2 of each AOC-specific report discusses the COPECs identified for each medium evaluated. Ecological risk screening tables included in each AOC-specific report, present the results of COPEC screening for the applicable sampling media. These tables include:

- Frequency of detection;
- Maximum detected concentration;
- Background concentrations;
- SRC determination;
- Screening values used for COPEC determination;
- COPEC determination; and
- COPEC rationale.

6.0 SUMMARY OF RESULTS

Within each AOC-specific report, this section briefly summarizes the existing conditions that were found at each AOC during the 14 AOCs characterization effort and the risk screening tasks that were completed.

7.0 REFERENCES

Efroymson, R.A., G.W. Suter II, B.E.Sample, and D.S.Jones, 1997a. Preliminary Remediation Goals for Ecological Endpoints. Prepared for U.S. DOE, Office of Environmental Management. Prepared by Lockheed Martin Energy Systems, Inc, Oak Ridge National Laboratory, Oak Ridge, Tennessee. ES/ER/TM-162/R2.

Efroymson, R.A., M.E. Will, and G.W. Suter II, 1997b. Toxicological Benchmarks for Contaminants of Potential Ecological Concern for Efforts on Soil and Litter Invertebrates and Heterotrophic Process: 1997 Revision. Prepared for U.S. DOE, Office of Environmental Management. Prepared by Lockheed Martin Energy Systems, Inc, Oak Ridge National Laboratory, Oak Ridge, Tennessee. ES/ER/TM-126/R2.

Efroymson, R.A., M.E. Will, G.W. Suter II, and A.C. Wooten, 1997c. Benchmarks for Screening Contaminants of Potential Concern for Effects on Terrestrial Plants: 1997 Revision. Prepared for U.S. DOE, Office of Environmental Management. Prepared by Lockheed Martin Energy Systems, Inc, Oak Ridge National Laboratory, Oak Ridge, Tennessee. ES/ER/TM-85/R3.

Efroymson, R.A., M.E. Will, G.W. Suter II, and A.C. Wooten, 1997d, Revision. Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Terrestrial Plants:, ES/ER/TM-85/R3, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831;

Envirostat, Inc. Planning for Environmental Decision Making. Course manual received during January 2003 training at Mohican State Park, Perrysville, Ohio.

Jacobs Engineering Group, Inc. 1989. EPA Technical Enforcement Support at Hazardous Waste Sites, RVAAP, Ravenna, OH, RCRA Facility Assessment, RR/VSI Report, Prepared by Metcalf and Eddy, Inc., Contract #68-01-7351, Work Assignment NO. R05031, October.

MacDonald, D.D., C.G. Ingersoll, and T.A. Berger, 2000. Development and Evaluation of Consensus-Bases Sediment Quality Guidelines for Freshwater Ecosystems. Arch. Enviorn. Contam. Toxicol. 39:20-31.

MKM Engineers, Inc. (MKM). 2004. Final sampling and analysis Plan Addendum for the Characterization of 14 RVAAP AOCs. Ravenna Army Ammunition Plant. Prepared for U.S. Army Corps of Engineers – Louisville District, Louisville, Kentucky 40202.

Morgan, Tim, 2005. Ohio Army National Guard, Ravenna Training and Logistic Site (RTLS), Personal Communication by e-mail with Stan Levenger, MKM, 09 May 2005.

Ohio Environmental Protection Agency (Ohio EPA). December 2002. Ohio EPA Chemical Specific Water Quality Criteria found in OAC 3745-1. Ohio River Basin Aquatic Life table, OMZM column.

Ohio Environmental Protection Agency (Ohio EPA). March 2003. Persistent, Bioaccumulative, and Toxic Pollutants (PBTs) listed in Section 3.3.5, para C of Ohio EPA Ecological Risk Assessment Guidance

Portage County Soil and Water Conservation District Resources Inventory 1985. pp. 6-8.

Science Application International Corporation (SAIC). 1998. Phase I Remedial Investigation Report for High Priority Areas of Concern.

Stevens, G., A. Wrather, H. Wilson, D. Dunn, 2002. Soil Sampling Fields With Four Types of Probes., Online. Crop Management doi:10.1094/CM-2002-1025-01-RS.

U.S. Army Corp. of Engineers, 1996a. Facility-Wide Sampling and Analysis Plan for the Ravenna Army Ammunition Plant, Ravenna, Ohio, DACA62-94-D-0029, D.O. 0009.

U.S. Army Corp. of Engineers, 1996b. Preliminary Site Assessment for the Ravenna Army Ammunition Plant, Ravenna, OH, DACA-62-94-D-0029, D.O. 0009, Final, February

U.S. Army Corp. of Engineers, 2001a. Revised Facility-Wide Sampling and Analysis Plan for the Ravenna Army Ammunition Plant, Ravenna, Ohio, DACA 62-00-D-0001, D.O. CY02

U.S. Army Corp. of Engineers, 2001b. Phase II Remedial Investigation Report for the Winklepeck Burning Grounds at Ravenna Army Ammunition Plant, Ravenna, Ohio, prepared for the U.S. Army Corps of Engineers Louisville District by SAIC.

U.S. Army Corp. of Engineers - Louisville District, 2002. Louisville Chemistry Guideline (Version 5). 2002.

U.S. Army Corp. of Engineers, 2003a. Phase II Remedial Investigation Report for Load Line 2 at the Ravenna Army Ammunition Plant, Ravenna, Ohio (Preliminary draft), prepared for the U.S. Army Corps of Engineers Louisville District by SAIC.

U.S. Army Corp. of Engineers, 2003b. Phase II Remedial Investigation Report for Load Line 3 at the Ravenna Army Ammunition Plant, Ravenna, Ohio (Preliminary draft), prepared for the U.S. Army Corps of Engineers Louisville District by SAIC.

U.S. Army Corp. of Engineers. 2003c. Phase II Remedial Investigation Report for Load Line 4 at the Ravenna Army Ammunition Plant, Ravenna, Ohio (Preliminary draft), prepared for the U.S. Army Corps of Engineers Louisville District by SAIC.

U.S. Army Corp. of Engineers, 2003d. RVAAP Facility wide Ecological Risk Work Plan. Louisville District, ESSAYONS, U.S. Army Corps of Engineers.

U.S. Army Corp. of Engineers, 2004. RVAAPs Facility Wide Human Health Risk Assessor Manual. 2004.

U.S. Army Centre for Health Promotion and Preventive Medicine (USACHPM), 1998. Relative Risk Site Evaluation for Newly Added Sites at the Ravenna Army Ammunition Plant, Ravenna, Ohio. Hazardous and Medical Waste Study No. 37-EF-5360-99, 19-23.

U.S. Army Environmental Hygiene Agency (USAETHA), 1994. Preliminary Assessment Screening No. 38-26-1329-94: Boundary Load Line Areas, Ravenna Army Ammunition Plant, Ravenna, Ohio.

U.S Army Toxic and Hazardous Materials Agency (USATHAMA), 1978. Installation Assessment of Ravenna Army Ammunition Plant, records Evaluation Report No. 132.

U.S Department of Agriculture, (USDA). 1978. Soil survey of Portage County, Ohio.

U.S. Environmental Protection Agency (EPA). 1990. Test Methods for Evaluating Solid Waste Physical/Chemical Methods, Analytical Protocols, SW-846.

U.S. Environmental Protection Agency (EPA), 1994a. *USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review,* EPA-540/R-94-012 (PB94-963501), Office of Emergency and Remedial Response, Washington, D.C.

U.S. Environmental Protection Agency (EPA), 1994b. *USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review,* EPA-540/R-94-013 (PB94-963502), Office of Emergency and Remedial Response, Washington, D.C.

U.S. Environmental Protection Agency (EPA), 1994c. *Guidance on Residential Lead-based Paint, Lead-contaminated Dust, and Lead-contaminated Soil.* Office of Prevention, Pesticides, and Toxic Substances, Washington, D.C.

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

U.S. Environmental Protection Agency (EPA). 2004a. Region 9 Preliminary Remediation Goals (PRGs), 1998, created by Stanford J. Smucker and found on the world wide web address http://www.epa.gov/region09/waste/sfund/prg/index.html.

U.S. Environmental Protection Agency (EPA). 2004b. Preliminary Remediation Goals – U.S. EPA, Region 9

U.S. Environmental Protection Agency (EPA), 2004c, Edition of the Drinking Water Standards and Health Advisories, Winter 2004.

(U.S. Geological Survey, (USGS). 1994. Winham Quadrangle, Ohio, 7.5 Minute Series (Topographic) Map.

Walsh, Marianne E., Charles A. Ramsey, Thomas F. Jenkins. 2002. The Effect of Particle Size Reduction By Grinding On Subsampling Variance For Explosives Residues In Soil. Elsevier Science Ltd, Prepared by Engineer Research and Development Center, Cold Regions Research and Engineering Laboratory, Hanover, New Hampshire. pp. 12767-1273.

White, G.W. 1982. Glacial Geology of Northern Ohio, Bulletin 68, Division of Geological Survey, Ohio Department of Natural resources. 1982.

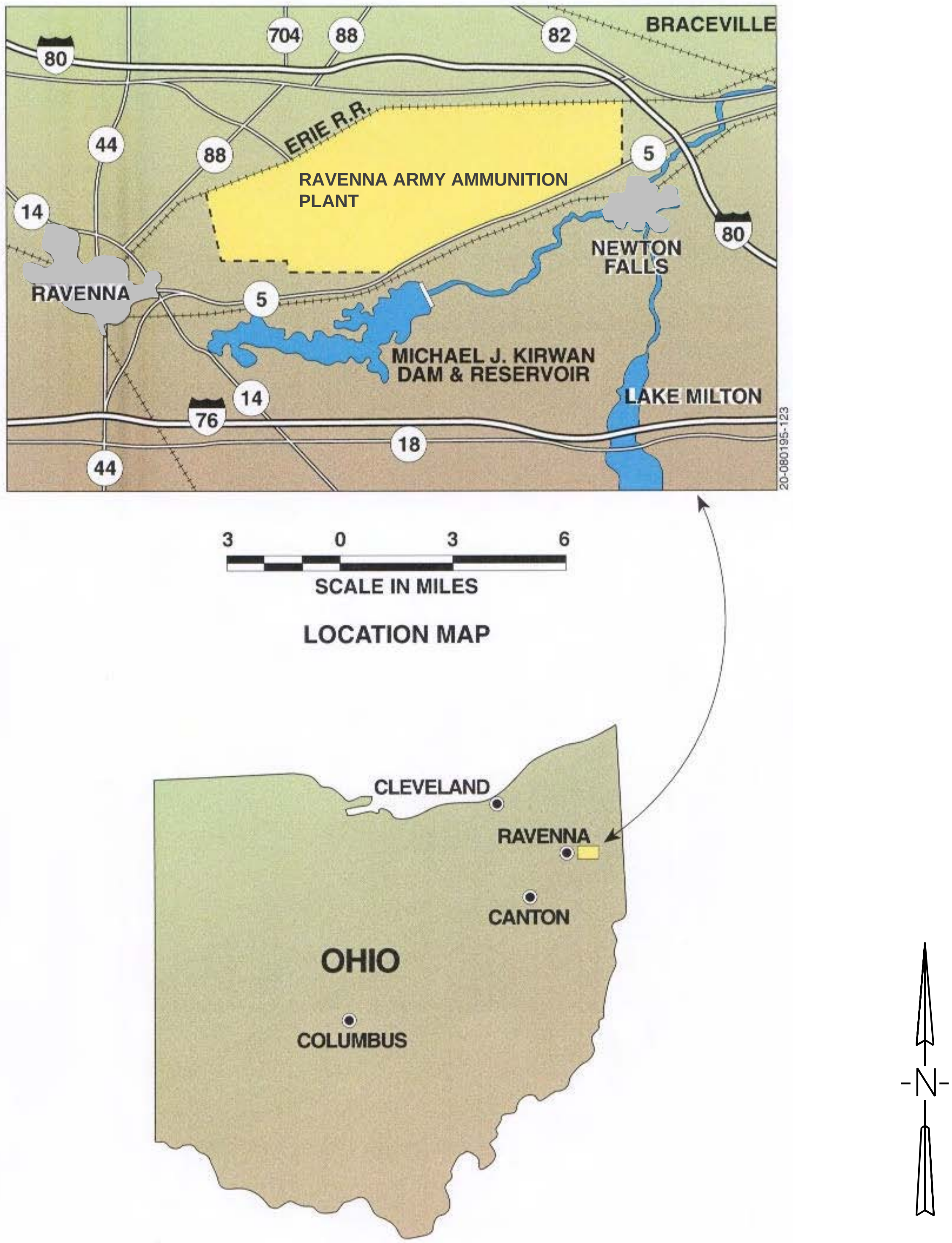
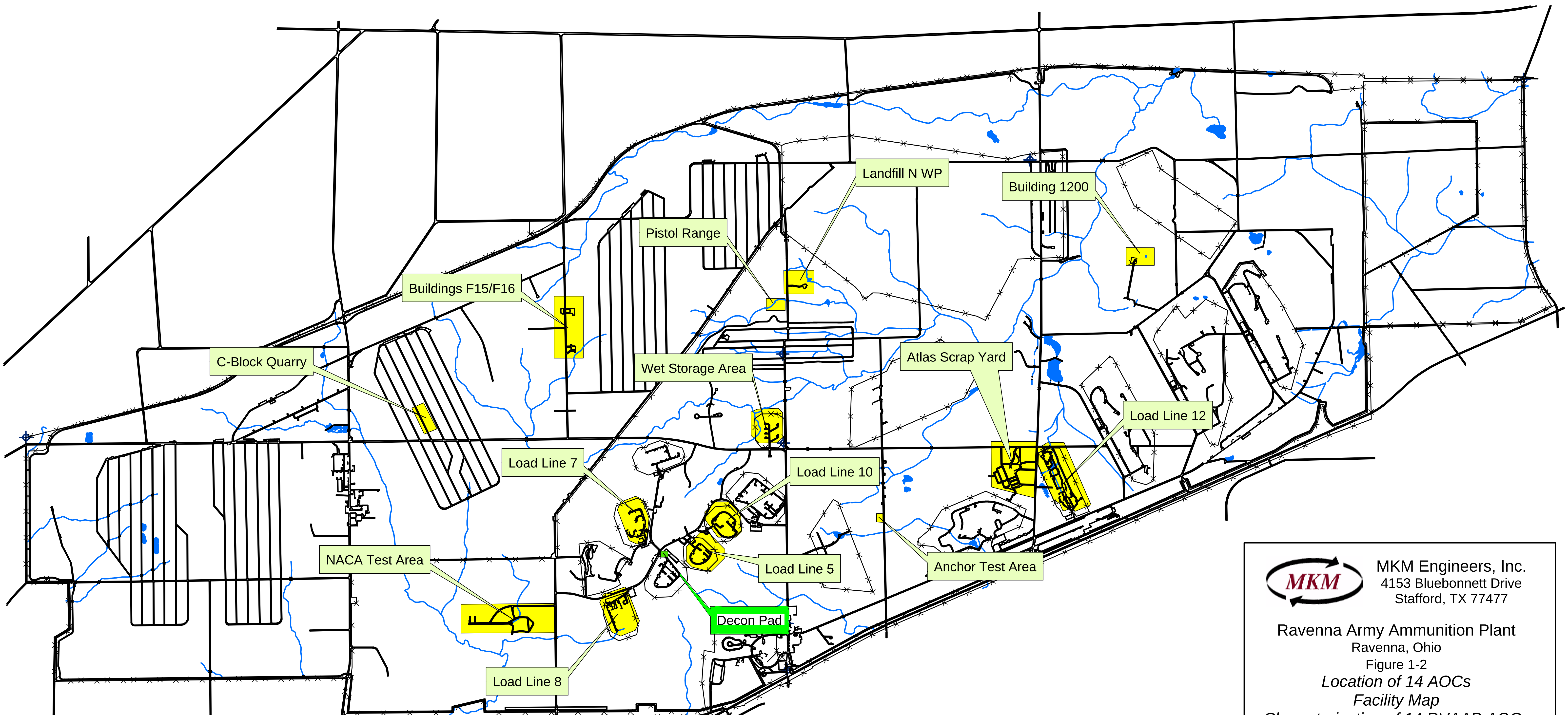


Figure 1-1. Ravenna Army Ammunition Plant Location Map



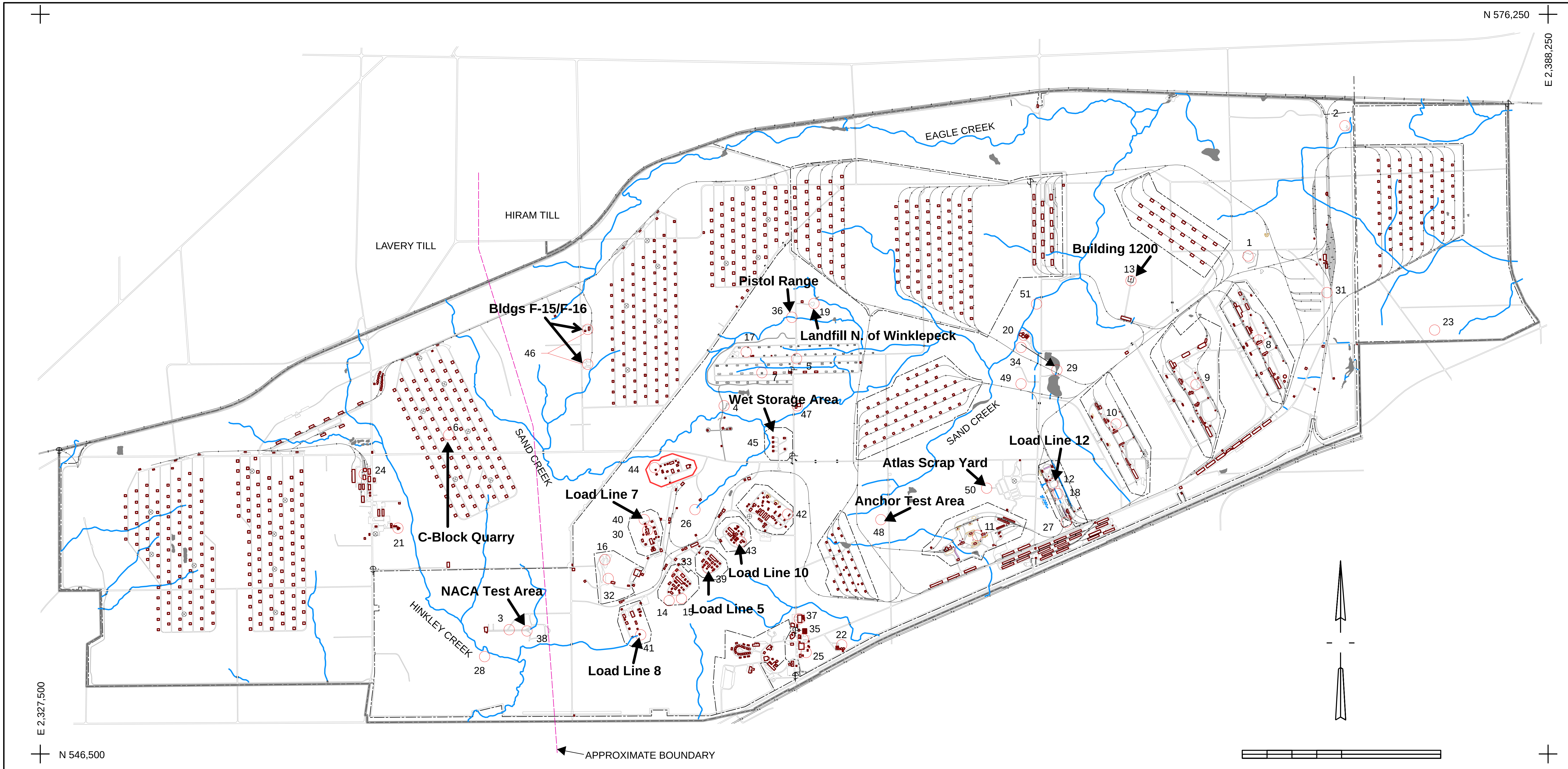
MKM
MKM Engineers, Inc.
4153 Bluebonnett Drive
Stafford, TX 77477

Ravenna Army Ammunition Plant
Ravenna, Ohio
Figure 1-2
Location of 14 AOCs
Facility Map
Characterization of 14 RVAAP AOCs

Drawn By: MGS
Checked By: SB
Date Drawn: 17 July 06

0 2,900 5,800 Feet

N
W E
S



LEGEND OF SITES:

1	RAMSDELL QUARRY LANDFILL
2	ERIE BURNING GROUNDS
3	DEMOLITIONS AREA #1
4	DEMOLITIONS AREA #2
5	WINKLEPECK BURNING GROUNDS
6	C BLOCK QUARRY
7	BLDG 1601 HAZARDOUS WASTE STORAGE
8	LOAD LINE 1 AND DILUTION/SETTLING POND
9	LOAD LINE 2 AND DILUTION/SETTLING POND
10	LOAD LINE 3 AND DILUTION/SETTLING POND
11	LOAD LINE 4 AND DILUTION/SETTLING POND
12	LOAD LINE 12 AND DILUTION/SETTLING POND
13	BLDG 1200 AND DILUTION/SETTLING POND
14	LOAD LINE 6, EVAPORATION UNIT
15	LOAD LINE 6, TREATMENT PLANT
16	QUARRY LANDFILL/FORMER FUZE & BOOSTER BURNING PITS
17	DEACTIVATION FURNACE
18	LOAD LINE 12 PINK WASTE WATER TREATMENT
19	LANDFILL NORTH OF WINKLEPECK BURNING GROUND
20	SAND CREEK SEWAGE TREATMENT PLANT
21	DEPOT SEWAGE TREATMENT PLANT
22	GEORGE ROAD SEWAGE TREATMENT PLANT
23	UNIT TRAINING SITE WASTE OIL TANK
24	RESERVE UNIT MAINTENANCE AREA WASTE OIL TANK
25	BLDG 1034 MOTOR POOL WASTE OIL TANK
26	FUZE BOOSTER AREA SETTLING TANKS
27	BLDG 854-PCB STORAGE
28	MUSTARD AGENT BURIAL SITE
29	UPPER AND LOWER COBBS POND COMPLEX
30	TREATMENT PLANT LOAD LINE 7 PINK WASTEWATER
31	ORE PILE RETENTION POND
32	40 AND 60 MM FIRING RANGE
33	FIRESTONE TEST FACILITY
34	SAND CREEK DISPOSAL ROAD LANDFILL
35	1037 BUILDING-LAUNDRY WASTEWATER SUMP
36	PISTOL RANGE
37	PESTICIDE BUILDING S-44S2
38	NACA TEST AREA
39	LOAD LINE 5/FUZE LINE 1
40	LOAD LINE 7/BOOSTER LINE 1
41	LOAD LINE 8/BOOSTER LINE 1
42	LOAD LINE 9/DETONATOR LINE
43	LOAD LINE 10/PERCUSSION ELEMENT
44	LOAD LINE 11/ARTILLERY PRIMER
45	WET STORAGE AREA
46	BUILDINGS F-15 AND F-16
47	BUILDING T-5301 DECONTAMINATION
48	ANCHOR TEST AREA
49	CENTRAL BURN PITS
50	ATLAS SCRAP YARD
51	DUMP ALONG PARIS - WINDHAM ROAD

RAILROAD TRACKS
FENCELINE
PROPERTY BOUNDARY
STREAM OR CREEK
20 AREAS OF CONCERN

Figure 2-1

Glacial Till Map

Ravenna Army Ammunition Plant
Ravenna, OH

Drawn By: ST | Date Drawn: 04/15/2005

MKM

MKM Engineers, Inc.
4153 Bluebonnet Road
Stafford, TX 77477