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RVAAP-66 Facility-Wide Groundwater
Remedial Investigation/Feasibility Study Work Plan
Ravenna Army Ammunition Plant
Ravenna, Ohio

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14. ABSTRACT

This document presents the Remedial Investigation/Feasibility Study Work Plan for the Facility-Wide Groundwater Monitoring Program (FWGWMP) Plan for the RVAAP-66 groundwater services project at the Ravenna Army Ammunition Plant. This document includes an a description of the approach for implementing the remedial investigation at the facility. Included in the document is a description of the groundwater modeling approach, risk assessment procedures and the installation of additional groundwater monitoring wells.

15. SUBJECT TERMS

Facility-wide, groundwater, RVAAP-66, monitoring wells, remedial investigation, feasibility study.

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FACILITY-WIDE GROUNDWATER MONITORING PROGRAM RVAAP-66 FACILITY-WIDE GROUNDWATER REMEDIAL INVESTIGATION/FEASIBILITY STUDY WORK PLAN

RAVENNA ARMY AMMUNITION PLANT
RAVENNA, OHIO

GSA Contract Number GS-10F-0293K
Delivery Order W912QR-11-F-0266

Prepared for

U.S. Army Corps of Engineers
600 Martin Luther King Jr. Place
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Prepared by

Environmental Quality Management, Inc.
1800 Carillon Boulevard
Cincinnati, Ohio 45240

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Draft

RVAAP-66 Facility-Wide Groundwater
Remedial Investigation/Feasibility Study Work Plan
Distribution List

Organization	Number of Printed Copies	Number of Electronic Copies
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USACE Project Manager	2	3
USAEC Program Manager	0	1
EQM	1	1
OHARNG – CRJMTC-ENV	1	1
NGB Cleanup Program Manager	0	1
Ohio EPA	3	3

RVAAP – Ravenna Army Ammunition Plant
USACE – U.S. Army Corps of Engineers
USAEC – U.S. Army Environmental Center
OHARNG – CRJMTC-ENV – Ohio Army National Guard Camp Ravenna Joint Military Training Center - Environmental
NGB – National Guard Bureau
Ohio EPA – Ohio Environmental Protection Agency
EQM – Environmental Quality Management, Inc.

STATEMENT OF INDEPENDENT TECHNICAL REVIEW

Environmental Quality Management, Inc. (EQM) has completed the *Draft Facility-Wide Groundwater Monitoring Program RVAAP-66 Facility-Wide Groundwater Remedial Investigation/Feasibility Study Work Plan*. Notice is hereby given that an independent technical review has been conducted that is appropriate to the level of risk and complexity inherent in the project. During the independent technical review, compliance with established policy, principles, and procedures, utilizing justified and valid assumptions, was verified. This included review of technical assumptions, methods, procedures, and materials to be used, and whether the product meets customer's needs consistent with law and existing U.S. Army Corps of Engineers policy.

John M. Miller, CHMM
Senior Project Manager

Date: 2/13/12

Scott A. Spesshardt, CPG
Senior Geologist

Date: 2/14/2012

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LIST OF GENERAL ACRONYMS

ACM	Asbestos-containing Materials
ADR	Automated Data Review
AEDB-CC	Army Environmental Database - Compliance-related Cleanup
AEDB-R	Army Environmental Database - Restoration
AOC	Area of Concern
ARAR	Applicable or Relevant and Appropriate Requirement
AST	Aboveground Storage Tank
ASTM	American Society for Testing and Materials
BRA	Baseline Risk Assessment
BRAC	Base Realignment and Closure
CA	Cooperative Agreement
CC	Compliance-related Cleanup
CEC	Civil and Environmental Consultants
CERCLA	Comprehensive Environmental Response Compensation and Liability Act
CERCLIS	Comprehensive Environmental Response Compensation and Liability Information System
CFR	Code of Federal Regulations
CHMM	Certified Hazardous Materials Manager
cm	Centimeter
CMCOPC	Contaminant Migration Chemical of Potential Concern
COPCs	Contaminants of Potential Concern
COR	Contracting Officer’s Representative
CPG	Certified Professional Geologist
CR	Compliance Restoration
CRJMTC	Camp Ravenna Joint Military Training Center
CRJMTC-ENV	Camp Ravenna Joint Military Training Center - Environmental
CRP	Community Relations Plan
CSM	Conceptual Site Model
CTT	U.S. Army Closed, Transferred, and Transferring
cu yd	Cubic Yard
DAF	Dilution Attenuation Factor
DERP	Defense Environmental Restoration Program
DFFOs	Director’s Final Findings and Orders
DLA	Defense Logistics Agency
DMM	Discarded Military Munitions
DNSC	Defense National Stockpile Center
DO	Dissolved Oxygen
DoD	Department of Defense
DOT	Department of Transportation
DPDO	Defense Property Disposal Organization
DQO	Data Quality Objective
DRMO	Defense Reutilization and Marketing Office
e2M	Engineering-Environmental Management, Inc.
EDD	Electronic Data Deliverable

LIST OF GENERAL ACRONYMS (continued)

EE/CA	Engineering Evaluation/Cost Analysis
EIS	Environmental Investigation Services
EM	Electromagnetic
EOD	Explosive Ordnance Disposal
EPC	Exposure Point Concentration
EQM	Environmental Quality Management, Inc.
EPA	Environmental Protection Agency
ESS	Explosives Safety Submission
EU	Exposure Unit
^{o}F	Degrees Fahrenheit
FAR	Federal Acquisition Regulation
FFS	Focused Feasibility Study
FS	Feasibility Study
ft	Feet
FWCUGs	Facility-Wide Cleanup Goals
FWGWMP	Facility-Wide Groundwater Monitoring Program
FWGWMPP	Facility-Wide Groundwater Monitoring Program Plan
FWQAPP	Facility-Wide Quality Assurance Project Plan
FWSAP	Facility-Wide Sampling and Analysis Plan
FWSHP	Facility-Wide Safety and Health Plan
FY	Fiscal Year
gal	Gallon
GC	Gas Chromatograph
GIS	Geographic Information System
GOCO	Government Owned, Contractor Operated
GSC	General Sciences Corporation
gpd	Gallons per Day
gpm	Gallons per Minute
GSA	Government Services Administration
HASP	Health and Safety Plan
HMX	Cyclotetramethylenetetranitramine
HPLC	High-Performance Liquid Chromatography
HRR	Historical Records Review
HSC	Health and Safety Coordinator
IAP	Installation Action Plan
I.D.	Inner Diameter
IDW	Investigative-Derived Waste
in.	Inch
IR	Installation Restoration
IRP	Installation Restoration Program
IRIS	Integrated Risk Information System
JMC	Joint Munitions Command
Kh	Horizontal Hydraulic Conductivity

LIST OF GENERAL ACRONYMS (continued)

KO	Contracting Officer
Kv	Vertical Hydraulic Conductivity
LAP	Load, Assemble, and Pack
lb	Pound
LG	Licensed Geologist
LTM	Long-Term Monitoring
LUC	Land Use Control
MC	Munitions Constituents
MCL	Maximum Contaminant Level
MD	Munitions Debris
MEC	Munitions and Explosives of Concern
μg/L	Micrograms per Liter
mg/L	Milligrams per Liter
ml/min	Milliliter per Minute
mm	Millimeter
MMRP	Military Munitions Response Program
MNA	Monitored Natural Attenuation
mph	Miles per Hour
MR	Munitions Response
MRS	Munitions Response Site
MS	Mass Spectrometer
MSDS	Material Safety Data Sheet
NAGPRA	Native American Graves Protection and Repatriation Act
NFA	No Further Action
NGB	National Guard Bureau
No.	Number
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
O&M	Operations and Maintenance
OAC	Ohio Administrative Code
ODA	Open Demolition Area
ODNR	Ohio Department of Natural Resources
ODUSD(I&E)	Office of the Deputy Under Secretary of Defense for Installations and Environment
OE	Ordnance and Explosives
OHARNG	Ohio Army National Guard
ORIS	Operational Range Inventory System
ORP	Oxidation Reduction Potential
OSC	Operations Support Command
%	Percent
PA	Preliminary Assessment
PAH	Polycyclic Aromatic Hydrocarbon
PBA	Performance Based Acquisition

LIST OF GENERAL ACRONYMS
(continued)

PBC	Performance Based Contract
PCB	Polychlorinated biphenyl
PDF	Portable Document Format
PI	Physics International
PIKA	PIKA International
PMP	Project Management Plan
POC	Point of Contact
PP	Proposed Plan
PPE	Personal Protective Equipment
ppm	Parts Per Million
PRG	Preliminary Remediation Goal
PRP	Potential Responsible Party
PVC	Polyvinyl Chloride
PWS	Performance Work Statement
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QASP	Quality Assurance Surveillance Plan
QC	Quality Control
RA	Remedial Action
RAB	Restoration Advisory Board
RAO	Remedial Action Objective
RBC	Risk Based Cleanup
RC	Response Complete
RCRA	Resource Conservation and Recovery Act
RD	Remedial Design
RDX	1,3,5-trinitroperhydro-1,3,5-triazine (cyclotrimethylenetrinitramine)
REIMS	Ravenna Environmental Information Management System
RI	Remedial Investigation
RIP	Remedy-in-Place
ROD	Record of Decision
RRSE	Relative Risk Site Evaluation
RSL	Regional Screening Level
RVAAP	Ravenna Army Ammunition Plant
SAIC	Science Applications International Corporation
SAP	Sampling and Analysis Plan
SCF	Sharon Conglomerate Formation
SDG	Secure Data Group
sec	Second
SI	Site Investigation
SOHIO	Standard Oil of Ohio
SOW	Scope of Work
sq yd	Square Yard
SRC	Site-related Constituent

LIST OF GENERAL ACRONYMS
(continued)

SSHP	Site Safety and Health Plan
STP	Sewage Treatment Plant
SVOC	Semi-volatile Organic Compound
SWMUs	Solid Waste Management Units
TA	TestAmerica
TAL	Target Analyte List
TBC	To Be Considered
TCLP	Toxicity Characteristic Leaching Procedure
TCRA	Time-Critical Response Action
TD	Transferred
TNT	Trinitrotoluene
TOW	Tube-launched, Optically- tracked, Wire-guided
TPH	Total Petroleum Hydrocarbons
U.S.	United States
USACE	United States Army Corps of Engineers
USACHPPM	United States Army Center for Health Promotion and Preventive Medicine
USAEC	United States Army Environmental Center
USAEHA	United States Army Environmental Hygiene Agency
USATHAMA	United States Army Toxic and Hazardous Materials Agency
USC	United States Code
USGS	United States Geological Survey
USP&FO	United States Property and Fiscal Officer
UST	Underground Storage Tank
UV	Ultraviolet
UXO	Unexploded Ordnance
VOC	Volatile Organic Compound

LIST OF AREA OF CONCERN ACRONYMS

ASY	Atlas Scrap Yard
B12	Building 1200
CBL	C-Block
CBP	Central Burn Pits
CP	Cobbs Pond
DA2	Demolition Area #2
EBG	Erie Burning Grounds
FBQ	Fuze and Booster Quarry
LNW	Landfill North of Winklepeck
LL	Load Line
MBS	Mustard Burial Site
NACA	National Advisory Committee for Aeronautics
NTA	NACA Test Area
RQL	Ramsdell Quarry Landfill
WBG	Winklepeck Burning Grounds

EXECUTIVE SUMMARY

The U.S. Army Corps of Engineers (USACE), Louisville District, is performing Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) closure at the former Ravenna Army Ammunition Plant (RVAAP) near the Town of Ravenna in the northeastern portion of Ohio. The USACE, under a Government Services Administration (GSA) Performance Based Acquisition (PBA) contract, retained Environmental Quality Management, Inc. (EQM) to obtain a signed Record of Decision (ROD) for the Facility-Wide groundwater (RVAAP-66) at the former RVAAP. This Remedial Investigation/Feasibility Study (RI/FS) will be conducted by USACE pursuant to the Ohio Environmental Protection Agency (EPA) Director's Final Findings and Orders (DFFOs) requiring publication of a ROD and to satisfy the legal requirements for a RI under CERCLA.

Past Department of Defense (DoD) activities at the RVAAP date to 1940 and include the manufacturing, loading, handling, and storage of military explosives and ammunition. Although no longer an active munitions manufacturing facility, the RVAAP has historically handled hazardous wastes and operated several waste management units in support of its previous operations. Industrial operations comprised twelve (12) munitions-assembly facilities referred to as "load lines." Load Lines 1 through 4 were used to melt and load 2,4,6-trinitrotoluene (TNT) and Composition B [a mixture of 1,3,5-trinitroperhydro-1,3,5-triazine (RDX) and TNT, generally in a 60:40 ratio by weight] into large-caliber shells and bombs. The operations on the load lines produced explosive dust, spills, and vapors that collected on the floors and walls of each building. Periodically, the floors and walls were cleaned with water and steam. The resulting wastewater, which contained TNT and Composition B, was known as "pink water" for its characteristic color. Pink water was collected in concrete holding tanks, filtered, and pumped into unlined ditches for transport to earthen settling ponds. Load Lines 5 through 11 were used to manufacture fuzes, primers, and boosters. Potential contaminants in these load lines include lead compounds, mercury compounds, and explosives. From 1946 to 1949, Load Line 12 was used to produce ammonium nitrate for explosives and fertilizers prior to use as a weapons demilitarization facility.

Various industrial operations at the RVAAP have been identified as potential sources of contaminants. These operations include the load lines, sewage treatment plants, wastewater treatment plants, vehicle maintenance areas, storage tanks, waste storage areas, equipment storage areas, and furnaces and evaporation units. Landfills at the RVAAP were used to bury wastes from industrial operations and sanitary sources. Settling and retention ponds at the site collected wastewater from munitions wash-down operations at various facilities. Additionally, the RVAAP includes several areas associated with the burning, demolition, and testing of various munitions. These burning grounds and demolition areas are located at several large areas or in abandoned quarries at the RVAAP. Strategic ores and other materials were stockpiled at several locations at the site; subsequent to removal by the Defense Logistics Agency (DLA), the residual materials may have left various contaminants in place. Potential contaminants at the site include, but are not limited to: primary explosives, secondary explosives, propellants, metals, polychlorinated biphenyls (PCBs), pesticides, waste oils, sludge from load lines, various laboratory chemicals, sanitary waste, mustard agent, and petroleum products.

The DoD Installation Restoration Program (IRP) administered by the U.S. Army directs the cleanup program at RVAAP. Management of the IRP sites follows CERCLA requirements. There are currently 27 individual IRP Areas of Concern (AOCs), two facility-wide AOCs, 14 compliance restoration (CR) sites, and 14 munitions response (MR) sites actively being addressed as identified in the 2011 RVAAP Installation Action Plan (IAP).

A significant amount of work has already been conducted at RVAAP surrounding the various AOCs including remedial investigations, human health risk evaluations, feasibility studies, interim remedial measures, groundwater monitoring, etc. This RI/FS work plan is designed to disengage from the previous AOC-based approach for RVAAP. Instead, the stakeholders have agreed to pursue a ROD for groundwater using a facility-wide approach. As a result, the RI for Facility-Wide groundwater will entail a thorough evaluation of historical data, assessment of key data gaps, geotechnical analyses, additional chemical analyses, aquifer testing, preparation of a baseline risk assessment, groundwater modeling, and installation of additional wells to supplement the hydrogeologic and fate-and-transport models.

Key elements that will be conducted under this RI/FS work plan include:

- Evaluation of Existing Data, including:
    - Review of historical studies and monitoring activities.
    - Preparation of isoconcentration maps.
    - Assessment of origin of common contaminants in groundwater.
    - Investigation of the potential origin and impact of bis(2-ethylhexyl)phthalate.
- Development of Conceptual Site Model
- Identification of Key Data Gaps, potentially including:
    - Evaluation of preferential flow zones/exit pathways.
    - Analysis of fracture/aperture density in bedrock cores and their effect on leakage potential of the aquifer.
    - Evaluation of potential source areas that have not previously been assessed and their contribution to facility-wide contaminant loading, if any.
    - Additional geochemical and geotechnical analyses.
- Field Investigation, including:
    - Installation of 39 new wells in support of hydrogeologic system modeling and contaminant fate-and-transport modeling and to address key data gaps.
    - Permeability testing on 20 test cores.
    - Aquifer testing, including two short-term pump tests.
    - Groundwater sampling, including quarterly sampling of the 39 new wells, semiannual sampling of 35 existing wells (including five Resource Conservation and Recovery Act wells), sampling of the six Mustard Burial Site wells for chemical warfare breakdown products, and assessing the presence of hexavalent chromium in the new and existing wells and perchlorate in the new wells.
- Contaminant Fate-and-Transport Modeling
    - Develop a facility-wide 3-dimensional groundwater flow model.
    - Predict migration paths and maximum future extent of contaminant migration.

  - Demonstrate early attainment use zones.
  - Screen alternative remedial actions in support of FS development via model simulations.

- Assessment of Risks
  - Conduct a baseline human health risk assessment for the facility-wide groundwater exposure.
  - Use results to document any no-action decision and/or to potentially reduce or eliminate the scope of the FS.

- Treatability Study/Pilot Testing (if necessary)

- Preparation of Remedial Investigation Report

- Preparation of Feasibility Study
  - Evaluate and screen potential remedial alternatives.
  - Identify "early attainment" groundwater resource use zones.
  - Perform detailed analysis of selected remedial alternatives [presumably long-term monitoring (LTM)/monitored natural attenuation (MNA) or groundwater resource use controls].

SECTION 1
INTRODUCTION

The primary purpose of this Remedial Investigation/Feasibility Study (RI/FS) is to investigate the nature and extent of various contaminants of potential concern (COPCs) in groundwater at the former Ravenna Army Ammunition Plant (RVAAP) located near Ravenna, Ohio, in order to assess the potential risk to human health and the environment, develop and evaluate potential remedial alternatives, and to recommend a preferred alternative. The RI and FS are interactive and may be conducted concurrently so that the data collected in the RI influences the development of remedial alternatives in the FS, which in turn affects the data needs and the scope of treatability studies, if necessary.

The U.S. Army is performing Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) closure at the former RVAAP. CERCLA closure is occurring under the Installation Restoration Program (IRP). Activities include monitoring of an extensive network of groundwater monitoring wells. The U.S. Army Corps of Engineers (USACE), Louisville District, under a Government Services Administration (GSA) Performance Based Acquisition (PBA) contract, retained Environmental Quality Management, Inc. (EQM) (Contract No. GS-10F-0293K – Delivery Order W912QR-11-F-0266) to obtain a signed Record of Decision (ROD) for the Facility-Wide groundwater (RVAAP-66) at the former RVAAP. The RI/FS will be conducted by USACE pursuant to the Ohio Environmental Protection Agency (EPA) Director's Final Findings and Orders (DFFOs) requiring publication of a ROD and to satisfy the legal requirements for a RI under CERCLA. The USACE will produce RI and FS deliverables that are in accordance with the *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (U.S. EPA, Office of Emergency and Remedial Response, October 1988), and any other guidance that Ohio EPA uses in conducting an RI/FS.

A significant amount of work has already been conducted at RVAAP surrounding the various Areas of Concern (AOCs) including remedial investigations, human health risk evaluations, feasibility studies, interim remedial measures, groundwater monitoring, etc. This RI/FS work plan is designed to disengage from the previous AOC-based approach for RVAAP. Instead, the stakeholders have agreed to pursue a ROD for groundwater using a facility-wide approach. As a result, the RI for facility-wide groundwater will entail a thorough evaluation of historical data, assessment of key data gaps, geotechnical analyses, additional chemical analyses, aquifer testing, preparation of a baseline risk assessment, groundwater modeling, and installation of additional wells to supplement the hydrogeologic and fate-and-transport models. In order to meet the overall schedule presented in the Performance Work Statement (PWS), installation of the new wells has been initiated under a previously submitted addendum prior to final approval of the RI/FS work plan task. A brief discussion regarding well installation is presented within this work plan.

SECTION 2
PROJECT MANAGEMENT

EQM's overall project organization and responsibilities are presented in the Project Management Plan prepared for this PBA. The Project Manager for this project will be John M. Miller, CHMM. Quality assurance/quality control (QA/QC) protocols are addressed in Part II of the *Final Facility-Wide Groundwater Monitoring Program Plan RVAAP 66 Facility-Wide Groundwater Addendum* (EQM, January 2012). Health and safety requirements are addressed in Part III of the above-referenced addendum.

2.1 Staffing

The EQM Project Team assembled to complete the RVAAP-66 groundwater project will include EQM and the following key subcontractors:

EQM – will provide overall project management, direction of all subcontractors, and responsibility for completion of all deliverables. EQM will also provide field crews for sampling and well installation, geology/hydrogeology expertise, engineering evaluation, and oversight for all groundwater modeling and risk assessment activities.

Science Applications International Corporation (SAIC) – will provide field support, groundwater modeling, risk assessment, and regulatory support.

Civil & Environmental Consultants (CEC) – will provide field support including surveying wells, groundwater sampling support, Geographic Information System (GIS) analysis, risk assessment and groundwater modeling support, and geotechnical expertise.

PIKA International (PIKA) – will provide Unexploded Ordnance (UXO) support primarily for clearance of any subsurface excavation activities at Munition Response (MR) sites associated with this project.

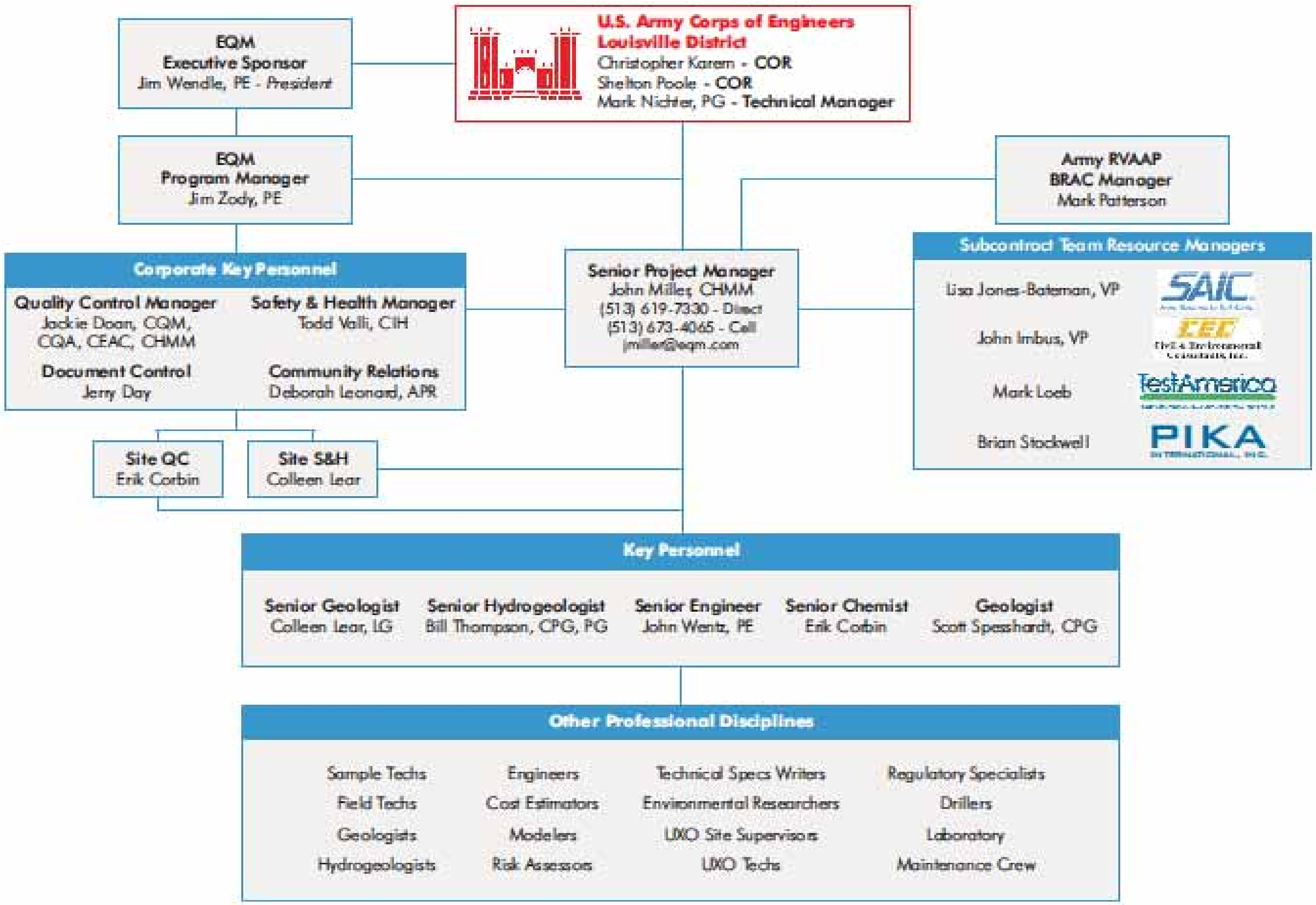
TestAmerica (TA) – will conduct analysis of groundwater samples.

Figure 2-1 is the project organizational chart showing the principal project-specific roles and lines of communication/reporting.

2.2 Coordination

2.2.1 <u>EQM Project Manager</u>

The EQM Project Manager or his designee will be responsible for overseeing daily project activities and for coordinating the various contractors involved in the project. He will be responsible for documenting and reporting daily progress and resolving issues related to safety,



1
2 **Figure 2-1. Project Organization**

air monitoring, or project operations. EQM's Project Manager will serve as the single point of contact (POC) and liaison for all work required. EQM will accept direction only from the USACE Contracting Officer (KO), designated Contracting Officer's Representative (COR), or the USACE technical contact, as directed. Any changes to the scope of work (SOW) must be authorized in writing by the KO. The Project Manager for this project will be John Miller, CHMM.

2.2.2 Field Team Leader

The Field Team Leader will be responsible for directing the sampling technicians during groundwater monitoring activities at the site. Generally, EQM mobilizes three field crews to perform the groundwater sampling. The Field Team Leader will ensure that all field sampling procedures are followed; equipment is properly calibrated, utilized, and decontaminated; health and safety measures are enforced; and field documentation protocols are met. The Field Team Leader will work closely with the Sample Manager to ensure that the data quality objectives are achieved. The Field Team Leader for this project will be Colleen Lear, LG.

During drilling activities, the Field Geologist will fulfill this function.

2.2.3 Sample Manager

The EQM Sample Manager will oversee all sampling events. During the scheduled sampling events for RVAAP, the EQM Sample Manager or his designee will be on site to coordinate sample-related activities. The EQM Sample Manager will ensure that all samples are properly handled and shipped by:

- Ensuring that all samples are properly cooled and appropriately preserved.
- Verifying that samples are correctly labeled and identified.
- Filling out sample chain-of-custody forms accurately.
- Properly packaging sample containers into shipping coolers for transport.
- Coordinating sample shipments with the contracted analytical laboratory in an expeditious manner.

The Sample Manager will also serve as the Laboratory Coordinator, and as such will maintain regular communication with laboratory personnel with regard to sample schedule and shipment of selected samples. The Sample Manager for this project will be Erik Corbin.

2.2.4 Site Health and Safety Coordinator

The site Health and Safety Coordinator (HSC) will have primary responsibility for the daily implementation of the Health and Safety Plan (HASP) at the site. This person will be responsible for all health and safety activities, including safety training, air monitoring, site inspections, and decontamination of personnel, equipment, and materials leaving the site. The HSC will also be charged with the responsibility of enforcing the use of personal protective equipment and training site personnel as outlined in the HASP. The HSC will have experience in field operations with air monitoring instruments, personal protective equipment, decontamination procedures, and emergency equipment and procedures. In addition, the HSC will conduct a project chemical inventory and will provide Material Safety Data Sheets (MSDSs) for each chemical identified to the Project Manager. Copies of the MSDSs will also be maintained with the Field Team Leader or Field Geologist.

2.2.5 Contractor Personnel

EQM, as well as all of our designated contractors, will provide a list of the names and trades of all personnel expected to be used on this project. This information will be used to ensure that only authorized personnel are granted access to the site. Daily sign-in and sign-out procedures will be followed by all site personnel; visitors will be required to provide advance notice of their visit to USACE, RVAAP site personnel, and the OHARNG.

Prior to the start of the investigation work, each contractor will be required to provide documentation of current training and medical monitoring for all field personnel to the HSC as required in the HASP. All individuals are required to have current training certificates at the start of the job and to maintain certification throughout the course of the project.

2.2.6 Subcontractor Personnel

Contractors must obtain approval from USACE prior to using any subcontractor at the site. USACE reserves the right to approve or reject any proposed subcontractor. Subcontractors must provide appropriate training certificates and medical monitoring records to the HSC before starting work at the site. Prime contractors will be responsible for ensuring that their subcontractors are familiar with and comply with all project procedures and requirements, including those presented in the HASP. Procurement and management of subcontractors is discussed in Section 4.3.2.

2.2.7 RVAAP Groundwater End State Working Group

To facilitate execution of the Performance Work Statement (PWS) and achieve an approved ROD, EQM will establish a RVAAP Groundwater End State Working Group comprising key stakeholders, including the USACE, Ohio EPA, United States Army Environmental Center (USAEC), Base Realignment and Closure (BRAC), and OHARNG. The Groundwater End State Working Group will provide a mechanism for systematic stakeholder interaction during all phases of execution of the PWS. Key objectives for the working group include:

- Identifying RI data needs for completing the RVAAP conceptual site model, contaminant nature and extent, contaminant fate and transport, and risk assessment/management considerations.
- Defining future groundwater resource uses.
- Establishing remedial action objectives and cleanup goals.
- Identifying points of compliance to apply facility-wide cleanup goals.
- Establishing mutually agreeable resource use controls (land use controls), as required.
- Interfacing with the RVAAP Restoration Advisory Board (RAB).

2.3 Deliverables

Deliverables for this project will include preliminary draft, draft, and final versions in printed copy and electronic Portable Document Format (PDF). Documents will be in compliance with the latest version of the *RVAAP Submission Format Guidelines*, currently Version 18.0 (VISTA, 2009). Preliminary draft versions of the documents will be prepared and submitted for Army review only. Once the Army comments on the preliminary draft have been addressed, a draft version of the document will be prepared for review by the regulators, the Army, and other stakeholders as appropriate. Following receipt and resolution of stakeholder comments on the draft document, it will be revised and a final version of the document issued.

Deliverables will include the following:

- Quarterly and semiannual groundwater monitoring reports
- Annual groundwater reports
- Amendments to the Facility-Wide Groundwater Monitoring Program (FWGWMP)
- Letter report for well installation
- RI Work Plan
- RI Report
- Feasibility Study
- Proposed Plan (PP)
- ROD
- Monthly Update Reports

Key deliverables and their associated deadlines are as follows:

- Approval of final Project Management Plan (PMP) and Quality Assurance Surveillance Plan (QASP) by December 31, 2011.
- Approval of final RI Work Plan by April 27, 2012.
- Submittal of draft 2012 Annual FWGWMP report by December 15, 2012 (per DFFOs).
- Approval of final RI Report by September 30, 2013.
- Submittal of draft 2013 Annual FWGWMP report by December 15, 2013 (per DFFOs).
- Approval of final FS Report by April 30, 2014.
- Approval of final PP by November 30, 2014.
- Submittal of draft 2014 Annual FWGWMP Report by December 15, 2014 (per DFFOs).
- Approval/signature of final ROD by December 31, 2015.

The Resource Loaded Schedule in Appendix A of the *Final Facility-Wide Groundwater Monitoring Program RVAAP-66 Facility-Wide Groundwater Project Management Plan* (EQM, November 2011) identifies all project-required deliverables including anticipated submittal dates.

This project will also include, as necessary:

- Biweekly status meetings – to be conducted with the appropriate stakeholders per the PWS by means of a conference call. The purpose of these meetings is to address the progress to date, summarize anticipated activities, address any problems or issues with regard to the project, and discuss any corrective actions.
- Biweekly contractors scheduling meetings – conducted to update stakeholders on the schedule for all project activities.

Additional information on Deliverable Management Procedures is presented in Section 6 of the PMP. Table 2-1 presents the anticipated Deliverables Distribution List for this project.

Table 2-1. Anticipated Deliverables Distribution List

Document Distribution Organization	Printed Copies	Electronic Copies
Preliminary Draft		
USACE Technical Manager	2	3
RVAAP Facility Manager	2	2
USAEC Program Manager	0	1
OHARNG – CRJMTC-ENV	1	1
NGB Cleanup Program Manager	0	1
EQM	1	1
Draft		
USACE Technical Manager	2	3
RVAAP Facility Manager	2	2
USAEC Program Manager	0	1
Ohio EPA	2	2
OHARNG – CRJMTC-ENV	1	1
NGB Cleanup Program Manager	0	1
EQM	1	1
Final		
USACE Technical Manager	2	3
RVAAP Facility Manager	2	2
USAEC Program Manager	0	1
Ohio EPA	2	2
OHARNG – CRJMTC-ENV	1	1
NGB Cleanup Program Manager	0	1
EQM	1	1
REIMS	0	1

Ohio EPA – Ohio Environmental Protection Agency , Twinsburg Office
OHARNG – CRJMTC-ENV – Ohio Army National Guard, Camp Ravenna Joint Military Training Center - Environmental
RVAAP – Ravenna Army Ammunition Plant
USACE – U.S. Army Corps of Engineers
USAEC – U.S. Army Environmental Center
NGB – National Guard Bureau
EQM – Environmental Quality Management, Inc.
REIMS - Ravenna Environmental Information Management System

SECTION 3
SITE BACKGROUND AND SETTING

3.1 Site Setting

Past Department of Defense (DoD) activities at the RVAAP date to 1940 and include the manufacturing, loading, handling, and storage of military explosives and ammunition. Until 1999, the RVAAP was identified as a 21,419-acre installation. The property boundary was resurveyed by the Ohio Army National Guard (OHARNG) from 2002 to 2003, and the actual total acreage of the property 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 by the OHARNG as a military training site. The current RVAAP consists of 1,280 acres in several distinct parcels scattered throughout the confines of the OHARNG Camp Ravenna Joint Military Training Center (CRJMTC). The RVAAP and CRJMTC are collocated on contiguous parcels of property and the CRJMTC perimeter fence completely encloses the remaining parcels of the RVAAP.

CRJMTC is located at 8451 State Route 5 in northeastern Ohio within Portage and Trumbull Counties, approximately 4.8 kilometers (3 miles) east-northeast of the city of Ravenna and approximately 1.6 kilometers (1 mile) northwest of the city of Newton Falls (Figure 3-1). The RVAAP portions of the property are solely located within Portage County. CRJMTC (inclusive of the RVAAP) is a parcel of property approximately 17.7 kilometers (11 miles) long and 5.6 kilometers (3.5 miles) wide bounded by State Route 5, the Michael J. Kirwan Reservoir, and the CSX System Railroad on the south; Garret, McCormick, and Berry roads on the west; the Norfolk Southern Railroad on the north; and State Route 534 on the east (see Figures 3-1 and 3-2). CRJMTC is surrounded by several communities: Windham on the north; Garrettsville 9.6 kilometers (6 miles) to the northwest; Newton Falls 1.6 kilometers (1 mile) to the southeast; Charlestown to the southwest; and Wayland 4.8 kilometers (3 miles) to the south. When the RVAAP was operational CRJMTC did not exist and the entire 21,683-acre parcel was a government-owned, contractor-operated (GOCO) industrial facility. The RVAAP IRP encompasses investigation and cleanup of past activities over the entire 21,683 acres of the former RVAAP, and, therefore, references to the RVAAP in this document are considered to be inclusive of the historical extent of the RVAAP, which is inclusive of the combined acreages of the current CRJMTC and RVAAP, unless otherwise specifically stated.

3.2 Site History

In August 1940, the United States Government purchased a tract of land covering 25,000 acres in the northeastern part of Ohio in Portage and Trumbull counties. Construction of the plant started in September 1940, and operations commenced shortly after completion circa December 1941/ January 1942 with the primary missions of depot storage and ammunition loading. Facilities were operated by the Atlas Powder Company from September 1940 until the end of World War II. The operation of the plant was subsequently turned over to the Ordnance Department.

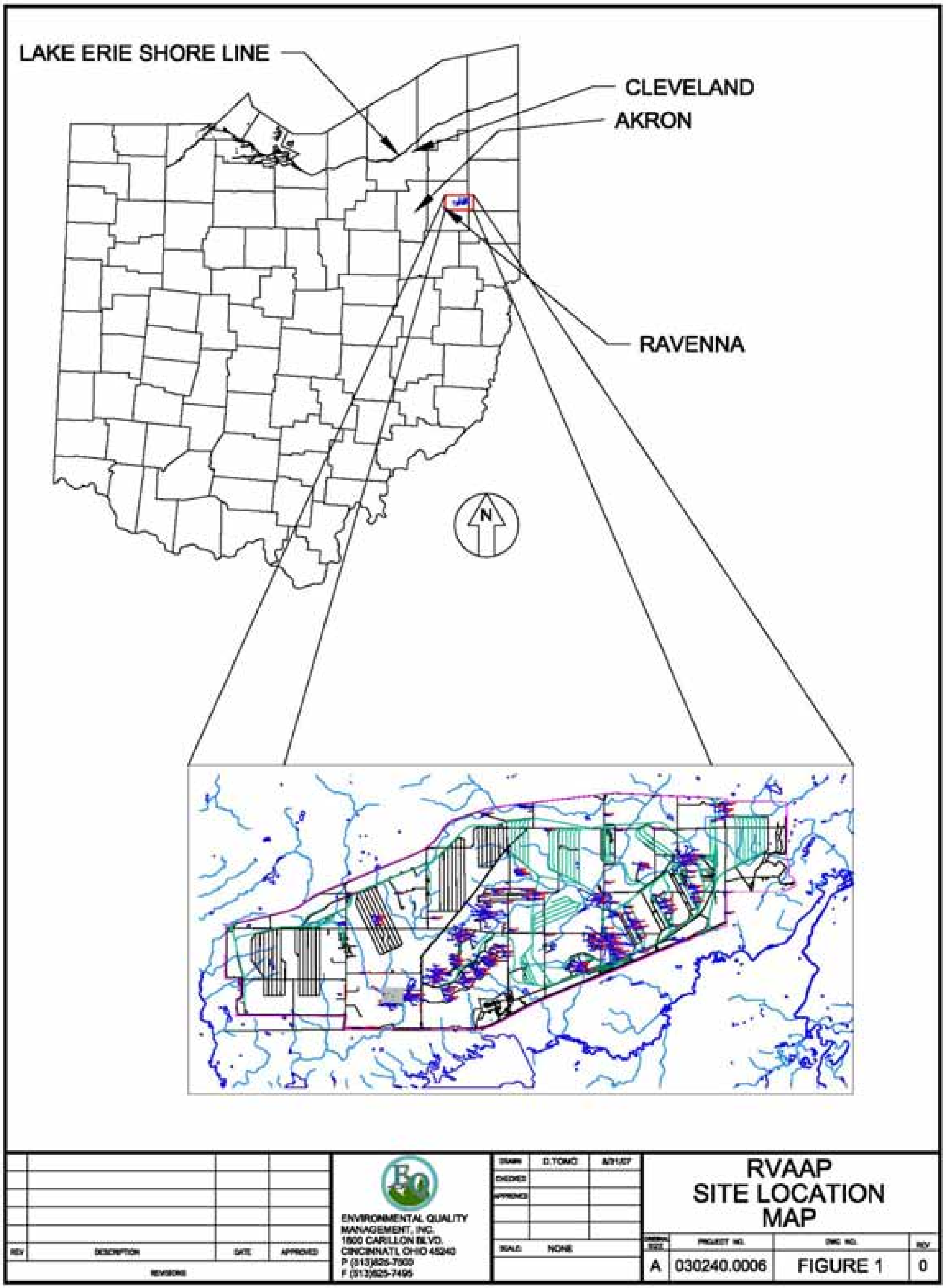


Figure 3-1. RVAAP General Location Map

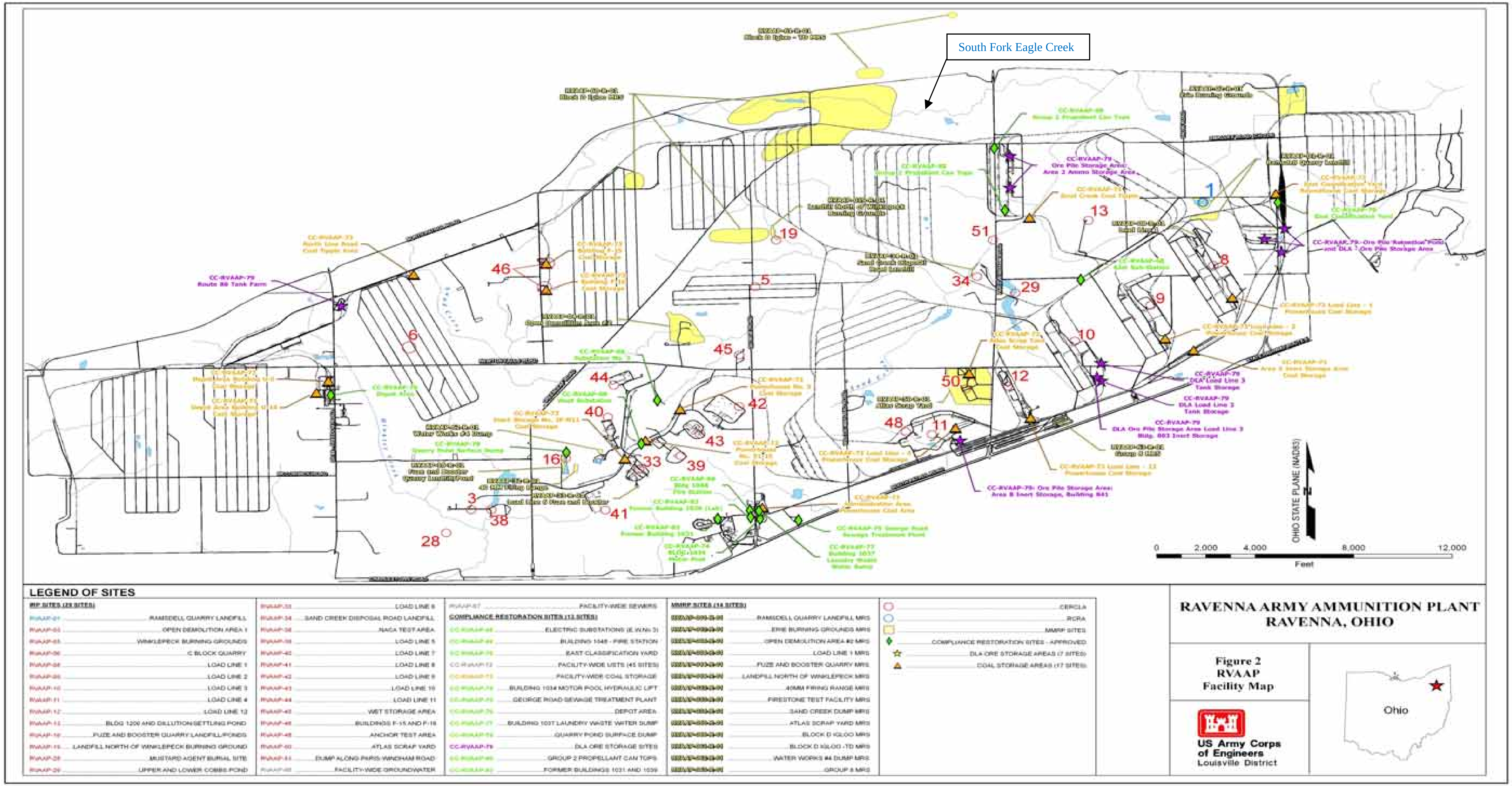


Figure 3-2. RVAAP Facility Map

From 1946 to 1949, the ammonium nitrate line was operated by the Silas Mason Company for the production of ammonium nitrate fertilizer.

The plant was placed in standby status in 1950, and operations were limited to renovation, demilitarization, and normal maintenance of equipment, along with storage of ammunition and components. Beginning in April 1951, facility operations were contracted with Ravenna Arsenal, Inc., a subsidiary of the Firestone Tire and Rubber Company of Akron, Ohio.

The plant was reactivated during the Korean Conflict for the loading and packing of major caliber shells and components. In July 1954, the Plum Brook Ordnance Works of Sandusky, Ohio, and the Keystone Ordnance Works of Meadville, Pennsylvania, were made satellites to Ravenna. All production ended in August 1957, and the installation was placed in standby condition by October 1957. In March 1958, the Plum Brook Plant ceased to be under the jurisdiction of Ravenna, and in July 1959, the Keystone Ordnance Works was transferred to the General Services Administration.

Rehabilitation work started in 1960 to establish facilities in the ammonium nitrate line for the processing and explosive melt-out of bombs. These operations commenced in January 1961, thereby establishing the first operation of this type in the ammunition industry. However, in July 1961, the plant was again deactivated, and in November 1961, the plant was divided. The industrial portion was redesignated as the Ravenna Ordnance Plant, and the entire facility was designated the Ravenna Army Ammunition Plant. The RVAAP was reactivated in May 1968 to load, assemble, and pack (LAP) munitions on three load lines and component lines in support of the Southeast Asian Conflict (Vietnam War). These facilities were subsequently deactivated in August 1972. A mission for the demilitarization of the M171A1 90-mm projectile extended from June 1973 until March 1974.

In October 1982, the Physics International Company, a subsidiary of Rockcor, Inc., purchased Ravenna Arsenal, Inc., from the Firestone Company. In June 1985, Rockcor was purchased by the Olin Corporation.

Demilitarization of various munitions continued on a periodic basis through 1992. In fiscal year (FY) 1993, the installation's status changed from inactive-maintained to modified caretaker (limited mission). On October 1, 1998, R&R International, Inc., took over as the installation's contractor. R&R was later replaced by Toltest, Inc. The current mission is storage of bulk explosives and propellants.

The Operations Support Command (OSC) transferred control and operation of 16,164 acres to the National Guard Bureau (NGB) in May 1999. In March 2002, an agreement was signed to immediately transfer an additional 3,774 uncontaminated acres to the NGB with the remaining acreage to be transferred as restoration of the AOCs is completed.

The RVAAP is currently used as a military training site; no manufacturing operations are conducted at the facility.

Although no longer an active munitions manufacturing facility, the RVAAP has historically handled hazardous wastes and operated several waste management units in support of its previous operations. Industrial operations comprised twelve (12) munitions-assembly facilities referred to as "load lines." Load Lines 1 through 4 were used to melt and load 2,4,6-trinitrotoluene (TNT) and Composition B [a mixture of 1,3,5-trinitroperhydro-1,3,5-triazine (RDX) and TNT, generally in a 60:40 ratio by weight] into large-caliber shells and bombs. The operations on the load lines produced explosive dust, spills, and vapors that collected on the floors and walls of each building. Periodically, the floors and walls were cleaned with water and steam. The resulting wastewater, which contained TNT and Composition B, was known as "pink water" for its characteristic color. Pink water was collected in concrete holding tanks, filtered, and pumped into unlined ditches for transport to earthen settling ponds. Load Lines 5 through 11 were used to manufacture fuzes, primers, and boosters. Potential contaminants in these load lines include lead compounds, mercury compounds, and explosives. From 1946 to 1949, Load Line 12 was used to produce ammonium nitrate for explosives and fertilizers prior to use as a weapons demilitarization facility.

Various industrial operations at the RVAAP have been identified as potential sources of contaminants. These operations include the load lines, sewage treatment plants, wastewater treatment plants, vehicle maintenance areas, storage tanks, waste storage areas, equipment storage areas, and furnaces and evaporation units. Landfills at the RVAAP were used to bury wastes from industrial operations and sanitary sources. Settling and retention ponds at the site collected wastewater from munitions wash-down operations at various facilities. Additionally, the RVAAP includes several areas associated with the burning, demolition, and testing of various munitions. These burning grounds and demolition areas are located at several large areas or in abandoned quarries at the RVAAP. Strategic ores and other materials were stockpiled at several locations at the site; subsequent to removal by the Defense Logistics Agency (DLA), the residual materials may have left various contaminants in place. Potential contaminants at the site include, but are not limited to: primary explosives, secondary explosives, propellants, metals, polychlorinated biphenyls (PCBs), pesticides, waste oils, sludge from load lines, various laboratory chemicals, sanitary waste, mustard agent, and petroleum products.

3.3 Regulatory Status

The RVAAP is not on the United States EPA (USEPA) National Priorities List (NPL), although it is in the USEPA's Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) database. The DoD IRP administered by the U.S. Army directs the cleanup program at RVAAP. Management of the IRP sites follows CERCLA requirements. There are currently 27 individual IRP AOCs, two facility-wide AOCs, 14 compliance restoration (CR) sites, and 14 MR sites actively being addressed as identified in the 2011 RVAAP Installation Action Plan (IAP).

In June 2004, Ohio EPA issued the DFFOs for RVAAP, which require conformance with CERCLA and the National Oil and Hazardous Substances Pollution Contingency Plan. All RVAAP environmental restoration activities are conducted in accordance with the requirements of the DFFO under work plans reviewed and approved by Ohio EPA.

3.3.1 <u>RVAAP Installation Restoration Program</u>

The original *Facility-wide Sampling and Analysis Plan* (OSC/Specpro 1996) presumed that all environmental activities carried out at RVAAP would be administered by the U.S. Army under the IRP, following a process that parallels CERCLA. In November 1996, under this plan, the Army was given authorization by Ohio EPA to fill, grade, excavate, drill, build, or mine at previously unranked AOCs on the facility. The U.S. Army has applied the IRP/CERCLA model to the majority of environmental investigations conducted to date at RVAAP to ensure the sufficiency, integrity, and defensibility of data on environmental contamination.

The Army utilizes an Installation Action Plan that outlines and defines a multi-year restoration program for the RVAAP. On June 10, 2004, the Ohio EPA issued the DFFOs for RVAAP, which require conformance with CERCLA and the National Oil and Hazardous Substances Pollution Contingency Plan for completion of environmental restoration activities.

3.3.2 <u>RVAAP Groundwater Monitoring Program</u>

In a March 20, 2001, submittal, the Army requested that the RVAAP be exempted from the groundwater monitoring requirements included in OAC rules 3745-54-90 through 3745-55-01 at DA-2 and the Deactivation Furnace and OAC rule 3745-27-10 at the RQL. The Army proposed that all groundwater monitoring activities be conducted as part of the CERCLA activities at the site. In a March 21, 2002, letter to the Army, the Ohio EPA stated that in order to be exempted from the OAC rules, the Army must commit "to ensuring that the ground water and surface water will be regularly monitored at these units," and that a Facility-wide groundwater monitoring program be implemented. In 2004, the Facility-Wide Groundwater Monitoring Program Plan was completed.

During the time period of 2005 through 2007, the USACE developed a database of groundwater quality information based on the sampling of approximately 36 monitoring wells. Beginning in FY 2008, the USACE expanded the FWGWMP to include the characterization of groundwater from 243 existing monitoring wells at the facility, which includes those wells monitored prior to 2005. The wells have been installed in the vicinity of defined AOCs or to provide background data. Presently, only the RCRA monitoring wells at DA-2 and the RQL are monitored on a regular schedule. The locations of monitoring wells at RVAAP are shown on Plate 1.

3.4 Site Geology

The regional geology at RVAAP consists of horizontal to gently dipping sedimentary bedrock strata of Mississippian- and Pennsylvanian-age overlain by varying thicknesses of Pleistocene-age unconsolidated glacial deposits. Water and associated environmental contamination in fine-grained glacial and alluvial materials travel down from the surface to underlying groundwater aquifers principally through fractures (termed secondary porosity) and flow between the grains (termed primary porosity).

3.4.1 Unconsolidated Deposits

Bedrock at RVAAP is overlain by deposits of the Wisconsin-aged Lavery Till in the western portion of the facility and the younger Hiram Till and associated outwash deposits in the eastern two-thirds of the facility. Unconsolidated glacial deposits vary considerably in their character and thickness across RVAAP, from zero (0) in some of the eastern portions of the facility to an estimated 46 meters (150 feet) in the south-central portion. The glacial till found at RVAAP was deposited as a more or less uniform sheet covering the bedrock surface as a ground moraine. Where the bedrock is reasonably level, the surface of the till cover is smooth and gently undulating. Where the bedrock surface has more relief, the till cover produces a masked erosional topography. There is some evidence that varved clays, indicative of lake deposits, exist in some of the deeper bedrock valleys (USACE, 1970, 2005). The Hiram Till is the most extensive till in northeast Ohio and covers approximately the eastern two-thirds of RVAAP. It is material from which the silty-clay loam and clay-loam soil of much of the northern part of northeastern Ohio is derived. The Hiram Till is the most clay-rich till of northeastern Ohio and is only sparsely pebbly with boulders and cobbles rarely found. The Hiram Till is characteristically thin with a median thickness of 5 feet in the eastern portion of RVAAP. The Lavery Till is a surface till that is found in a large portion of central Portage County. It is comprised of a clayey-silt that contains approximately 28 percent sand and 30 percent clay. The Lavery Till contains few pebbles and only a few cobbles and boulders in marked contrast to earlier tills found in this area. In the subsurface, below the Hiram Till, the Lavery Till is almost always present with maximum thicknesses up to 40 feet in the western portion of the facility; although, its median thickness is only 4 feet. The Lavery Till can be found exposed across the western third of RVAAP. The till is reported to be somewhat impermeable, with hydraulic conductivities greater than 10^{-6} cm/sec.

It is unclear whether the glacial outwash deposits located in the northeast corner of RVAAP are of the Hiram, Lavery, or another glacial episode in origin. No gravel deposits of Hiram age have been positively identified in Portage County. Likewise, Lavery outwash is scanty and inconspicuous. Only the most meager gravel deposits were formed in this age.

In addition to the glacial deposits, other unconsolidated deposits include alluvium associated with the surface drainages that may or may not be continuous with the surrounding glacial tills.

3.4.2 Bedrock

The bedrock underlying the glacial deposits comprises sedimentary deposits, predominantly Pennsylvanian in age, with minor deposits of Mississippian-age rocks. According to the *Preliminary Assessment for the Ravenna Army Ammunition Plant* (USACE, 1996), the bedrock units at RVAAP display a gentle southward dip of 5 to 10 ft/mile. In the bedrock below the glacial deposits, earlier erosion has exposed progressively older bedrock units in an eastern direction across RVAAP. The *Installation Assessment of Ravenna Army Ammunition Plant*

(USATHAMA, 1978) provides a map that illustrates the subsurface geology at RVAAP. The youngest bedrock unit found on RVAAP is the Homewood Sandstone Member (Homewood) of the Pottsville Formation. The Homewood comprises coarse- to fine-grained clay-bonded micaceous sandstone with thin shale lenses. The Mercer Member of the Pottsville Formation directly underlies the Homewood and consists of gray to black micaceous shale, thin sandstones, and coal. The Connoquenessing Sandstone Member underlies the Mercer Member and comprises coarse- to fine-grained sandstone and silty to sandy shale. The Sharon Member Shale unit (Sharon Shale) consists of gray to black sand and micaceous shale with thin coal and separates the Connoquenessing Sandstone Member from the underlying Sharon Conglomerate (Sharon). Comprised of tan, coarse- to fine-grained orthoquartzite sandstone, the Sharon is loosely cemented and is the most important aquifer found at RVAAP. The Mississippian bedrock units found in the eastern portion of RVAAP comprise the Meadville Shale, a blue-gray shale, and the Berea Sandstone, a massive, moderately hard, medium- to fine-grained sandstone.

3.5 Site Hydrogeology

3.5.1 Groundwater in Unconsolidated Deposits

Groundwater in the unconsolidated deposits is limited to sandy lenses in the glacial tills, saturated lake clays and outwash material, and the alluvium deposits associated with the numerous surface drainages at RVAAP. Groundwater is also present at the glacial till-bedrock contact. Outside of the facility boundaries, unconsolidated deposits can be an important source of groundwater, as many of the domestic wells and small public water supplies located near the facility obtain reasonable quantities of water from wells completed in unconsolidated deposits. There is evidence that a buried valley tributary to the Mahoning River is present in the west-central portion of RVAAP (USATHAMA, 1978). Although buried valleys can be important aquifers, there is no evidence to support the occurrence of significant water-bearing material in this buried valley tributary. The main buried valley aquifer associated with the Mahoning River does not yield significant quantities of water (USATHAMA, 1978). Because the buried valley aquifer that may be found at RVAAP is a tributary, finer-grained sediment would be expected in this stream valley compared to the main buried valley aquifer, culminating in potentially lower water yields in the tributary sediments. Water production wells previously drilled in the area (Barnes, 1950) also support the insignificance of a buried valley aquifer at RVAAP. Plate 2 shows the potentiometric surface of unconsolidated sediment at the facility from October 2011. Groundwater in the unconsolidated aquifer predominantly flows in an eastward direction; however, the unconsolidated zone shows numerous local flow variations influenced by topography and drainage patterns. The local variations in flow direction suggest: (1) groundwater in the unconsolidated deposits is generally in direct hydraulic communication with surface water; and (2) surface water drainage ways may also act as groundwater discharge locations. In addition, topographic ridges between surface water drainage features act as groundwater divides in the unconsolidated deposits.

3.5.2 Groundwater in Bedrock Deposits

The principle water-bearing aquifer at RVAAP is the Sharon Conglomerate. Depending on the existence and depth of overburden, the Sharon ranges from a confined to a leaky artesian aquifer. Water yields from area wells completed in the Sharon range from 30 to 400 gallons per minute (gpm) (USATHAMA, 1978). Well yields of 5 to 200 gpm were reported for on-site bedrock wells completed in the Sharon (Kammer, 1982). Other local bedrock units capable of producing water include the Homewood Sandstone, which is generally thinner and only capable of well yields less than 10 gpm, and the Connoquenessing Sandstone. The Connoquenessing Sandstone is a good aquifer where it occurs, but it is less productive than the Sharon Conglomerate (Kammer, 1982).

Plate 3 shows the potentiometric surface of bedrock groundwater at the facility from October 2011. The bedrock potentiometric map shows a regional eastward flow direction that is not affected by local surface topography. For much of the eastern half of RVAAP, the bedrock potentiometric surface is higher than the overlying unconsolidated potentiometric surface, thus indicating an upward hydraulic potential. This evidence suggests that there is a confining layer that separates the two aquifers. In the far eastern area, the two potentiometric surfaces are approximately at the same elevation, thus suggesting that hydraulic communication between the two aquifers is occurring.

3.6 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 were obtained from the National Weather Service Office 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, with the highest monthly average occurring in July (4.07 inches) and the lowest monthly average occurring in February (2.03 inches). Average annual total snowfall is approximately 56.2 inches, with the highest monthly average occurring in January (12.9 inches). Due to the influence of lake-effect snowfall events associated with Lake Erie, which is located approximately 35 miles northwest of the RVAAP, snowfall totals vary widely throughout northeastern Ohio.

The average annual daily temperature in the RVAAP area is 48.3^{o}F, with an average daily high temperature of 57.7^{o}F and an average daily low temperature of 38.7^{o}F. The record high temperature of 100^{o}F occurred in July 1988, and the record low temperature of -22^{o}F 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 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 property occurred as the result of a tornado in 1985.

3.7 Physiographic Setting

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

Locally, a pre-glacial buried valley potentially exists in the central portion of the facility, oriented in a southwest-northeast direction. This valley is filled with glacial outwash comprising poorly-sorted clay, till, gravel, and silty sand. The presumed thickness of glacial deposits within the valley ranges from 100 to 200 feet. However, bedrock outcrops have been documented in the same area, so the existence of a buried valley cannot be confirmed (Winslow, *et al*, 1966).

3.8 Surface Water

The RVAAP 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 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 RVAAP 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 (see Figure 3-2). All of these water courses have many associated tributaries.

Sand Creek flows generally in a northeast direction to its confluence with the South Fork of Eagle Creek. In turn, the South Fork of Eagle Creek continues in a northerly direction for 2.7 miles to its confluence with Eagle Creek, which eventually flows into the Mahoning River to the east. It is likely that limited agricultural and recreational use of the South Fork of Eagle Creek does occur off facility property, although no data are available to allow a more detailed study. Hinkley Creek originates just southeast of the intersection between State Routes 88 and 303 to the north of the facility. Hinkley Creek flows in a southerly direction through the facility to its confluence with the west branch of the Mahoning River south of the facility (USACE, 2001). It is doubtful that Hinkley Creek is used for agricultural purposes, although limited recreational use may occur.

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 and resulted from glacial action or beaver activity. All water bodies at RVAAP are capable of supporting abundant aquatic vegetation and biota.

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.

Past and present surface water utilization at RVAAP was generally limited to use by wildlife and recreational users. Some surface water may have been intermittently used for various facility operations, but the vast majority of process water was provided by on-site groundwater production wells. There is no available documentation that indicates any past irrigation or other agricultural use of surface water sources on facility property. However, it is likely that there was some agricultural use of surface water in this area prior to facility construction due to the presence of homesteads and farms at that time. CRJMTC has an established fishing program administered through the OHARNG. Recreational trespasser use of surface water reportedly occurs on a limited basis.

3.9 Groundwater Utilization

All groundwater utilized at RVAAP during past operations was obtained from on-site production wells, with the majority of the wells screened in the Sharon Conglomerate. The Army discontinued use of groundwater production wells prior to 1993 when RVAAP was placed in modified caretaker status. The status of plugging and abandonment of former groundwater production wells is currently under evaluation by the Army. Currently, one of the original groundwater production wells remains in use by the Army. This well, located in the Administration Area of the facility, provides sanitary water to the remaining personnel. As of 2010, an additional two wells had been installed by OHARNG to provide drinking water for personnel.

Residential groundwater use in the surrounding area is similar to that for RVAAP, with the Sharon Conglomerate acting as the major producing aquifer in the area. The Connoquenessing and Homewood Sandstones also provide limited groundwater resources, primarily near the western half of RVAAP. Many of the local residential wells surrounding RVAAP are completed in the unconsolidated glacial material.

The Ground Water Pollution Potential of Portage County, Ohio map (ODNR, 1990) provides additional insight into the groundwater characteristics of RVAAP. This map indicates the relative vulnerability of groundwater in a specific area to contamination from surface sources. Intended primarily as a groundwater resource management and planning tool, the Ground Water Pollution Potential of Portage County, Ohio map presents index values based on several hydrogeologic criteria, including depth to water, hydraulic conductivity, topography, and others. Resulting index values range from a low pollution potential (zero) to a high pollution potential (200+).

Based on this mapping system, the majority of RVAAP has a moderate pollution potential that ranges between 100 and 159, depending on location. In addition, three general hydrogeologic settings are defined for RVAAP: 1) glacial till overlying bedded sedimentary rock, 2) glacial till overlying sandstone, and 3) alluvium overlying bedded sedimentary rock. Generally, the highest pollution potential values at RVAAP occur in the areas where alluvium overlies bedded sedimentary rock (index range from 100 to 159); these areas occur primarily in the northeast portion of the facility. The majority of RVAAP has pollution potential indices that range between 100 and 139.

3.10 Ecological Setting

The RVAAP/CRJMTC has a diverse range of vegetation and habitat resources. Habitats present within the facility include large tracts of closed-canopy hardwood forest, scrub/shrub open areas, grasslands, wetlands, open-water ponds and lakes, and semi-improved administration areas (AMEC, 2008).

Vegetation at CRJMTC can be grouped into three categories: herb-dominated, shrub dominated, and tree-dominated. Approximately 60 percent of the facility is covered by forest or tree-dominated vegetation. The facility has a total of seven forest formations, four shrub formations, eight herbaceous formations, and one non-vegetated formation. (AMEC, 2008).

Surface water features within the RVAAP/CRJMTC include a variety of streams, ponds, floodplains, and wetlands. Numerous streams drain the facility, including approximately 19 miles of perennial streams. The total combined stream length of streams at the facility is 212 linear miles. Approximately 153 acres of ponds are found on the facility. These ponds generally provide valuable wildlife habitat. The ponds generally support wood ducks, hooded mergansers, mallards, Canada goose, and many other birds and wildlife species. Some ponds have been stocked with fish and are used for fishing and hunting (AMEC, 2008).

Wetlands are abundant and prevalent throughout the facility. These wetland areas include seasonal wetlands, wet fields, and forested wetlands. Most of the wetland areas on the facility are the result of natural drainage and beaver activity; however, some wetland areas are associated with anthropogenic settling ponds and drainage areas.

An abundance of wildlife is present on the facility. A total of 35 species of land mammals, 214 species of birds, 41 species of fish, and 34 species of amphibians and reptiles have been identified on the facility. No federally listed species are known to reside at the facility, and no critical habitat occurs (AMEC, 2008). Ohio State-listed plant and animal species have been identified through confirmed sightings and/or biological inventories at the facility and are presented in Table 3-1 (CRJMTC Rare Species List, dated April 27, 2010).

3.11 Contamination Assessment

The contamination at RVAAP originated from past industrial activities associated with the production and demilitarization of large caliber shells, gravity bombs, and parts for these munitions. The RVAAP produced munitions during World War II, the Korean Conflict, and the Vietnam War. The industrial operations at RVAAP comprised 12 production areas known as "load lines." Load Lines 1 through 4 (melt-pour lines) were the primary sources of secondary explosives contamination such as TNT, cyclotetramethylenetetranitramine (HMX), and cyclotrimethylenetrinitramine (RDX), which were melted and poured into shell and bomb cavities. Load Lines 1 and 12 were used for demilitarization of shells. Load Line 1 was also used to produce and recondition tank mines. Workers would periodically use steam and hot water to hose down equipment and the floors and walls of buildings contaminated with explosive dust, spills, and vapors. The explosive-contaminated water from the cleaning, known as "pink water," then drained out doorways and through floor drains onto the soils surrounding the buildings or was discharged into open ditches or ponds after being filtered through saw dust to remove suspended explosives. Waste explosives from the melt-pour lines were routinely disposed of by open burning and detonation at other sites on the installation.

Load Lines 5 through 11 (fuze and booster) were used to manufacture fuzes, primers, and boosters while Load Line 12 housed the ammonium nitrate plant. Potential contaminants in Load Lines 5 through 11 include lead azide, mercury fulminate, lead styphnate, black powder, heavy metals, TNT, and Composition B. The amount of explosives used at the fuze and booster lines was much less than that used at the melt-pour lines because of the types of small munitions components being made there. Also, the operations did not create as much waste and were cleaner due to the special handling procedures needed when working with the highly shock- and heat-sensitive primary explosives. Load Line 12 recrystallized ammonium nitrate for explosives, fertilizers, and aluminum chloride. It was also periodically used for demilitarization projects involving the melt-out of TNT and other secondary explosives from the cavities of bombs and shells. As in the other melt-pour lines, these activities resulted in pink water being released to the soils, ditches, and ponds in and around the line. Other types of contaminated sites associated with past industrial activities at RVAAP include landfills, testing facilities, dumps, burial sites, a pistol range, storage facilities, a scrap yard, and decontamination buildings. Although not present at every one of these sites, the contaminants of potential concern include primary and secondary explosives, propellants, heavy metals, volatile and semivolatile organics, PCBs, asbestos, and pesticides. Industrial activities ceased in 1992 when RVAAP was declared excess.

During the last 30 years, multiple environmental-related investigations were conducted at RVAAP. Beginning in 1978, an Installation Assessment was conducted of RVAAP and concluded that no migration of contamination to groundwater had occurred at the facility (USATHAMA, 1978). Several years later, a re-assessment also concluded that no migration of

Table 3-1. RVAAP Rare Species List*

Camp Ravenna Joint Military Training Center (CRJMTC) Rare Species List
April 27, 2010

1. Species confirmed to be on CRJMTC property by biological inventories and confirmed sightings.

   A. State Endangered

      i. American bittern, *Botaurus lentiginosus* (migrant)
      ii. Northern harrier, *Circus cyaneus*
      iii. Yellow-bellied sapsucker, *Sphyrapicus varius*
      iv. Golden-winged warbler, *Vennivora chrysoptera*
      v. Osprey, *Pandion haliaetus* (migrant)
      vi. Trumpeter swan, *Cygnus buccinators* (migrant)
      vii. Mountain brook lamprey, *Ichthyomyzon greeleyi*
      viii. Graceful underwing, *Catocala gracilis*
      ix. Tufted moisture-loving moss, *Philonotis Fontana var. caespitosa*
      x. Bobcat, *Felis rufus*
      xi. Narrow-necked Pohl's moss, *Pohlia elongate var. elongate*
      xii. Sandhill crane, *Grus canadensis* (probable nester)
      xiii. Bald eagle, *Haliaetus leucocephalus* (nesting pair)

   B. State Threatened

      i. Barn owl, *Tyto alba*
      ii. Dark-eyed junco, *Junco hyemalis* (migrant)
      iii. Hermit thrush, *Catharus guttatus* (migrant)
      iv. Least bittern, *Ixobrychus exilis*
      v. Least flycatcher, *Empidonax minimus*
      vi. *Psilotreta indecisa* (Caddis fly)
      vii. Simple willow-herb, *Epilobium strictum*
      viii. Woodland horsetail, *Equisetum sylvaticum*
      ix. Lurking leskea, *Plagiothecium latebricola*
      x. Pale sedge, *Carex pallescens*

   C. State Potentially Threatened Plants

      i. Gray birch, *Betula populifolia*
      ii. Butternut, *Juglans cinerea*
      iii. Northern rose azalea, *Rhododendron nudiflorum var. roseum*
      iv. Hobblebush, *Viburnum alnifolium*
      v. Long beech fern, *Phegopteris connectilis* (*Thelypteris phegopteris*)
      vi. Straw sedge, *Carex straminea*
      vii. Water avens, *Geum rivale*
      viii. Tall St. John's wort, *Hypercium majus*
      ix. Swamp oats, *Sphenopholis pensylvanica*
      x. Shining ladies' tresses, *Spiranthes lucida*
      xi. Arbor vitae, *Thuja occidentalis*
      xii. American chestnut, *Castanea dentate*

Table 3-1 (continued). RVAAP Rare Species List*

D. State Species of Concern

- i. Pygmy shrew, *Sorex hovi*
- ii. Star-nosed mole, *Condylura cristata*
- iii. Woodland jumping mouse, *Napaeozapus insignis*
- iv. Sharp-shinned hawk, *Accipiter striatus*
- v. Marsh wren, *Cistothorus palustris*
- vi. Henslow's sparrow, *Ammodramus henslowii*
- vii. Cerulean warbler, *Protonaria citrea*
- viii. Prothonotary warbler, *Protonotaria citrea*
- ix. Bobolink, *Dolichonyx oryzivorus*
- x. Northern bobwhite, *Colinus virginianus*
- xi. Common moorhen, *Gallinula chloropus*
- xii. Great egret, *Ardea alba* (migrant)
- xiii. Sora, *Porzana carolina*
- xiv. Virginia rail, *Rallus limicola*
- xv. Creek heelsplitter, *Lasmigona compressa*
- xvi. Eastern box turtle, *Terrapene carolina*
- xvii. Four-toed salamander, *Hemidacrylium scuta/um*
- xviii. *Stenonema ithica* (Mayfly)
- xix. *Apamea mixta* (Moth)
- xx. *Brachylomia algens* (Moth)
- xxi. Sedge wren, *Cistothorus platensis*

E. State Special Interest

- i. Canada warbler, *Wilsonia canadensis*
- ii. Little blue heron, *Egretta caerula*
- iii. Magnolia warbler, *Dendroica magnolia*
- iv. Northern waterthrush, *Seiurus noveboracensis*
- v. Winter wren, *Troglodytes troglodytes*
- vi. Black-throated blue warbler, *Dendroica caerulescens*
- vii. Brown creeper, *Certhia americana*
- viii. Mourning warbler, *Oporornis philadelphia*
- ix. Pine siskin, *Carduelis pinus*
- x. Purple finch, *Carpodacus purpureus*
- xi. Red-breasted nuthatch, *Sitta canadensis*
- xii. Golden-crowned kinglet, *Regulus satrapa*
- xiii. Blackburnian warbler, *Dendroica fusca*
- xiv. Blue grosbeak, *Guiraca caerulea*
- xv. Common snipe, *Gallinago gallinago*
- xvi. American wigeon, *Anas americana*
- xvii. Gadwall, *Anas strepera*
- xviii. Green-winged teal, *Anas crecca*
- xix. Northern shoveler, *Anas clypeata*
- xx. Redhead duck, *Aythya americana*
- xxi. Ruddy duck, *Oxyura jamaicaensis*

Note: There are currently NO FEDERALLY listed species or critical habitat on CRJMTC property. There are a few species currently under federal observation for listing, but none listed.

*Adapted from Table 2-1 of the *Facility-Wide Field Sampling Plan for Environmental Investigations, Ravenna Army Ammunition Plant, Ravenna, Ohio* (FWSAP; SAIC, February 2011).

contamination to groundwater had occurred (USATHAMA, 1982). In 1988, the United States Army Environmental Hygiene Agency (USAEHA) conducted a groundwater contamination survey and an evaluation of solid waste management units (SWMUs). Twenty-nine (29) potentially contaminated SWMUs were identified. Further investigation was recommended for 15 of the 29 SWMUs to determine if contaminants had migrated from these units. The following year, Jacob's Engineering, Inc., performed a *RCRA Facility Assessment, Preliminary Review and Visual Site Inspection* (USEPA, 1989). The report identified 31 SWMUs, 13 of which were recommended for no further action (NFA). These 31 SWMUs are listed as sites in the REIMS database.

Several other investigations took place in the early 1990s. In 1996, USACE performed a facility-wide preliminary assessment covering all known environmental AOCs at RVAAP. Also that year, USACE conducted Phase I remedial investigations of 11 high-priority sites identified as Load Lines 1 through 4, Load Line 12, Winklepeck Burning Grounds (WBG), Landfill North of WBG, Building 1200, Demolition Area #2, Upper and Lower Cobbs Ponds, and Load Line 12 Pink Wastewater Treatment Plant. A final RI report was issued in 1997. The study concluded that Load Lines 1 through 4 and 12 appeared to be the most contaminated, and contaminants were probably not migrating far from the sources in significant concentrations. The report recommended further study.

Preliminary well sampling, conducted by Ohio EPA in 1997 and 1998, showed no off-post explosives contamination of residential wells.

For the most part, results from more recent studies have confirmed that explosives and heavy metals are the most common contaminants and are generally located immediately around buildings in the load lines and in the ditches and ponds draining the sites. Less common contaminants include polycyclic aromatic hydrocarbons (PAHs), semivolatile organic compounds (SVOCs), and propellants. These same contaminants have been detected in the water and sediment within the storm and sanitary sewers. Monitoring wells located to the southeast of Load Line 2 near the perimeter have shown trace amounts of explosives.

The Annual IAP contains a full description of the status of all investigations and other activities at the facility. The current IAP and a complete listing of RVAAP investigations can be found at RVAAP Access (www.rvaap.org). A brief summary of these investigations is provided below.

Date	Previous Studies
1978	U.S. Army Toxic and Hazardous Materials Agency (USATHAMA) conducted an Installation Assessment of RVAAP and concluded that no migration of contamination to groundwater has occurred at the installation (USATHAMA, 1978).
1982	Reassessment by USATHAMA also concluded that no migration of contamination to groundwater had occurred (USATHAMA, 1982).
1988	The USAEHA conducted a groundwater contamination survey and an evaluation of SWMUs. Twenty-nine potentially contaminated SWMUs were identified. Further investigation was recommended for 15 of the 29 SWMUs to determine if contaminants had migrated from these units.

1989	The USEPA contracted Jacobs Engineering to perform a RCRA Facility Assessment (RFA) – Preliminary Review and Visual Site Inspection (USEPA, 1989). The report identified 31 SWMUs, 13 of which were recommended for No Further Action. These 31 SWMUs are listed as sites in the RMIS.
1992	USAEHA conducted a hydrogeologic study of the open burn/open demolition areas as part of a response to a Notice of Deficiency issued by Ohio EPA regarding the installation's RCRA Part B permit application. Minor amounts of contamination were reported at these areas.
1994	USAEHA performed a Preliminary Assessment Screening (PAS) of the Boundary Load Line areas at RVAAP and provided a Statement of Findings to support a Record of Environmental Considerations along with recommendations for additional activities at these sites.
1996	The USACE performed a facility-wide preliminary assessment covering all known environmental sites at RVAAP.
1996	The USACE developed a Facility-wide Sampling and Analysis Plan and Facility-wide Safety and Health Plan for conducting investigations at CERCLA AOCs at RVAAP.
1996	The USACE conducted Phase I RIs of 11 AOCs. These AOCs were Load Lines 1-4, Load Line 12, Winklepeck Burning Grounds, Landfill North of Winklepeck Burning Grounds, Building 1200, Demolition Area #2, Upper and Lower Cobbs Ponds, and Load Line 12 Pink Wastewater Treatment Plant.
1997	The USACE conducted a field investigation to support RCRA and other clean closures at the following SWMUs: Building 1601, Open Burning Area (Pad #37 at Winklepeck Burning Grounds), Open Detonation Area (in Demolition Area #2), Deactivation Furnace Area (Pad #45 at Winklepeck Burning Grounds), and the Pesticides Building S-4452.
1998	The USACE conducted a Phase II RI at Winklepeck Burning Grounds, including baseline human health and ecological risk assessments.
1998	The USACE performed a groundwater investigation at Ramsdell Quarry Landfill.
1998	The United States Army Center for Health Promotion and Preventive Medicine (USACHPPM) performed Relative Risk Site Evaluations (RRSEs) at several known or suspected former waste disposal sites. These included Erie Burning Grounds, NACA Test Area, and Demolition Area #1, among others, and resulted in the establishment of 13 additional AOCs.
1999	The USACE performed Phase I RIs at Erie Burning Grounds, NACA Test Area, and Demolition Area #1. They also completed the installation of monitoring wells for the Phase II RI at Load Line 1.
2000	U.S. Army OSC performed a Phase I RI and Interim Removal Action (IRA) at Load Line 11.
2000	U.S. Army OSC performed a UXO Removal and Site Restoration at a portion of Demolition Area #2.

2000	The USACE performed Phase II RIs at Load Lines 1 and 12.
2000	The USACE performed a biological assessment at Winklepeck Burning Grounds to support a feasibility study.
2000	An IRA of Building T-5301 was conducted, and the Pesticide Building was closed.
2000	The USACE performed a field investigation to support the Feasibility Study at Winklepeck Burning Grounds.
2001	The USACE performed Phase II RIs at Load Lines 2, 3, and 4.
2001	U.S. Army Joint Munitions Command (JMC) performed a Phase II RI at Load Line 11.
2001	U.S. Army JMC performed a Phase I Remedial Investigation at the Central Burn Pits.
2002	U.S. Army JMC performed a Phase II RI at Upper and Lower Cobbs Pond.
2002	U.S. Army JMC performed a Phase II RI at Demolition Area #2.
2003	The USACE performed a Phase I RI at the Ramsdell Quarry Landfill.
2003	U.S. Army JMC performed a Phase I RI at Load Lines 6 and 9.
2003	U.S. Army JMC performed a Phase I/II RI at the Fuze and Booster Quarry Ponds.
2003	The USACE performed a Phase II RI at the Erie Burning Grounds.
2003	U.S. Army JMC performed an assessment of potential contamination at the DLA outdoor storage areas.
2003	Engineering-Environmental Management, Inc. (e2M) completed Final U.S. Army Closed, Transferring and Transferred Range/Site Inventory for Ravenna Army Ammunition Plant, Ohio.
2004	MKM Engineers prepared an Ordnance and Explosives (OE)/UXO Removal & Interim Removal Action Report for the Open Demolition Area #1.
2004	MKM Engineers prepared a Remedial Design/Removal Action (RD/RA) Plan for Sand Creek Dump (RVAAP-34).
2004	MKM Engineers prepared the Final Report Interim Removal Action at Load Line 11.
2004	MKM Engineers prepared the Final Report for RD/RA at Paris Windham Road Dump.
2004	Installation Action Plan for RVAAP 2005 was completed.
2004	USACE performed facility-wide biological and water quality study.
2004	Shaw/SAIC collaborated to conduct a Supplemental Baseline Human Health Risk Assessment.
2004	Shaw/SAIC prepared the Phase II RI Reports for Load Lines 2, 3, and 4.
2004	U.S. Army Technical Center for Explosive Safety (USATCES) prepared the Work Plan for the Phase I MEC Density Survey of Winklepeck Burning Grounds.
2004	Shaw prepared the Facility-Wide Groundwater Monitoring Program Plan, Portage.

2004	Shaw prepared the Proposed Remedial Goal Options for Soil at Load Lines 1 (AOC-08), 2 (AOC-09), 3 (AOC-10), and 4 (AOC-11).
2004	Shaw prepared the Sampling and Analysis Plan for the Data Gap Analysis and Additional Sampling and Security, the Emergency Response and Contingency Plan, and the Safety, Health and Emergency Response Plan for the Remediation of Soils at Load Lines 1 (AOC-08), 2 (AOC-09), 3 (AOC-10), and 4 (AOC-11) at RVAAP.
2004	MKM Engineers prepared the Final Sampling and Analysis Plan Addendum for the Characterization of 14 RVAAP AOCs at RVAAP, as well as the Final Site Safety and Health Plan for the Characterization of 14 RVAAP AOCs.
2004	Shaw prepared the Sampling and Analysis Plan for the Data Gap Analysis and Additional Sampling in Support of the Remediation of Soils at Load Lines 1 (AOC-08), 2 (AOC-09), 3 (AOC-10), and 4 (AOC-11) at RVAAP.
2004	USACE completed the Archives Search Report
2005	Shaw submitted the Final November 2004 Sampling Completion Report for Load Lines 1-4.
2005	SAIC prepared the Focused Feasibility Study for the Winklepeck Burning Grounds (AOC-05) at RVAAP.
2005	MKM Engineers prepared the Phase I MEC Density Survey after Action Report at Winklepeck Burning Grounds (AOC-05) at RVAAP.
2005	SAIC prepared the Phase III Remedial Investigation Report for the Winklepeck Burning Grounds (AOC-05) at RVAAP.
2005	USACE completed the Phase III Remedial Investigation Report for the Winklepeck Burning Grounds (AOC-05) at RVAAP.
2005	MKM Engineers submitted the Final Work Plan for Phase II MEC Clearance and Munitions Response at Winklepeck Burning Grounds (AOC-05).
2005	MKM Engineers prepared the Final Site Safety and Health Plan for the Phase II MEC Clearance and Munitions Response at Winklepeck Burning Grounds (AOC-05).
2005	Shaw prepared the Focused Feasibility Study for the Remediation of Soils at Load Lines 1 through 4 (AOC-08) (AOC-09) (AOC-10) (AOC-11) at the RVAAP.
2005	SAIC submitted the Phase I Remedial Investigation December 2004 Follow-On Groundwater Sampling at the Ramsdell Quarry Landfill (AOC-01).
2005	SpecPro prepared the Final Report on the Groundwater Monitoring Well Installation and Groundwater Sampling at the Suspected Mustard Agent Burial Site (RVAAP AOC-28).
2005	Installation Action Plan RVAAP – FY 2006 was completed.
2005	Shaw submitted the Final Proposed Plan for the Remediation of Soils at LL1-4 (RVAAP-08, RVAAP-09, RVAAP-10, and RVAAP-11).
2005	SpecPro completed the Final Report Facility Wide Groundwater Monitoring Program Sampling Event Report.

2005	MKM Engineers completed the Site Safety and Health Plan for the Phase I MEC Density Survey of Winklepeck Burning Grounds (AOC-05).
2005	SpecPro prepared the Final Facility Wide Groundwater Monitoring Program Report on the July 2005 Sampling Event.
2005	The RVAAP/Ohio EOA Cooperative Agreement (CA) Work Plans were completed.
2005	SpecPro completed the Final Work Plan Containing Addendums (SAP, QAPP, SSHP, UXO) for Groundwater Monitoring Well Installation and Groundwater Sampling at the Suspected Mustard Agent Burial Site (AOC-28).
2005	SAIC/MKM Engineers submitted the Final Remedial Investigation Report Central Burn Pits (RVAAP-49).
2005	MKM Engineers completed the remedial investigation at Load Line 11 (AOC-44).
2005	SAIC prepared the Phase I Remedial Investigation Report for the Ramsdell Quarry Landfill at RVAAP.
2005	MKM Engineers completed the Phase II RI at the Upper and Lower Cobbs Pond (AOC-29).
2005	SAIC prepared the Final Phase II Remedial Investigation Report for the Erie Burning Grounds (AOC-02) at RVAAP.
2005	SpecPro/SAIC prepared the Final Phase II Remedial Investigation Report for the Open Demolition Area #2 (AOC-4).
2005	SAIC completed the Final Proposed Plan for the Winklepeck Burning Grounds.
2005	USACE completed the Facility-Wide Biological and Water Quality Study 2003, Part 1-Streams, Part 2-Ponds.
2005	SAIC prepared the Final Phase II Remedial Investigation Supplemental Report for Load Line 12 (AOC-12).
2005	SAIC submitted the Final Sampling and Analysis Plan Addendum No. 1 Supplemental Phase II Remedial Investigations (RVAAP-04) ODA#2, (RVAAP-16) F&BQL/P, and (RVAAP-49) CBPs.
2005	SpecPro/SAIC completed the Final Report Phase I/II Remedial Investigation of the Fuze and Booster Quarry Landfill/Ponds (RVAAP-16).
2005	SpecPro prepared the Final Facility Wide Groundwater Monitoring Program Report on the July 2005 Sampling Event.
2005	SAIC submitted the Final Proposed Plan for the Winklepeck Burning Grounds.
2005	MKM Engineers prepared the Phase II MEC Clearance and Munitions Response at Winklepeck Burning Grounds (AOC-05).
2006	SAIC prepared the Sampling and Analysis Plan Addendum No. 2 for the Winklepeck Burning Grounds Feasibility Study at RVAAP.
2006	SAIC prepared the Final Feasibility Study reports for Ramsdell Quarry Landfill, Load Line 12, and Fuze and Booster Quarry Landfill/Pond.

2006	SpecPro completed the Facility-Wide Ground Water Sampling Event #1.
2006	SAIC submitted the Revised Eco Field Truthing Report.
2006	SAIC completed the Final RI Addendums for Open Demolition Area #2 and Erie Burning Grounds.
2006	SAIC prepared the Final P&A after Action Report for Ramsdell Quarry Landfill.
2006	SpecPro completed the Facility-Wide Ground Water Sampling Event #2.
2007	SAIC prepared the Final EE/CA for Central Burn Pits.
2007	Shaw submitted the Final Structural Analysis Report for Load Lines 1 through 4.
2007	SAIC prepared the Final Proposed Plans for Soil and Dry Sediment at Erie Burning Grounds, Load Line 12, Fuze and Booster Quarry Landfill/Ponds, and Ramsdell Quarry Landfill.
2007	SpecPro completed the Facility-Wide Groundwater Sampling Event #3 and submitted the Final Facility Wide Groundwater Monitoring Program Reports for the July and October 2006 and January 2007 sample events.
2007	MKM Engineers prepared the Final Report of the Characterization of 14 Areas of Concern.
2007	SpecPro prepared the Final Work Plan for the DLA Storage Area Reclamation-Route 80 Tank Farm and East Ore Yard Culvert Replacement.
2007	SpecPro prepared the Final Facility Wide Groundwater Monitoring Program Annual Report for 2006.
2007	Shaw submitted the Final Interim Record of Decision for Load Lines 1-4.
2007	SAIC completed the Final Action Memorandum for RVAAP-49 Central Burn Pits.
2007	Shaw prepared the Final Storm Water Pollution Prevention Plan for the Remediation of Soils at RVAAP-08, 09, 10, and 11 (Load Lines 1-4).
2007	USACE prepared the Final Sampling and Analysis Plan and the Site Safety and Health Plan for the Exposed Soil Sampling and Characterization after Slab and Foundation Removals at RVAAP-39 Load Line 5, RVAAP-40 Load Line 7, RVAAP-41 Load Line 8, and RVAAP-43 Load Line 10.
2007	PIKA prepared the Final Construction Completion Report on the Munitions Response for the Demolition of RVAAP-41 and RVAAP-43, Load Lines 8 and 10.
2007	MKM Engineers submitted the Final Report for the Phase I Remedial Investigation of RVAAP-33 Load Line 6.
2007	SAIC prepared the Final Removal Action Work Plan for RVAAP-49 Central Burn Pits.
2007	SAIC submitted the Final Records of Decision for Soil and Dry Sediment at the Fuze and Booster Quarry Landfill/Ponds, the Erie Burning Grounds, and Open Demolition Area #2.

2007	MKM Engineers completed the Final Report for the Phase I Remedial Investigation at RVAAP-42 Load Line 9.
2007	USACE submitted a Draft Proposal to Update the Facility-Wide Groundwater Monitoring Program.
2007	SAIC prepared the Preliminary Draft Remedial Investigation Addendum No. 1 for the RVAAP-49 Central Burn Pits.
2007	EQM submitted the Final Work Plan for the Geophysical Investigation of the Suspected RVAAP-28 Mustard Agent Burial Site.
2007	SpecPro prepared the Draft Project Completion Report for the DLA Storage Reclamation-Route 80 Tank Farm and East Ore Yard Culvert Replacement.
2007	PIKA prepared the Final Report on the Disposal of Munitions and Explosives of Concern (MEC), Discarded Military Munitions (DMM) and Munitions Constituents (MC).
2007	EQM submitted the Final Facility-Wide Groundwater Monitoring Program April 2007 Sampling Event.
2007	Lakeshore Engineering Services, Inc., completed the Final Project Completion Report for the Munitions Response for Demolition of Load Lines 5, 7, Building 1039, and Transite Removal at Building T-1604.
2007	EQM prepared the Draft Facility-Wide Groundwater Monitoring Program Annual Report for 2007.
2007	e2M completed the Military Munitions Response Program Historical Records Review.
2007	e2M submitted the Final Work Plan for Sand Creek Survey Rocket Ridge of Open Demolition Area #2 Military Munitions Response Program Time Critical Response Action.
2008	Installation Action Plan RVAAP – FY2007 was completed.
2008	Shaw prepared the Final Propellant Removal Summary Report for MEC Support for RVAAP-08 Load Line 1.
2008	SAIC prepared the Final Remedial Investigation Report Addendum No. 1 for the RVAAP-49 Central Burn Pits.
2008	SAIC completed the Final ROD for Soil and Dry Sediment at RVAAP-05, Winklepeck Burning Grounds.
2008	SAIC completed the Final Proposed Plan for Soil and Dry Sediment at the RVAAP-49 Central Burn Pits.
2008	e2M completed the Final Site Inspection for the Military Munitions Response Program.
2008	EQM submitted the Facility-Wide Groundwater Monitoring Program reports for January, April, July, and October 2008.

2009	SAIC prepared the Draft Remedial Design for RVAAP-16, Fuze and Booster Quarry Landfill Ponds.
2009	SAIC submitted the Final RODs for Soil and Dry Sediment at Central Burn Pits (RVAAP-49), Ramsdell Quarry Landfill (RVAAP-01), Load Line 12 (RVAAP-12), and Central Burn Pits (RVAAP-49).
2009	EQM completed the Final Facility Wide Groundwater Monitoring Program Annual Report 2008.
2009	SAIC prepared the Final Remedial Designs for Load Line 12 and Fuze and Booster Quarry Landfill.
2009	Shaw submitted the Final DQO reports for RVAAP-28 Mustard Agent Burial Site and RVAAP-34 Sand Creek Disposal Landfill.
2009	EQM submitted the Final Facility Wide Groundwater Monitoring Program reports for the October 2008 and January and April 2009 sampling events.
2009	URS prepared the Final PBA 08 LL 1-4 Sub Slab Sampling Short Report.
2009	SAIC submitted the Final Remedial Design Approval for RVAAP-12 Load Line 12.
2009	SAIC completed the Final ROD Signoffs for Soil and Dry Sediment at RVAPP-12 Load Line 12 and RVAAP-01 Ramsdell Quarry Landfill.
2009	MKM Engineers completed the Final Remedial Action Closeout Report for RVAAP-05 Winklepeck Burning Grounds.
2009	PIKA submitted the Final RCRA Closeout Report for RVAAP-04 ODA 2 Rocket Ridge.
2009	URS submitted the Final Multi-Increment Sampling and Analysis of Soils below Floor Slabs at RVAAP-09 Load Line 2, RVAAP-10 Load Line 3, and RVAAP-11 Load Line 4.
2009	PIKA submitted the Final Project Work Plan for the Time Critical Removal Action (TCRA) at Rocket Ridge Area within RVAAP-004-R-01 Open Demolition Area #2.
2009	PIKA prepared the Final Public Involvement Plan Addendum for Rocket Ridge.
2009	PIKA prepared the Final Explosives Safety Submission TCRA at Rocket Ridge, Version 6.0.
2009	PIKA prepared the Addendum to the Final Safety and Health Plan for the Rocket Ridge TCRA.
2009	PIKA submitted the Final Amendment 1 Explosives Safety Submission Disposal of Material Potentially Presenting an Explosive Hazard.
2009	e2M completed the Operations and Maintenance Trip Reports and Quarterly Effectiveness Evaluation Reports for August 2008 through September 2009 for the Rocket Ridge TCRA.
2009	USA Environmental submitted the Final Explosive Siting Plan 2008 and Final Work Plan under the Performance-Based Acquisition for Environmental Investigation and Remediation MEC Avoidance/Removal Services.

2009	Shaw completed the Final Project Management Plan for Environmental Services at 14 Military Munitions Response Program Sites.
2009	Vista submitted the Operations and Maintenance Trip Reports and Quarterly Effectiveness Evaluation Reports for the Rocket Ridge TCRA.
2009	PIKA completed the Final Removal Action Report for the Rocket Ridge TCRA.
2010	EQM completed the July and October 2009 and January, July, and October 2010 facility-wide groundwater sampling event reports.
2010	SAIC submitted the Revised Final Remedial Design for the RVAAP-01 Ramsdell Quarry Landfill.
2010	URS prepared the Sub Slab Final Field Sampling Report for Load Lines 1-4.
2010	SAIC submitted the Final Facility Wide Human Health Cleanup Goals.
2010	SAIC prepared the Pre-Draft Six Sharon Conglomerate Wells Monitoring Report.
2010	SAIC prepared the Final Remedial Action Closeout Report for RVAAP-16 Fuze and Booster Quarry Landfill.
2010	EQM submitted the Final Facility Wide Groundwater Monitoring Program Annual Report 2009.
2010	EQM submitted the Final Facility Wide Groundwater Monitoring Program Metals Report 2010.
2010	Shaw prepared the Final Geophysical Prove-out Report for Environmental Services at RVAAP-34 Sand Creek Disposal Road Landfill, RVAAP-03 Open Demolition Area #1, and RVAAP-28 Mustard Agent Burial Site.
2010	SAIC completed the Final Project Management Plan for the Performance-Based Acquisition of Six Environmental Areas of Concern.
2010	SAIC prepared the Draft ESS Report for RVAAP-01 Ramsdell Quarry Landfill.
2010	SAIC prepared the Final Monitoring Report for the Deep Bedrock Well Installation in the Basal Sharon Conglomerate.
2010	Shaw submitted the Final Quality Control Plan for the Geochemical Evaluation of Metals in Groundwater.
2010	URS completed the Load Lines 2 & 3 Excavation Soil Removal.
2010	SAIC prepared the Final Quality Control Plan for the Revision of the Facility-Wide Environmental Documents.
2010	Prudent prepared the Final Work Plan and Project Management Plan for Sampling & Closure of Load Lines 1, 2, 3, 4, and 12 (RVAAP-08, RVAAP-09, RVAAP-10, RVAAP-11, and RVAAP-12) and other Areas of Concern.
2010	Shaw prepared the Geochemical Evaluation of Metals in Groundwater Draft Geochemical Report.
2010	SAIC submitted the Final Remedial Action Report for the RVAAP-12 Load Line 12.

2010	SAIC completed the Final Site Characterization and Focused Feasibility Study Work Plan for the RVAAP-51 Dump along Paris-Windham Road at Ravenna Army Ammunition Plant.
2010	URS completed the Removal Load Line 1 Excavation Soil.
2010	URS submitted the Final Sampling and Analysis of Soils below Floor Slabs at RVAAP-08 Load Line 1 and Other Building Locations.
2010	PIKA prepared the Disposal of MD & MC, and Misc. Demo Final Report.
2010	PIKA prepared the Final Project Work Plan for the Rocket Ridge TCRA.
2010	PIKA completed the Final Public Involvement Plan Addendum for the Time Critical Removal Action at the Rocket Ridge Area.
2010	PIKA submitted the Final Project Management Plan for the Rocket Ridge TCRA.
2010	SAIC/PIKA submitted the Final Explosives Safety Submission (ESS) Munitions and Explosives of Concern (MEC) Non-Time Critical Construction Support at RQL.
2010	PIKA prepared the Final Explosives Safety Submission MEC Non-Time Critical Interim Removal Action at Rocket Ridge, Version 3.1 & Version 3.1, Amendment 1.
2010	Shaw completed the Final Public Involvement Plan Addendum for Military Munitions Response Program Remedial Investigation Environmental Services.
2010	SAIC completed the Final Quality Control Plan for the 2010 Phase I Remedial Investigation Services at Compliance Restorations Sites (9 Areas of Concern).
2010	SAIC prepared the Final Project Management Plan for the 2010 Phase I Remedial Investigation Services at Compliance Restoration Sites (9 Areas of Concern).
2010	SAIC prepared the Final Site Safety and Health Plan for the 2010 Phase I Remedial Investigation Service at Compliance Restoration Sites (9 Areas of Concern), Addendum No. 1.
2010	Prudent submitted the Final Site Safety and Health Plan Addendum for 2010 Phase I Remedial Investigation Services Compliance Restoration Sites (CC RVAAP-78 and CC RVAAP-80).
2010	Prudent completed the Final Project Management Plan for 2010 Phase I Remedial Investigation Services Compliance Restoration Sites CC RVAAP-78 Quarry Pond Surface Dump & CC RVAAP-80 Group 2 Propellant Can Tops.

3.12 Preliminary Identification of IRP Operable Units

As mentioned previously, the RVAAP is not on the NPL, although it is in the USEPA's CERCLIS database. The DoD IRP administered by the U.S. Army directs the cleanup program at RVAAP. Management of the IRP sites follows CERCLA requirements. There are currently 27 individual IRP AOCs, two facility-wide AOCs, 14 CR sites, and 14 MR sites actively being addressed as identified in the 2011 RVAAP Installation Action Plan. Information on the operable units of concern has been extracted from the 2011 IAP. However, additional RI field activities were conducted in 2010 and 2011 at the PBA-08 AOCs, which include Load Lines 5 through 12, C Block Quarry, Landfill North of Winklepeck Burning Grounds, Building 1200, Upper and Lower Cobbs Ponds, NACA Test Area, Wet Storage Area, Buildings F-15 and F-16, Anchor Test Area, Atlas Scrap Yard, and Facility-Wide Sewers. The results of the RI activities will be provided in RI or RI/FS reports in 2012.

Operable units managed under IRP that have been found to contain COPCs in groundwater are described in this section. Note that one additional AOC, Central Burn Pits, is also included in this section, even though it is not listed as a currently active IRP operable unit in the 2011 IAP. This AOC is routinely monitored as part of the facility-wide groundwater network. Consequently, a brief description of the Central Burn Pits is included herein. The MR and CR sites are described in Sections 3.13 and 3.14, respectively. Other sites may also be identified as contributing contaminant source areas during future actions at RVAAP.

3.12.1 Ramsdell Quarry Landfill

Ramsdell Quarry Landfill (RVAAP-01) is located in the eastern portion of the RVAAP facility and is a 10-acre unlined landfill, with an 18- to 20-ft depth, in part of an abandoned quarry. The quarry was excavated to the Sharon Conglomerate.

This landfill was used from 1941 to 1989. During the period of 1946 to 1950, the site was used as a land surface burning site to thermally destroy waste explosives from Load Line 1 and napalm bombs. From 1976 to 1989, a portion of the site was used strictly as a nonhazardous solid waste landfill. No historical information has been located for the years from 1950 to 1976. The landfill ceased operation in September 1989. Closure of the landfill was completed in May 1990 under state of Ohio solid waste regulations. Because this unit is unlined, there is potential for releases from the landfill to surrounding soils and groundwater. In accordance with paragraph (C) of Ohio Administrative Code (OAC) Rule 3745-27-10, post-closure care activities must be conducted for a minimum of 30 years. On July 20, 1998, the Director of Ohio EPA granted the Army authorization to conduct investigative activities at and in the vicinity of the RQL in performance of the IRP.

Landfill material comprises variable domestic, commercial, industrial, and solid wastes, including but not limited to explosives (e.g., TNT, Composition B), napalm, gasoline, acid dip liquor, annealing residue (sulfuric acid, shell casings, sodium orthosilicate, chromic acid, and alkali), aluminum chloride, and inert material. The volume of landfill material is unknown (Jacobs Engineering, 1989).

Five groundwater monitoring wells were installed around the landfill perimeter in 1988. These wells were decommissioned in 2006. In 1998, new wells were installed to further investigate the nature and extent of groundwater contamination at the landfill. In fall 2003, additional wells were installed, and soil, sediment, and surface water samples were collected to further assess the nature and extent of impact of the CERCLA portion of the quarry. The new wells are monitored on a regular basis as part of the facility-wide groundwater monitoring program. Low levels of explosives and metals have been detected in groundwater. The groundwater unit transferred from the RCRA solid waste program to CERCLA in June 2004. A Performance Based Contract

(PBC) was awarded in 2005 to complete the investigation and any required remediation in accordance with Defense Planning Guidance. A final RI/FS was completed and approved in April 2007. The final ROD was signed by the Army and Ohio EPA in October 2009. The Remedial Design will contain additional appropriate land use control (LUC) language as will the Property Management Plan. The RVAAP-01 remedial action has been delayed due to the discovery of asbestos-containing materials. The RA approach will be reevaluated under an Engineering Evaluation/Cost Analysis (EE/CA).

3.12.2 Open Demolition Area #1

Open Demolition Area #1 (ODA-1; RVAAP-03), comprising approximately 6 acres, was used to thermally treat munitions by open burning/open demolition. The site now consists of a circular 1-ft berm surrounding a grassed area of approximately 1.5 acres. The entire AOC is located within the National Advisory Committee on Aeronautics (NACA) Test Area. Contaminants of concern include explosive compounds and metals. The 1989 report from Jacobs Engineering indicates that munition fragments including scrap metal, small arms primers, and fuzes were found outside the bermed area and that the area was operational from 1941 through 1949.

The AOC has been used as a training area since the 1960s. In May 1999 this site was officially assigned to the NGB and transferred to the OHARNG. Groundwater monitoring is being conducted under the NACA Test Area (RVAAP-38).

In December 2001 a final Phase I RI report was completed. In July 2001 a BRAC-funded IRA involving removal of approximately 6 acres of surface hot spots containing high levels of metals and explosives was completed. Site closeout documentation was initiated in FY03. Concern remained over potential MEC kick-outs and push-out material beyond the IRA area. Because this site is located on the Operational Range Inventory System (ORIS), the area is considered an active range, and therefore ineligible for the Military Munitions Response Program (MMRP).

A geophysical investigation was conducted in FY10 to investigate the potential MEC kick-outs/push-outs outside the IRA area. Results of the geophysical investigation were received in the fourth quarter of FY10 and the final report was published in January 2011. A subsequent contract was awarded to conduct a feasibility study, proposed plan, and record of decision with completion expected by the end of FY13.

3.12.3 Winklepeck Burning Grounds

The total Winklepeck Burning Grounds (RVAAP-05) area comprises 200 acres and has been in operation since 1948. Prior to 1980, open burning was carried out in pits, pads, and sometimes on the roads within the 200-acre area. Burning was conducted on the bare ground and the ash was abandoned at the site. Prior to 1980, wastes treated in the area included RDX, antimony sulfide, Composition B, lead azide, TNT, propellants, black powder, waste oils, sludge from the load lines, domestic wastes, and small amounts of laboratory chemicals. Unexploded ordnance is present at the AOC. From 1980 to 1998, burns of scrap explosives, propellants, and explosive-contaminated materials were conducted in raised refractory-lined trays within a 1.5-acre area.

The RVAAP Deactivation Furnace, established in 1968, was located on the Winklepeck Burning Grounds in the north-central portion of the facility. Operation of the deactivation furnace ceased in 1983. Closure of the storage units and the open burn trays in WBG was completed and approved in 1998. Three (3) 90-day hazardous waste storage areas were also officially closed. The final closure plan for the deactivation furnace was submitted on February 23, 2001.

A USAEHA geotechnical study was conducted at the active position of this site in 1992. The Part B permit application covering the active portion of the site was withdrawn in 1994. The burn trays along with the 90-day storage unit, Building 1601, were closed in accordance with Ohio EPA guidance in 1998. Minor amounts of contamination were detected in the soils. The deactivation furnace soils were transferred from the RCRA to the CERCLA program under the DFFOs in June 2004. The management of groundwater monitoring is under the FWGWMP.

A limited MEC clean-up took place within various portions of the site during 2004, 2005, 2008, and 2009. A proposed plan was finalized in 2006.

Field work for a Phase II RI was conducted in 1998 and the report finalized in late 2002 (end use has since changed). The report includes facility-wide background levels, as well as human health and ecological risk assessments. Additional Phase II RI field studies were completed in fall 2000 at Winklepeck and RVAAP reference locations to more accurately define the risk to ecological receptors at the site.

The Army transferred approximately 180 acres to the NGB in 2006 for the construction of a Mark 19 grenade machine gun range. The remaining 20 acres containing four burn-pad locations were remediated based on a ROD dated August 2008 and signed by the Army and Ohio EPA. The additional remediation was completed in the summer of 2009. Ohio EPA approved the final completion report during the first quarter of FY10. The 20 acres were transferred in June 2010 and combined with the NGB 180-acre parcel. Additional cleanup involving soil excavation will be required to support construction of a multi-purpose machine gun range, which will partially overlap with the existing Mark 19 range.

3.12.4 C Block Quarry

The C Block Quarry (CBL; RVAAP-06) is an abandoned borrow pit approximately 0.3 acres in size. The AOC was used as a disposal area for annealing process wastes (chromic acid) for a short time during the 1950s. Liquid wastes were apparently dumped on the ground in the pit bottom. This AOC is now heavily forested with trees of 1-ft-diameter or larger. Installation Restoration Program constituents of concern include metals, SVOCs, volatile organic compounds (VOCs), and propellants.

In May 1999 the Army transferred this site to the NGB.

A detailed sampling investigation of the soils from this unit in 1986 detected no metals above RCRA-regulated levels. In the fall of 2001, additional samples were collected. Metals, including hexavalent chromium, and organics were identified in soils above screening levels. Based on this sampling, the amount of contaminated soil is larger than previously expected.

3.12.5 Load Line 1

Load Line 1 (LL1; RVAAP-08) comprises nearly 160 acres and was used between 1941 and 1971 to melt and load TNT and Composition B into large-caliber projectiles. The load line also was used for the demilitarization of projectiles and the production and reconditioning of anti-tank mines. Workers would periodically use steam and hot water to hose down equipment and the floors and walls of buildings contaminated with explosive dust, spills, and vapors. Wash-down water and wastewater from the load line operations was collected in concrete sumps, pumped through sawdust filtration units, and then discharged to a settling pond. Wash-down water from the melt-pour buildings would, in some instances, be swept out through doorways onto the ground surrounding the buildings. The settling pond was an unlined, approximately 2-acre, triangular-shaped pond with an average depth of 4 feet. Water from the impoundment discharged to a stream that ultimately exited the installation.

Structures underwent demolition between FY00 and FY09. Environmental controls were implemented during all demolition activities to prevent/mitigate potential migration of contaminants from the buildings to the ground surface. Elevated walkways (between buildings) remain in place.

The RI sampling (1999-2000) found high levels of explosives in the soil around the melt-pour and preparation buildings. Groundwater was found to contain low levels of explosives and metals. Preliminary screening of the contaminant levels indicated that the sediments may cause an ecological risk. Surface water did not show any significant contamination.

Chemicals of concern at this site are explosive compounds, SVOCs, and heavy metals. The media of concern include soils, surface water, sediment, and groundwater. A PBC was awarded in September 2003 to complete an interim soil and dry sediment removal action at Load Lines 1, 2, 3, and 4 (which paralleled a BRAC Division building demolition project). The final Interim ROD addressing only soil and dry sediment was signed by the Army and Ohio EPA in July 2007. At the end of the first quarter of FY08, contaminated soils were removed and transported offsite for disposal at an EPA-approved/permitted landfill, and the project close-out report was approved by September 2008, prior to contract expiration. Subsequent to this date, an additional contract action was initiated to sample the soils within the former building slab footprints, and an USACE-led sampling event was conducted in December 2009 to sample areas outside of the former building footprints to determine whether or not soil contamination occurred during the building/slab demolition. Surface water and wet sediments are being evaluated for further action.

Subsurface multi-increment sampling was conducted in August 2010 beneath some of the former building slabs at Load Lines 1, 2, 3, and 4 to obtain fixed lab data and ensure COPCs were adequately characterized in subsurface soils. Results from this and all other historical sampling events will be used to complete a LUC assessment. The goal of this project will be to minimize restrictions at these AOCs and possibly obtain an Unrestricted OHARNG Land Use. Additional characterization and remediation may be conducted due to findings from the LUC Assessment. Once all work is completed, a ROD addendum will be completed.

A January 2008 change memorandum to the interim ROD was prepared by the Army and submitted to the Ohio EPA describing additional removal actions. Contaminated soil, as determined by the underslab sampling and the post-demolition sampling led by USACE, will be removed and transported offsite for final disposal at an EPA-approved/permitted landfill. This work affects RVAAP-08, -09, -10, and -11.

3.12.6 Load Line 2

Load Line 2 (LL2; RVAAP-09) is an approximately 212-acre parcel that was used between 1941 and 1971 to melt and load TNT and Composition B into large-caliber projectiles. Workers would periodically use steam and hot water to hose down equipment and the floors and walls of buildings contaminated with explosive dust, spills, and vapors. Wash-down water and wastewater from the load line operations was collected in concrete sumps, pumped through sawdust filtration units, and then discharged to a settling pond. Wash-down water from the melt-pour buildings would, in some instances, be swept out through doorways onto the ground surrounding the buildings. The settling pond was an unlined triangular-shaped pond approximately 1 acre in size with an average depth of 4 feet, based on a GIS approximation. Water from the impoundment discharged to a stream that ultimately exited the installation.

Structures underwent demolition between FY03 and FY09. Environmental controls were implemented during all demolition activities to prevent/mitigate potential migration of contaminants from the buildings to the ground surface. Elevated walkways (between buildings) remain in place.

A Phase I RI was completed in 1998. Explosives and metals were the most common soil contaminants. Organics, PCBs, propellants, and pesticides were also detected. Low levels of some contaminants were found in the groundwater at this site. Fieldwork for a Phase II RI was completed in 2001 to further determine the nature and extent of the contamination.

Contaminants of concern at this site are explosive compounds, SVOCs, and heavy metals. The media of concern include soils, surface water, sediment, and groundwater. A PBC was awarded in September 2003 to complete an interim soil and dry sediment removal action at Load Lines 1, 2, 3, and 4 (which paralleled a BRAC Division building demolition project). The final Interim ROD addressing only soil and dry sediment was signed by the Army and Ohio EPA in July 2007. At the end of the first quarter of FY08, contaminated soils were removed and transported offsite for disposal at an EPA-approved/permitted landfill, and the project closeout report was approved by September 2008, prior to contract expiration. Subsequent to this date, an additional contract action was initiated to sample the soils within the former building slab footprints, and an USACE-led sampling event was conducted in December 2009 to sample areas outside of the former building footprints to determine whether or not soil contamination occurred during the building/slab demolition. Surface water and wet sediments are being evaluated for further action.

Subsurface multi-increment sampling was conducted in August 2010 beneath some of the former building slabs at Load Lines 1, 2, 3, and 4 to obtain fixed lab data and ensure COPCs were adequately characterized in subsurface soils. Results from this and all other historical sampling events will be used to complete a Land Use Control Assessment. The goal of this project will be to minimize restrictions at these AOCs and possibly obtain an Unrestricted OHARNG Land Use. Additional characterization and remediation may be conducted due to findings from the LUC Assessment. Once all work is completed, a ROD addendum will be completed.

A January 2008 change memorandum to the interim ROD was prepared by the Army and submitted to the Ohio EPA describing additional removal actions. Contaminated soil, as determined by the underslab sampling and the post-demolition sampling led by USACE, will be removed and transported offsite for final disposal at an EPA-approved/permitted landfill. This work affects RVAAP-08, -09, -10, and -11.

3.12.7 Load Line 3

Load Line 3 (LL3; RVAAP-10) is an approximately 174-acre parcel that was used between 1941 and 1971 to melt and load TNT and Composition B into large-caliber projectiles. Workers would periodically use steam and hot water to hose down equipment and the floors and walls of buildings contaminated with explosive dust, spills, and vapors. Wash-down water and wastewater from the load line operations was collected in concrete sumps, pumped through sawdust filtration units, and then discharged to a settling pond. Wash-down water from the melt-pour buildings would, in some instances, be swept out through doorways onto the ground surrounding the buildings. Water from the impoundment discharged to a stream that flowed in a northerly direction and ultimately discharged into Cobbs Ponds (CP; RVAAP-29).

Structures underwent demolition between FY03 and FY09. Environmental controls were implemented during all demolition activities to prevent/mitigate potential migration of contaminants from the buildings to the ground surface. Elevated walkways (between buildings) remain in place.

A Phase I RI was completed in 1998. Explosives and metals were the most common soil contaminants. Organics, PCBs, propellants, and pesticides were also detected. Low levels of some contaminants were found in the groundwater at this site. Fieldwork for a Phase II RI was completed in 2001 to further determine the nature and extent of the contamination.

Chemicals of concern at this site are explosive compounds, SVOCs, and heavy metals. The media of concern include soils, surface water, sediment, and groundwater. A PBC was awarded in September 2003 to complete an interim soil and dry sediment removal action at Load Lines 1, 2, 3 and 4 (which paralleled a BRAC Division building demolition project). The final Interim ROD addressing only soil and dry sediment was signed by the Army and Ohio EPA in July 2007. At the end of the first quarter of FY08, contaminated soils were removed and transported offsite for disposal at an EPA-approved/permitted landfill, and the project close-out report was approved by September 2008, prior to contract expiration. Subsequent to this date, an additional contract action was initiated to sample the soils within the former building slab footprints, and an USACE-led sampling event was conducted in December 2009 to sample areas outside of the former building footprints to determine whether or not soil contamination occurred during the building/slab demolition. Surface water and wet sediments are being evaluated for further action.

Subsurface multi-increment sampling was conducted in August 2010 beneath some of the former building slabs at Load Lines 1, 2, 3, and 4 to obtain fixed lab data and ensure COPCs were adequately characterized in subsurface soils. Results from this and all other historical sampling events will be used to complete a Land Use Control Assessment. The goal of this project will be to minimize restrictions at these AOCs and possibly obtain an Unrestricted OHARNG Land Use. Additional characterization and remediation may be conducted due to findings from the LUC Assessment. Once all work is completed, a ROD addendum will be completed.

A January 2008 change memorandum to the interim ROD was prepared by the Army and submitted to the Ohio EPA describing additional removal actions. Contaminated soil, as determined by the underslab sampling and the post-demolition sampling led by USACE, will be removed and transported offsite for final disposal at an EPA-approved/permitted landfill. This work affects RVAAP-08, -09, -10, and -11.

3.12.8 Load Line 4

Load Line 4 (LL4; RVAAP-11) is an approximately 129-acre area that was used between 1941 and 1971 to melt and load TNT and Composition B into large-caliber projectiles. Workers would periodically use steam and hot water to hose down equipment and the floors and walls of buildings contaminated with explosive dust, spills, and vapors. Wash-down water and wastewater from the load line operations was collected in concrete sumps, pumped through sawdust filtration units, and then discharged to a settling pond. Wash-down water from the melt-pour buildings would, in some instances, be swept out through doorways onto the ground surrounding the buildings. The on-site settling pond was an unlined earthen impoundment approximately 2 acres in size with an average depth of 4 feet, based on a GIS approximation. Water from the impoundment discharged to a stream that ultimately exited through the southern side of the installation.

Structures underwent demolition between FY03 and FY09. Environmental controls were implemented during all demolition activities to prevent/mitigate potential migration of contaminants from the buildings to the ground surface. Elevated walkways (between buildings) remain in place.

A Phase I RI was completed in 1998. Explosives and metals were the most common soil contaminants. Organics, PCBs, propellants, and pesticides were also detected. Low levels of some contaminants were found in the groundwater at this site. In 2001, fieldwork for a Phase II RI to further determine the nature and extent of the contamination was completed.

Chemicals of concern at this site are explosive compounds, SVOCs, and heavy metals. The media of concern include soils, surface water, sediment, and groundwater. A PBC was awarded in September 2003 to complete an interim soil and dry sediment removal action at Load Lines 1, 2, 3, and 4 (which paralleled a BRAC Division building demolition project). The final Interim ROD addressing only soil and dry sediment was signed by the Army and Ohio EPA in July 2007. At the end of the first quarter of FY08, contaminated soils were removed and transported offsite for disposal at an EPA-approved/permitted landfill, and the project close-out report was approved by September 2008, prior to contract expiration. Subsequent to this date, an additional contract action was initiated to sample the soils within the former building slab footprints, and an USACE-led sampling event was conducted in December 2009 to sample areas outside of the former building footprints to determine whether or not soil contamination occurred during the building/slab demolition. Surface water and wet sediments are being evaluated for further action.

Subsurface multi-increment sampling was conducted in August 2010 beneath some of the former building slabs at Load Lines 1, 2, 3, and 4 to obtain fixed lab data and ensure COPCs were adequately characterized in subsurface soils. Results from this and all other historical sampling events will be used to complete a Land Use Control Assessment. The goal of this project will be to minimize restrictions at these AOCs and possibly obtain an Unrestricted OHARNG Land Use. Additional characterization and remediation may be conducted due to findings from the LUC Assessment. Once all work is completed, a ROD addendum will be completed.

A January 2008 change memorandum to the interim ROD was prepared by the Army and submitted to the Ohio EPA describing additional removal actions. Contaminated soil, as determined by the underslab sampling and the post-demolition sampling led by USACE, will be removed and transported offsite for final disposal at an EPA-approved/permitted landfill. This work affects RVAAP-08, -09, -10, and -11.

3.12.9 Load Line 12

From 1941 to 1943 and 1946, ammonium nitrate was produced at Load Line 12 (LL12; RVAAP-12), which occupies an approximately 75-acre parcel. From 1949 to 1993, munitions were periodically demilitarized with building wash-down water and bomb melt-out wastewater that was collected via a house gutter system, which flowed through a piping system to two stainless steel tanks. The first tank was used for settling, and the second tank was used for filtration. Prior to the 1980s, the water leaked under the building and accumulated there. Building wash-down water from Building F-904 was also swept out through doorways onto the ground surrounding the building. After 1981, the water was treated in the Load Line 12 wastewater treatment C system (RVAAP-18), which discharged to an on-site pond then discharged to a receiving stream that ultimately entered into Cobbs Ponds.

Contaminants of concern at this unit are explosive compounds and heavy metals. Media of concern include soil, surface water, sediment, and groundwater. The original pink water treatment plant servicing Building F-904 was officially closed as of May 2000.

A composting pilot study using soils contaminated with explosives from the area around Building F-904 was started in 2000. This pilot project was successful for the bioremediation of explosives. Samples of environmental media were collected in the fall of 2000 as part of a Phase II RI. High levels of nitrates were detected in the groundwater. Metals and explosives were detected in the soil, sediment, and groundwater, and metals were also detected in surface water.

3.12.10 Building 1200 Dilution/Settling Pond

From approximately 1941 to 1971, ammunition was de-milled at Building 1200 (B12; RVAAP-13) by steaming munitions rounds. The steam decontamination generated pink water, which drained to a man-made ditch. The ditch discharged into a 0.5-acre sedimentation pond, and the overflow from this pond discharged into Sand Creek. Contaminants of concern at this unit are explosive compounds, propellants, and heavy metals (including lead, chromium, and mercury). Media of concern include soil, surface water, sediment, and groundwater. Limited explosives and metals contamination was detected in the ditch and settling ponds during the Phase I RI.

This site was transferred to NGB in May 1999. The buildings were demolished, and all foundations and footings were removed

3.12.11 Landfill North of Winklepeck Burning Grounds

The landfill north of WBG (LNW; RVAAP-19) is a 2.5-acre unlined and unpermitted landfill, which operated from 1969 to 1976 and is located upgradient of a wetland. The general appearance of the site suggests that a trench-and-fill method type of operation was used for waste disposal. Possible waste types associated with this landfill include booster cups, aluminum liners, municipal waste, explosive and munitions waste and ash, and scrap metal from the Winklepeck Burning Grounds (RVAAP-05). Potential COPCs at this site include metals, explosives, and SVOCs.

3.12.12 Mustard Agent Burial Site

This unit is a possible mustard agent burial site (MBS; RVAAP-28) and comprises a triangular-shaped plot with dimensions of approximately 15-ft by 18-ft. In 1969, records indicate that an Explosive Ordnance Disposal (EOD) Unit had excavated a suspected mustard agent burial site near the west end of the NACA runway. One 190-liter (50-gallon) drum and seven rusty canisters were recovered. All recovered items were empty, and no contamination was discovered.

Another suspected area, located to the southwest across Hinckley Creek, is presently marked by reflective Seibert stakes. Surface soil samples collected in 1996 as part of the RRSE conducted by the USACHPPM contained no thiodiglycol (mustard agent breakdown product). Two non-intrusive geophysical surveys (EM-31 and EM-61) were completed in 1998. The two surveys identified the demarcated area with positive metallic responses. Some, if not all, of the responses are most likely related to artificial features (e.g., rusted fencing) at or near the ground surface. There was no sign of disturbed soils or sufficient buried metallic objects to clearly delineate a formal burial site. The site was transferred to NGB in May 1999.

Groundwater samples were collected in 2004. No mustard agent or mustard agent breakdown products were found. In 2006, additional wells were installed and sampled for mustard agent and associated breakdown products. The chemical analysis reported no detections of mustard agent or breakdown products. Groundwater monitoring is ongoing.

An additional potential burial area located at the west end of the NACA crash strip was suggested by a member of the public and investigated in FY08. The geophysical investigation detected unidentified anomalies. A follow-on FY08 contract was awarded to perform a Data Quality Objective (DQO) study and an additional geophysical survey that included areas on the north and south sides of the test crash strip. The additional geophysical survey work and report were completed in the fourth quarter of FY10.

3.12.13 Upper & Lower Cobbs Ponds

The Upper and Lower Cobbs Pond complex (RVAAP-29) comprises two unlined ponds that received discharges from the Load Lines 3 and 12 explosive wastewater treatment systems during the period of 1941 through 1971. Upper CP is about 5 acres in size, and Lower CP is approximately 4 acres in size. The Upper and Lower Cobbs Ponds contain abundant fish and wildlife. A shallow water-filled depression known as "a backwater area" is located south of Upper CP. This area comprises approximately 1 acre and was created by beaver activity. This backwater area was not present during facility operations.

The Phase I RI found low levels of explosives in sediment; no contaminants were found in the surface water. The Phase II RI field work was completed in the summer of 2001. Soil, sediment, surface water, and groundwater were sampled. Waste types associated with this site include TNT, RDX, HMX, Composition B, lead, chromium, mercury, and aluminum chloride.

This site is partially addressed under the Facility-Wide Surface Water sampling program.

3.12.14 Load Line 6

Load Line 6 (LL6; RVAAP-33) is approximately 45 acres and was operated primarily as a fuze assembly line from 1941 to 1945. The area was reactivated in 1950 when the Firestone Defense Products Division became a tenant, which lasted until the late 1980s. During that latter timeframe Firestone sold its Defense Products Division to Physics International. Three years later, Physics International became a subsidiary of Olin Corporation, and Olin remained as a tenant until early 1993. Throughout the history of the tenant occupancy the work regimen remained the same. As reported by former workers at RVAAP, Load Line 6 was a classified experimental test facility for munitions. Shaped charges were constructed and tested under contract for the Department of Defense. The site consisted of a pond (underwater test chamber), two above ground test-firing chambers, and several buildings. No original file documentation exists for this site.

The COPCs are explosives and metals.

Demolition of all Load Line 6 buildings was completed in July 2006. The test chamber foundation and the concrete blocks around the test pond remain at the site.

3.12.15 Sand Creek Disposal Road Landfill

Former workers at RVAAP reported that the Sand Creek Disposal Road Landfill (RVAAP-34) was an open dump used for concrete, wood, asbestos debris, lab bottles, 55-gal drums, and fluorescent light tubes. Debris was disposed of at the surface, but the area later became covered by vegetation. The site is approximately 2.7 acres and is located adjacent to Sand Creek. The dates of operation of this site are unknown, but are believed to be around the 1950s.

Sediment and surface water samples indicated metals and SVOCs were leaching into Sand Creek, a state resource water.

The site was transferred to the NGB in May 1999. Surface soil and debris removal (IRA) was completed in summer 2003. The IRA was documented in a report submitted in April 2004. An FY08 DQO study was awarded to determine data gaps for the FY03 IRA. Following the DQO study, the recommended geophysical magnetometer study and soil sampling were conducted in the fourth quarter of FY10 and first quarter of FY11. Related findings will provide the basis for additional IRP actions.

This site also carries the facility-wide non-groundwater LTM and programmatic support requirements. These requirements are common to all other IR sites and are carried here to streamline the associated funding, contracting, and scheduling. This facility-wide approach was reviewed and approved by USAEC in FY10. RVAAP-34 was selected because it was already in the LTM phase at the time and was best suited for carrying these requirements.

3.12.16 NACA Test Area

The NACA Test Area (NTA; RVAAP-38) is an approximately 12.4-acre AOC that was used as an aircraft test area. Surplus military aircraft were crashed into a barrier using a fixed rail attached to the aircraft landing gear in an attempt to develop crashworthy fuel tanks and/or high flashpoint fuel. Some of the aircraft were burned at the site after the tests. Demolition Area #1 (RVAAP-03) is located within the RVAAP-38 boundary. This site was transferred to the NGB in May 1999.

Phase I RI samples were taken in October 1999. The Phase I RI was completed in 2000. Low levels of metals, inorganics, and VOCs were detected in soil. Nitrocellulose was detected in the sediment, but it is believed to be attributed to RVAAP-03. Nevertheless, it was determined that additional study was needed, and a SI/Phase I RI for the site was completed in 2002.

In 2004, 12 groundwater monitoring wells were installed and sampled at the NACA Test Area. Analytical results indicated the presence of metals and low levels of SVOCs.

3.12.17 Load Line 5

Load Line 5 (LL5; RVAAP-39), which comprises approximately 39 acres, was operated from 1941 to 1945 to produce fuzes for artillery projectiles. Load Line 5 was deactivated and its equipment removed in 1945.

The relative risk site evaluation was completed in 1998 by USACHPPM. The surface soil and groundwater pathways are considered complete. Metals and SVOCs above screening criteria were detected in soil, sediment, and surface water samples. Nitrates above screening criteria were also detected in surface water.

Removal of buildings, including slabs and foundations, was completed in FY07. An FY08 USACE underslab soil and dry sediment survey was completed with findings reported to the RVAAP stakeholders in the second quarter of FY09.

3.12.18 Load Line 7

Load Line 7 (LL7; RVAAP-40) is a 37-acre site that was used to assemble booster charges for artillery projectiles between 1941 and 1945. In 1945, Load Line 7 was deactivated, and the equipment was removed. Load Line 7 was used again in 1969 and 1970 to produce 40-mm projectiles. The site was reactivated between 1989 and 1993 under a tenant contract operated by an Olin Corporation subsidiary, Physics International (PI), for the manufacture of large caliber conventional weaponry. The PI Load Line 7 munitions process constructed and utilized a carbon-adsorption filtration plant to treat process wastewaters contaminated with explosives. The plant was closed in May 2000 with the termination of the NPDES permit.

In 1998, USACHPPM completed the relative risk site evaluation, which indicated the presence of metals, VOCs, SVOCs, and explosives in soil, sediment, surface water, and groundwater above agreed upon screening levels. The surface soil and groundwater pathways are considered complete.

Removal of buildings, including slabs and foundations, was completed in FY07. An FY08 USACE underslab soil and dry sediment survey was completed with findings reported to the RVAAP stakeholders in the second quarter of FY09.

3.12.19 Load Line 8

Load Line 8 (LL8; RVAAP-41) comprises approximately 44 acres. This AOC was used to assemble booster charges for artillery projectiles between 1941 and 1945. In 1945, Load Line 8 was deactivated, and the equipment was removed.

The relative risk site evaluation was completed in 1998 by USACHPPM. This investigation indicated the presence of metals, VOCs, SVOCs, and explosives in soil, sediment, surface water, and groundwater above agreed upon screening levels. The surface soil, groundwater, and sediment pathways are considered complete.

Removal of buildings, including slabs and foundations, was completed in FY07. An FY08 USACE underslab soil and dry sediment survey was completed with findings reported to the RVAAP stakeholders in the second quarter of FY09.

3.12.20 Load Line 9

This 106-acre AOC operated from 1941 to 1945 to produce detonators. In 1945, Load Line 9 (LL9; RVAAP-42) was deactivated, and its equipment was removed.

The relative risk site evaluation was completed in 1998 by USACHPPM. Limited samples taken in 2000 detected low levels (below 2 percent) of lead azide in sediment and surface water in the sumps. The surface soil and groundwater pathways are considered complete.

The removal of buildings, including slabs and foundations, was completed in FY07.

3.12.21 Load Line 10

This 36-acre AOC operated from 1941 to 1945 to produce percussion elements. Load Line 10 (LL10; RVAAP-43) was placed on standby in 1945. From 1951 to 1957, Load Line 10 produced primers and percussion elements. From 1969 to 1971, this AOC was used again to produce primers. It has been inactive since.

In 1998, the relative risk site evaluation was completed by USACHPPM. The results indicated the presence of metals, VOCs, SVOCs, and explosives in soil, sediment, surface water, and groundwater above screening levels. The surface soil and groundwater pathways are considered complete.

Removal of buildings, including slabs and foundations, was completed in FY07. An FY08 USACE underslab soil and dry sediment survey was completed, and the findings were reported to the RVAAP stakeholders in the second quarter of FY09.

3.12.22 Load Line 11

Load Line 11 (LL11; RVAAP-44) comprises a 47-acre parcel that was operated from 1941 to 1945 to produce primers for artillery projectiles. Load Line 11 was placed on standby in 1945. From 1951 to 1957, Load Line 11 was used to produce primers and fuzes.

In 1998, the relative risk site evaluation was completed by USACHPPM. Arsenic was detected in the sediment slightly above the RRSE ecological screening concentration. Lead [maximum 11,000 parts per million (ppm)] was the only contaminant found in the surface soil. The surface soil, groundwater, and sediment pathways are considered complete.

In 2001, lead/asbestos-lined sumps, lead-contaminated sediments, and solvent-contaminated soils were removed during an IRA. Some of the sewer lines were also intentionally plugged with grout to prevent migration of contaminants. The SI/Phase I RI was completed in FY05 prior to demolition of the buildings. The complete removal of buildings, including slabs and foundations, occurred in FY05.

3.12.23 Wet Storage Area

The Wet Storage Area (RVAAP-45) is a 36-acre parcel that was used from 1941 to 1945 to store primary explosives in water-filled tanks and metal carboys. There is no documentation of any spills in the area.

The COPCs at this site include metals and explosives. Four of the six igloos in this area were demolished in spring 2003-2004.

This is one of 14 sites that were investigated in FY04-FY05 to provide data for a future contract. A PBA was awarded in FY08 and will address all investigation and cleanup through Response Complete (RC) for this site.

3.12.24 Buildings F-15 and F-16

Buildings F-15 and F-16 (RVAAP-46) were used during World War II, the Korean Conflict, and Vietnam War to test disassembly processes and munitions surveillance. Quantities and types of materials, as well as exact dates of testing, are unknown.

The site was transferred to NGB in May 1999. An SI/Phase I RI (2005-2006) found metals, explosives, and SVOCs in soil and surface water above the screening criteria. The Phase I RI did not investigate groundwater.

All buildings, foundations, and slabs were removed from both sites in the fourth quarter of FY09. Following removal, confirmation sampling within and outside the building footprints was completed in the first quarter of FY10.

This is one of 14 sites that were investigated in FY04-FY05 to provide data for a future contract. A PBA was awarded in FY08 and will address all investigation and cleanup through RC for this site.

3.12.25 Anchor Test Area

The Anchor Test Area (RVAAP-48) comprises 2 acres in the central part of the installation. Limited information is known about this research and development area, including dates of operation. It is believed that the site was used for testing explosively driven soil anchoring devices. It currently consists of several dirt mounds with a nearby sand pit (approximately 6-ft by 30-ft). There is metal debris in the area.

This is one of 14 sites that were investigated in FY04-FY05 to provide data for a future contract. Metals were found in soil above agreed upon screening levels. A PBA was awarded in FY08 and will address all investigation and cleanup through RC for this site.

3.12.26 Central Burn Pits

The approximately 20-acre Central Burn Pits (CBP; RVAAP-49) was used for the burning of nonexplosive scrap materials. The dates of operation for this AOC are unknown. This AOC is not an active IRP, MR, or CR site; however, historical operations at this AOC were a contributing source of contaminants to groundwater, and as such, it remains an AOC for facility-wide groundwater.

The surface soil and groundwater pathways are considered complete. Surface soil samples were collected and analyzed for SVOCs, PCBs, herbicides, explosives, and metals during the RRSE. The subsurface soil used to estimate the groundwater pathway was collected from the eastern limit (downhill side) of the main disturbed area. The USACHPPM sampling detected significant levels of antimony (maximum 9,000 ppm), arsenic (maximum 30 ppm), and lead (maximum 2,200 ppm) in the soil. Field work for the Phase I RI was completed in the summer of 2001.

3.12.27 Atlas Scrap Yard

In the 1940s, Atlas Scrap Yard (ASY; RVAAP-50) contained a complex of buildings on approximately 150 acres that supported the principal construction and engineering company staff and included barracks-type housing. After World War II, a majority of the Atlas building complex was demolished leaving the remaining portion of structures to support the installation of roads and grounds, maintenance staff and equipment, as well as a large contingent of railroad maintenance personnel. The post-World War II structures stood until after the Vietnam War at which point all remaining buildings were demolished, and the site became a storage/stockpile yard for various types of bulk materials used in the day-to-day installation operations such as gravel, railroad ballast, sand, culvert pipe, railroad ties, and telephone poles. In the mid- to late-1980s, the southeastern portion of the old Atlas Scrap Yard area became a staging area for salvaged ammunition boxes from the demilitarization of defunct Vietnam War-era munitions. Unexploded ordnance is present at the southwest corner of the site.

Non-IRP sorting and removal of OE and OE scrap at the site has been partially completed. Soil samples showed PAHs at concentrations above the human RRSE standard concentrations.

This site was transferred to NGB in May 1999.

3.12.28 Dump along Paris-Windham Road

The dump along Paris-Windham Road (RVAAP-51) is adjacent to the Sand Creek flood plain and was used as an open dump for miscellaneous materials, including transite siding. The dates of operation for the landfill are unknown.

Collection and analyses of surface water, sediment, and biological samples occurred in Sand Creek adjacent to the site. There were no detections above background levels identified in the surface water and sediment. Biological samples collected under a separate initiative and in the vicinity of the dump reflected excellent stream quality.

Debris removal was completed in January 2004. Confirmation sampling detected PAHs and asbestos close to the road within the embankment. No attempt was made to remove remaining debris within the roadbed embankment as it would have compromised the stability of Paris-Windham Road.

A focused feasibility study (FFS) was awarded in the fourth quarter of FY09 to address remaining Ohio EPA concerns.

3.12.29 Facility-Wide Groundwater

Groundwater issues at RVAAP are managed through a facility-wide approach called the FWGWMP under RVAAP-66. The FWGWMP is a component of the DFFOs issued in June 2004. Soil issues are addressed at the individual sites under separate contract. The FWGWMP at RVAAP now consists of 243 wells and includes all Installation Restoration (IR) and MR sites at RVAAP. In 2004, the FWGWMP was approved, and monitoring of 36 wells was initiated in 2005. A review of the FWGWMP was completed in 2007 and 2010. The 2007 review resulted in an increase in monitoring, which was then reduced as a result of the 2010 review. The program has been expanded to include all 243 monitoring wells at RVAAP.

Both shallow aquifers and deeper regional aquifers are being monitored. Several COPCs have been identified in the shallow aquifers that exceed drinking water standards and facility-wide cleanup goals (FWCUGs). Some of the source areas are known but nature and extent is not yet established. Site-related constituents have been identified in the deeper aquifers, but concentrations are below applicable screening criteria. The USACE completed a review and evaluation of the entire groundwater database currently maintained in the REIMS. The review and evaluation included available analytical data collected from 1996 through January 2010. The results of this evaluation are discussed in the *Draft 2010 Addendum to the Facility-Wide Groundwater Monitoring Program Plan RVAAP-66 Facility-Wide Groundwater* (USACE, 2010). Table 3-2 summarizes the COPCs identified above site-screening levels at various areas of the site.

All of the sites will remain in the RI stage for characterization of groundwater in RVAAP-66 until 2012, followed by an FS in 2013. Once the FS is complete, some sites may require remediation of groundwater, and others may not. Monitored natural attenuation (MNA) is assumed for all of the sites as reflected in the Remedial Action Objective (RAO) phase starting in 2014 for RVAAP-66.

3.12.30 Facility-Wide Sewers

The RVAAP started operations in 1941 and continued intermittently until the late-1970s either loading or demilitarizing ammunition. Plant operations required processing large quantities of secondary explosives. Periodic cleaning of the process areas resulted in explosive residues in the sanitary and storm sewers and settling ponds. Facility-wide sewers are addressed by RVAAP-67.

Table 3-2. Groundwater Quality Summary for RVAPP

	Analytes									
Area of Concern	VOCs	SVOCs			Metals	Explosives	Pesticides	PCBs	Nitrate	Hexavalent Chromium
		Nitroaromatics & Phthalates	Phenols	PAHs						
Load Line 1	X	X			X	X	X			
Load Line 2	X	X	X		X	X	X	X		
Load Line 3	X	X			X	X	X			
Load Line 4	X	X			X	X	X			
Load Line 5		X			X			X		
Load Line 6		X		X	X					
Load Line 7	X	X			X	X				
Load Line 8		X			X					
Load Line 9		X		X	X		X			
Load Line 10	X	X		X	X	X				
Load Line 11	X	X			X	X	X			
Load Line 12	X	X	X	X	X	X	X	X	X	
Atlas Scrap Yard		X			X					X
Building 1200		X		X	X					
Building T-5301					X					
C Block Quarry		X		X				X		X
Central Burn Pits		X			X		X	X		
Cobbs Ponds		X		X	X		X			
Demo Area #1					X					
Demo Area #2		X			X	X		X		X
Erie Burning Grounds		X			X					
Fuze and Booster	X	X			X	X	X			X
NACA Test Area	X	X		X	X			X		
Ramsdell Quarry	X	X		X	X	X	X	X		
Winklepeck	X	X			X	X				
Site-wide Background	X	X			X	X	X	X		
Sharon Conglomerate		X			X	X				

X = present at concentration above applicable screening criteria.
No exceedance above applicable screening criteria.
VOCs = volatile organic compounds.
SVOCs = semivolatile organic compounds.
PAHs = polycyclic aromatic hydrocarbons.
PCBs = polychlorinated biphenyls.

Sewers thought to have transported explosive residues during plant operations are believed to be limited to the 12 process areas and Buildings 1037 (laundry) and 1039 (laboratory) in the administrative area of the plant. The sanitary sewers (approximately 28,500-ft) are assembled from either cast iron or vitreous clay tile that has been lined with resin. Storm sewers (estimated at 30,000-ft) are fabricated from either vitreous clay or corrugated galvanized steel.

Sewers were installed in trenches lined with washed gravel then covered by about 6 inches of gravel and backfilled with the removed soil, generally heavy clay. If the sewers leaked contaminants they should be in the gravel fill, trapped by the clay backfill. The main sources of explosives in sanitary sewers are change houses within the various load lines where coveralls were removed and people showered prior to leaving the facility, the laundry where the clothes were washed and the laboratory where small quantities of explosives were tested.

Storm sewers within the load lines were subject to contamination by virtue of wash-down procedures where explosive residue and dusts were scrubbed from the floors and washed through doorways onto the surrounding grounds. The wash-down water could then migrate to the storm water drain system. Explosives could also enter the storm system from explosive filter effluent traveling to settling ponds.

Lakeshore Engineering was contracted to determine the explosive residues in sewers and make recommendations as recorded in its report, Explosive Evaluation of Sewers, dated November 2007. The Lakeshore Engineering study was done under safety qualification parameters; not quantifying the presence of any explosive deposits. The Corps of Engineers Research

Laboratory performed a similar investigation of explosive contamination in the sewer system in a letter report dated 15 June 2007, which was included in the Lakeshore report as an appendix. Following an Ohio EPA-approved work plan, Tier I (sediment and liquids) surveys/investigation were completed in the second quarter of FY10.

A PBA was awarded in FY08 and will address all investigation and cleanup through RC for this site.

3.13 Preliminary Identification of MMRP Operable Units

In October 2007, a CERCLA SI was completed at RVAAP to initially assess the munitions response sites at the facility. The MMRP SI activities included historical records reviews (HRRs), magnetometer-assisted UXO surveys, and sampling and laboratory analysis of surface soils. The results of these activities are presented in the Final SI report submitted by e2M in May 2008.

Nineteen Munitions Response Sites (MRSs) were originally identified at RVAAP. Two of the MRSs became ineligible for the MMRP because of their redevelopment as active operational ranges. As such, they were not investigated during the SI.

Overall, 17 sites were investigated as part of the SI. Fourteen sites were recommended for further investigation. The three sites recommended by the SI for NFA were: Anchor Test Area (RVAAP-048-R-01), LL12 (RVAAP-012-R-01), and Building F15/F16 (RVAAP-046-R-01). The remaining 14 sites are currently being investigated as part of a RI.

Information on the operable units of concern has been extracted from the 2011 IAP. However, additional RI field activities were conducted in 2010 and 2011. The results of the RI activities will be provided in RI or RI/FS reports in 2012.

3.13.1 Ramsdell Quarry

During the period 1946 to 1950, the 13.4 acre Ramsdell Quarry (RVAAP-001-R-01) was used to thermally treat waste explosives and napalm bombs. No historic information has been located for the period of 1950-1976. From 1976, a portion of the site was used as a nonhazardous solid waste landfill, which was permitted as a sanitary landfill in 1978 by the state of Ohio until its closure in 1990. The landfill is not part of the MRS.

The MRS comprises two separate areas: a northern area where OB/OD operations were conducted in a former quarry, and a southern area that contains a small inactive quarry and wooded area where installation personnel had found munitions debris. The northern quarry area is collocated with an IRP AOC. Munitions debris was identified during field investigation of the IRP site, RVAAP-01.

The Final SI was completed in May 2008. For the SI fieldwork, a magnetometer and metal detector-assisted UXO survey was conducted in the northern quarry area and at the southern quarry area, where little historical data exists. Subsurface anomalies were detected in the northern quarry, specifically around the pond; however, no evidence of MEC was observed at the MRS. Large-caliber munitions debris (MD) was found at two locations in the southern quarry during the SI field work. The potential presence of MEC in the pond in the northern quarry area (Area 1) and munitions constituents (MC) in the southern quarry area (Area 2) will require additional investigation under future CERCLA actions.

A PBA was awarded in July 2009 (as PBA09) for RVAAP-001-R-01 to address remedial investigation work for this site, with the objective of an RI report in 3 years.

3.13.2 Erie Burning Grounds

Erie Burning Grounds (EBG; RVAAP-002-R-01) comprises a 35-acre area located in the northeast portion of RVAAP. This area was used from 1941 to 1951 to thermally treat bulk, obsolete, off-specification propellants, conventional explosives, rags, and large explosive-contaminated items (e.g., railcars) through open burning on the ground surface. The ash residue from the burns was left at the AOC, and UXO is present at the site. Waste constituents of concern at this location include RDX, TNT, and heavy metals. There is a potential for release of contaminants from this unit to the surrounding soils, surface water/sediment, and groundwater. This site is in a wetland area. The MRS is collocated with a former IRP AOC (RVAAP-02).

The Preliminary Assessment/Site Investigation (PA/SI) was completed in 1989. Phase I RI work was conducted at this site in July 1999. It was determined that additional groundwater sampling was needed. The final SI was completed in May 2008. During the SI, several subsurface anomalies were detected in the northwestern and central portions of the MRS; however, no MEC was observed. Further, several subsurface anomalies were detected in the southwestern portion of the MRS and one possible MEC item was found partially buried northwest of the wooded area. Munitions and explosives of concern are also expected in the flooded sections of the MRS and will require further investigation under future CERCLA actions.

A PBA was awarded in July 2009 and contains an option for an RI at RVAAP-002-R-01 that is scheduled to be completed within 3 years. Soil and dry sediment IR concerns are addressed under RVAAP-2 at this location.

3.13.3 Demolition Area #2

The 35.4-acre Demolition Area #2 (RVAAP-004-R-01) was used from 1948 until 1991 to detonate large caliber munitions and off-specification bulk explosives that could not be deactivated or demilitarized by any other means due to their condition. Detonation was performed in a backhoe-dug pit with a minimum depth of 4 feet. After detonation, metal parts were picked up and removed from the site. The site was also used for burial of white phosphorus and bombs of unknown type. The MRS is collocated with an IRP AOC (RVAAP-04). The IRP portion of the site is about 25 acres located near the center of RVAAP. The MRS consists of the former demolition area, Burial Sites 1 and 2, Rocket Ridge, the Bomb Disposal Area located adjacent to the northwestern section of the MRS, and all areas in between. Contaminants of concern at this AOC are white phosphorous, explosives, and heavy metals. Sand Creek bisects the site.

There is a smaller 1.5-acre area regulated under RCRA on the north side of Sand Creek, which was regularly used until 1992 for demolition activities. A USAEHA geotechnical study was conducted at this site in 1992, with minor amounts of contamination being detected in the soils. Four groundwater monitoring wells were installed at the AOC as part of the USAEHA study. Currently, the RCRA wells are sampled semiannually. Low levels of explosives have been periodically detected in the RCRA wells. Non-IRP funding was used in 1999 and 2000 to remove UXO and ordnance and explosives to a depth of 4 feet in the area of the 1.5-acre RCRA unit.

A Phase I RI was completed for the site in February 1998. The RI found explosives, particularly TNT, and several inorganics including cadmium, lead, and mercury in both surface and subsurface soils. Concentrations of inorganic compounds in sediment appear to be within site-wide background values. Groundwater was investigated under the Phase II RI, which was completed in the summer of 2002.

The final SI was completed in May 2008. Munitions and explosives of concern were found at Rocket Ridge, the Bomb Disposal Area, Burial Site 2, and on the hill across Sand Creek from Rocket Ridge. At Rocket Ridge, observed MEC included T-bar fuzes, white phosphorus rifle grenades, and possibly 500-lb bombs. One partially buried fuze, considered MEC, was found at the Bomb Disposal Area. A partially buried fuze was also found at Burial Site 2. On the hill directly across (north) from Rocket Ridge, two 40-mm cartridges (considered MEC) with intact primers were found. Munitions debris was found throughout the MRS and consisted of demilitarized 155-mm projectiles, remnants of 40-mm rounds, casing fragments from large caliber projectiles, and remnants of donor charge bags.

Rocket Ridge, where MEC items have been discarded on the ground surface and into Sand Creek, is located along a 70-ft embankment northeast of Building 1503 overlooking Sand Creek. In June 2007, a white phosphorous rifle grenade detonated at Rocket Ridge. A time-critical response action (TCRA) was conducted in May 2008 to abate potential munitions migration during high stream storm events via the installation of steel mesh barrier screens within the main stream channel of Sand Creek. A second TCRA removal action for four suspected conventional MEC items from Rocket Ridge was executed during the third quarter of FY09 and was completed in the fourth quarter of FY09. During this phase, the three suspected 500-lb bombs were determined to be MD and a 105-mm shell was determined to be live and was blown in place. Additionally, Rocket Ridge was divided into two sections: one is contaminated with white phosphorous rifle grenade rounds, and the other is contaminated with miscellaneous MEC and MD. Additionally, this investigation provided volume estimates and types of materials that need to be removed during the third phase of the TCRA, which commenced in the fourth quarter of FY10.

A PBA was awarded in July 2009 for RVAAP-004-R-01 to address remedial investigation work for this site, with the objective of a final RI report in 3 years. The RVAAP-04 addressed IR concerns for soil and dry sediment at this location.

3.13.4 <u>Load Line 1</u>

Load Line 1 (RVAAP-008-R-01) operated from approximately 1941 to 1971 for loading various types of projectiles. Additionally, ordnance was demilitarized at this site from 1973 to 1974. Load Line1 was used to melt and load TNT and Composition B explosives into large-caliber shells during World War II and the Korean War. Workers, on a weekly basis during operations, would periodically use steam and hot water to hose down equipment and the floors and walls of buildings contaminated with explosive dust, spills, and vapors. Wash-down water from the melt-pour buildings was also swept out through doorways onto the ground surrounding the buildings. Wash-down water and wastewater from the load line operations that collected in concrete sumps was pumped through sawdust filtration units and then discharged to an off-AOC settling pond. The settling pond was an unlined rectangular-shaped pond approximately 1 acre in size and 4-ft-deep. Water from the impoundment discharged to a stream that ultimately exited from the southern end of the installation.

The final SI was completed in May 2008. The MRS consists of approximately 0.5 acre of the LL1 site and comprises several areas associated with Buildings CB-13/CB-13B and CB-14, and areas where triple base propellants still exist.

A PBA was awarded in FY09 to address work for this site through RC. The performance objective is to achieve remedy-in-place (RIP)/RC in 5 years. The RVAAP-08 addresses IR concerns at this location.

3.13.5 <u>Fuze and Booster Quarry</u>

The 4.9-acre Fuze and Booster Quarry AOC (RVAAP-016-R-01) operated from 1945 through 1993. The site comprises three elongated ponds, which were constructed within an abandoned rock quarry. The ponds are 20- to 30-ft deep and are separated by earthen berms. Prior to 1976, the quarry was reportedly used for open burning and as a landfill. The debris from the burning/landfill was reportedly removed during pond construction. From 1976 to 1993, spent brine regenerate and sand filtration backwash water from one of the RVAAP drinking water treatment plants was discharged into the ponds. This discharge was regulated under a National Pollutant Discharge Elimination System (NPDES) permit. In 1998, this AOC was expanded to include three other shallow settling ponds and two debris piles, bringing the site to approximately 45 acres. The lands adjacent to the quarry were utilized as an impact area to test 40-mm projectiles and to incinerate/deactivate fuze and booster components. The site is collocated with an IRP AOC (RVAAP-16).

The Phase I RI field work was completed in November 2003. Constituents of concern include explosive compounds and heavy metals. There is a potential for release of contaminants to the groundwater, soils, and surface water/sediment from this AOC.

The final SI was completed in May 2008. No MEC was observed during the SI; however, munitions debris was found on the southeastern side of the southern pond. It is suspected that subsurface anomalies identified during the MMRP SI represent buried munitions debris and possibly MEC. Additionally, RVAAP personnel have observed the presence of potential MEC in the northern and southern ponds when water levels are low. The bottoms of the ponds have not been investigated.

Debris piles north of the ponds are not included in this site but are included under RVAAP-032-R-01 and RVAAP-062-R-01.

The PBA awarded in FY09 contains an option for an RI at RVAAP-016-R-01 that is scheduled to be completed within 3 years. The RVAAP-16 addresses IR concerns at this location.

3.13.6 <u>Landfill North of Winklepeck</u>

The 2.3-acre LNW (RVAAP-019-R-01) accepted general plant refuse, explosive wastes residue, and OB waste, including flares and booster cups from WBG. The landfill was used from 1969 to 1976. The MRS consists of the landfill (RVAAP-19), the slope area, and an adjacent small stream where MEC was reportedly found.

The Final SI was completed in May 2008. No MEC was discovered during the SI, although munitions debris was found.

A PBA was awarded in FY09 for RVAAP-019-R-01 to address remedial investigation work for this site, with the objective of an RI report in 3 years. The RVAAP-19 addresses IR concerns at this location.

3.13.7 40-mm Firing Range

The 1.3-acre 40-mm Firing Range (RVAAP-032-R-01) is a former test range for the 40-mm cartridge and is surrounded by forest. The MRS was used from 1969 to 1971. The site is collocated with an IRP site (RVAAP-32). The impact area was located in the western portion of the site while the firing point was sited at the opposite end. Unexploded ordnance was reportedly present beyond the impact area, on the slope that leads down to the Fuze and Booster Quarry.

The final SI was completed in May 2008. Munitions and explosives of concern were not discovered during the SI; however, munitions debris was found scattered from the target point to a point approximately 100 ft beyond the former impact area.

The PBA awarded in FY09 contains an option for an RI at RVAAP-032-R-01 that is scheduled to be completed within 3 years.

3.13.8 Firestone Test Facility

The 0.4-acre Firestone Test Facility (RVAAP-033-R-01) consisted of two buildings that were used as test chambers for tube-launched, optically- tracked, wire-guided (TOW) missiles and Dragon missiles. In addition, shaped charges were tested in a very small nearby pond. The site was used from the late 1960s to 1992. The former test chambers have been demolished and all of the debris removed. The test chamber foundations remain. Another suspect area comprising a small clearing and piles of dirt and large timbers was included in the SI fieldwork. The site is collocated with IRP AOC Load Line 6 (RVAAP-33).

The final SI was completed in May 2008. Neither MEC nor munitions debris were discovered during the SI of the two former missile test chambers locations, the ground surface around the pond, and the small clearing. Multiple closely-spaced subsurface anomalies were detected around the pond and the location of the test chamber. The submerged portion of the pond was not investigated under the SI.

A PBA was awarded in FY09 to address work for this site through RC. The performance objective is to achieve RIP/RC in 5 years. The RVAAP-33 addresses IR concerns at this location.

3.13.9 Sand Creek Dump

The 0.9-acre Sand Creek Dump (RVAAP-034-R-01), which is collocated with an IRP site (RVAAP-34), is undeveloped land that stretches along the banks of Sand Creek for approximately 1,000 feet. The Sand Creek Dump was used as a disposal site (1950 to 1960) for concrete, wood, asbestos debris, lab bottles, 55-gal drums, and fluorescent light tubes. Debris remains at the site. The RVAAP-34 addresses IR concerns at this location. This site was identified in the SI as a smaller area lying within the IR site.

During a surface IRA performed in October 2003, two 75-mm inert projectiles were discovered at this site. No MEC was discovered during the SI; however, one empty 105-mm projectile was discovered in Sand Creek downstream of the former dump. The MMRP SI, which was completed in FY08, recommended further investigation to address a potential MEC concern along a reach of Sand Creek. A last quarter FY08 contract for a full geophysical investigation of the affected stream bank area was completed in FY10.

The PBA awarded in FY09 contains an option for RIP/RC at RVAAP-034-R-01 that commenced in FY10. The performance objective is to achieve RIP/RC in 5 years.

3.13.10 Atlas Scrap Yard

The Atlas Scrap Yard (RVAAP-050-R-01), which is collocated with IRP AOC RVAAP-50, comprises mostly open land that contains a network of roads. Originally used as a construction camp, the 66-acre site was formerly used for scrap storage and currently consists of scattered piles of debris.

During the 2004-2005 IRP RI, MEC was discovered in the southwest corner of the site. Most of the MEC and MEC scrap was removed under a separate contract. Accessible areas were later surveyed during the MMRP SI. The final MMRP SI was completed in May 2008. No MEC or munitions debris were found lying on the ground surface, and only a few scattered subsurface anomalies were detected. In the north-central section, no MEC or MD was observed lying on the ground surface around or on top of the debris piles. No MEC or MD was observed lying on the ground surface in the east-central section of the site. Areas known to have been previously used for storage of MEC and MD were calculated to be roughly 2 acres.

A PBA was awarded in FY09 for RVAAP-050-R-01 to address remedial investigation work for this site, with the objective of an RI report in 3 years. The RVAAP-50 addresses IR concerns at this location.

3.13.11 Block D Igloo

The Block D Igloo MRS (RVAAP-060-R-01) resulted when fuzed bombs in Igloo 7-D-15 (D Block) exploded on March 24, 1943. The initial 3,000-ft radial MRS boundary was established by the USACE, Huntsville District to capture the probable debris field resulting from the explosion and was based on the type of munitions stored in the bunker at the time of the explosion. In 1943, a response action was performed by USACE immediately after the explosion. As described below, the area of this site was adjusted based on the 2008 SI findings.

The final SI was completed in May 2008. During the 2008 SI, a magnetometer/metal detector-assisted UXO survey was conducted within and around the former igloo and at four documented locations where explosion-related debris was found. Neither MEC nor munitions debris were found within the interior of the former igloo and within a circumference of approximately 100 ft surrounding this area. At the four documented debris locations, no visual evidence of MEC and/or munitions debris was found, and very few subsurface anomalies were detected. Based on the observations and findings of the UXO survey, MEC and/or munitions debris are not present at these locations; however, no such declaration can be made for the remaining areas that were not included in the SI fieldwork.

A PBA was awarded in June 2009 for RVAAP-060-R-01 to address remedial investigation work for this site, with the objective of an RI report in 3 years. Based on the SI, this site comprises 340 acres. The final determination of size will occur at the end of the RI.

3.13.12 Block D Igloo-TD

The Block D Igloo (RVAAP-061-R-01) site resulted when fuzed bombs in Igloo 7-D-15 (D Block) exploded on March 24, 1943. The transferred (TD) designation in the site name indicates that this is land located outside of the installation property boundary. The initial 3,000-ft radial MRS boundary was established by the USACE, Huntsville District to capture the probable debris field resulting from the explosion and was based on the type of munitions stored in the bunker at the time of the explosion. The 2008 HRR identified 19.25 acres for the offsite portion. This area was investigated during the 2008 MMRP SI, and it was determined that no further action was required to address MEC or MC.

However, the 2008 SI did identify a new area of land that may potentially contain debris. The new area consists of 14.13 acres and will require additional characterization work during the MMRP RI to address any potential MC and MEC issues.

A PBA was awarded in June 2009 and contains an option for an RI at RVAAP-061-R-01 that is scheduled to be completed within 3 years.

3.13.13 Water Works #4 Dump

The Water Works #4 Dump (RVAAP-062-R-01) is an approximate 0.77-acre open area located immediately west of Water Works No.4 and Load Line 7 in the southwestern portion of RVAAP. The site boundary identified in the U.S. Army Closed, Transferred, and Transferring (CTT) range/site inventory was not accurate. The actual site is located approximately 400 feet east.

The final SI was completed in May 2008. During the MMRP SI, no MEC or MC was identified, although further characterization is needed to confirm the presence/absence of MEC and/or MC. Munitions debris was found during the MMRP SI, and several subsurface anomalies were also detected in the open field.

A PBA was awarded in June 2009 and contains an option for RIP/RC at RVAAP-062-R-01. The performance objective is to achieve RIP/RC in 5 years.

3.13.14 Group 8 MRS

The 2.6-acre Group 8 MRS (RVAAP-063-R-01) comprises most of the area between Buildings 846 and 849. This area is disturbed land that may have historically been used for debris and rubbish burning. In 1996, one loaded anti-personnel fragmentation bomb (referred to as a hammerhead anti-personnel bomb) was found at the site. Munitions and explosives of concern, MD, and MC were identified during the MMRP SI.

A PBA was awarded in June 2009 and contains an option for an RI at RVAAP-063-R-01 that is scheduled to be completed within 3 years.

3.14 Preliminary Identification of CR Operable Units

Fourteen CR sites have been identified at the former RVAAP facility. The sites were identified during the time period FY09-FY10 and consist of new AOCs that qualify for environmental investigation and remediation under the Army's IRP expanded guidelines. The guidelines were expanded in December 2008 to extend the time period for eligible sites from October 17, 1986, to present-day activities. The investigation of CR sites was initiated under CERCLA in FY10. IRAs will be conducted as needed. Long-term monitoring may be required at several of the CR sites and may extend well into the future after completion of remediation. Site-specific details can be found under the individual site descriptions.

On December 29, 2008, the Office of the Deputy Under Secretary of Defense for Installations and Environment [ODUSD(I&E)] issued an interim policy for Defense Environmental Restoration Program (DERP) eligibility that rescinded the 1986 eligibility date for the IRP and the 2002 eligibility date for the MMRP. This made many sites previously addressed in the Army's Compliance-related Cleanup (CC) program eligible for the DERP. Sites now eligible for the MR program have been removed from the Army Environmental Database - Compliance-related Cleanup (AEDB-CC) and given the naming convention of other MR sites. The newly eligible non-MR type sites are considered to be IR sites; however, the newly eligible sites are being coded as CR in the Army Environmental Database - Restoration (AEDB-R) to distinguish them from the original IR sites and IR metrics.

Unless otherwise stated, a stage 1 RI was started at each CR site in FY10. The stage 1 RI consisted of a background search for historical information (consistent with a preliminary assessment). A stage 2 RI is anticipated for FY11. Information on the operable units of concern has been extracted from the 2011 IAP. However, additional RI field activities were conducted in 2010 and 2011. The results of the RI activities will be provided in RI or RI/FS reports in 2012.

3.14.1 Electric Substations

Electricity for the installation was purchased from the Ohio Edison Company. The electricity was supplied from Newton Falls and Garrettsville, Ohio. Distribution occurred through three substations, each generating approximately 24,000 volts. The three substations are included in this CR (CC RVAAP-68).

The east electrical substation is located close to the intersection of Remalia Road and Load Line No. 2 Road. The substation comprises an approximately 12,300-sq-ft area, which includes the land surrounding Building 25-27. There are no documented releases; however, aerial photographs and visual observations demonstrate stressed vegetation and staining outside the building and around the former transformers. Volatile organic compounds, SVOCs, and PCBs are possible contaminants of concern for soil.

The west electrical substation is located west of Load Line 5 on Fuze & Booster Service Road. The substation comprises an approximately 3,000-sq-ft area, which includes the land around Building 28-28 and the surrounding land formerly used as the transformer station. This AOC excludes Building 28-28. One spill of approximately 500 gallons of transformer fluid occurred on the north side of the building. The affected area was cleaned up by Emerald Environmental in 1997. Potentially impacted soils may exist outside the building near the former transformers. Volatile organic compounds, SVOCs, and PCBs are possible contaminants of concern in soil.

Substation No. 3 is located in the Fuze & Booster service area between Load Lines 10 and 11. The substation comprises an approximately 10,000-sq-ft area. The substation and all transformer equipment have been removed from the site. There are no documented releases; however, aerial photographs and visual observations identified stressed vegetation and staining outside the building and around the former transformers. Volatile organic compounds, SVOCs, and PCBs are possible contaminants of concern in soil.

3.14.2 Building 1048 Fire Station

The Building 1048 Fire Station (CC RVAAP-69) was located in the plant administration area in the northwest quadrant of the intersection of George Road and South Service Road. In 1968, the 12,130-sq-ft fire station was referred to as the Fire and Guard Building. The fire station building was demolished in late 2008, and the site currently remains undeveloped.

Reportedly, it was common practice for the fire department to clean out fire extinguishers behind the west side of the fire building and to allow the contents of the fire extinguishers (carbon tetrachloride) to spill onto the ground surface. The area of potential impact (ground surface behind building) covers approximately 28,000 sq ft. Based on the reported historical practices used at the site, it is anticipated that a release(s) of carbon tetrachloride has occurred at the site and further assessment is warranted to characterize the environmental quality of the soils and groundwater at this location.

3.14.3 East Classification Yard

The RVAAP was originally equipped with east and west classification yards during its early years of operation. The classification yards were used for the switching and maintenance of railroad cars.

The East Classification Yard (CC RVAAP-70) is located east of Load Line 1 near the intersection of Ramsdell Road and Irons Road. The rail yard reportedly had 18 tracks with a 750-car capacity and three Hi-X tracks with a 120-car capacity. The rail yard also included the wash rack south of the main track area, a locomotive repair building (Round House), and herbicide storage shed. The area surrounding the Round House and herbicide storage area comprises nearly 20,000-sq-ft. The shed contained a mobile herbicide tank. No documented releases are available. However, the soils located near the Round House and former herbicide storage shed may have been impacted by historical operations involving oily residues potentially containing PCBs and other lubricants and oils and cleaning and/or degreasing operations that used organic-based solvents.

3.14.4 Barn No. 5 Petroleum Release

Barn No. 5 was formerly located on the south-central portion of the RVAAP close to the Post No. 6 gate. A letter dated May 13, 1964, documents the release of approximately 20 barrels of gasoline to the ground surface inside the south fence near former Barn No. 5. Reportedly, the release occurred from a buried Standard Oil of Ohio (SOHIO) pipeline that runs parallel to the RVAAP fence line at this location. The pipeline is located within a 12-ft easement on RVAAP property at the release location. This release is addressed by CC RVAAP-71.

The historical petroleum release at this location may have affected the soil and/or groundwater quality on the installation property. The potentially affected area comprises approximately 85,000-sq-ft and includes the footprint of the former barn area and the land between the former barn and the fence line, which lies roughly 60 feet within the RVAAP property in this area. Potential COPCs are VOCs, SVOCs, and lead.

3.14.5 Facility-Wide Underground Storage Tanks (USTs)

Installation records document the former presence and use of 45 underground storage tanks (USTs; CC RVAAP-72) at the RVAAP. Approximately 34 of the USTs were installed in 1941, with the remaining USTs installed between 1941 and 1981. The USTs were used for the storage of gasoline, diesel fuel, No. 5 heating oil, and No. 6 fuel oil. When not in use, the USTs were reportedly filled with potassium dichromate to prevent corrosion. Readily available records suggest that nearly all of the USTs have been closed by removal, and the tanks have been scrapped.

Closure documents and official tank status records have not been obtained for most of the USTs. As such, additional record searches are required to further characterize the USTs. It is anticipated that a small percentage of the facility USTs may not have accomplished sufficient closure per State requirements and that additional assessment may be warranted. Petroleum-impacted soils and/or groundwater may exist at the former UST sites.

3.14.6 Facility-Wide Coal Storage

Installation records document the former presence of 17 coal storage locations at RVAAP, all of which are included in CC RVAAP-73. Coal was historically used to fuel powerhouses and various other buildings at the site. Typically, coal storage consisted of placing the coal on the ground surface as surface piles or in railcars adjacent to the subject buildings. The total area of potentially impacted media associated with the coal is approximately 222,500-sq-ft (about 5 acres). Coal storage occurred at the following locations at RVAAP:

1) Load Line 1 Powerhouse
2) Load Line 2 Powerhouse
3) Load Line 4 Powerhouse
4) Load Line 12 Powerhouse
5) Building F-15
6) Building F-16
7) Atlas Scrap Yard
8) North Line Road Coal Tipple
9) Sand Creek Coal Tipple
10) East Classification Yard Round House
11) Administration Area
12) Depot Area Building U-5
13) Depot Area Building U-14
14) Fuze and Booster Road Powerhouse No. 5
15) Fuze and Booster Road Inert Storage No. 2F-N21
16) Fuze and Booster Service Road Powerhouse
17) Area 6 Inert Storage

Available historical aerial photographs and site observations indicate that coal residue may still remain on or at the ground surface at the above locations. As such, the surface soils may be impacted by typical coal contaminants (e.g., PAHs, metals).

3.14.7 Building 1034 Motor Pool Hydraulic Lift

An in-ground hydraulic floor lift system located at Building 1034 has been identified and included in CC RVAAP-74. The hydraulic floor lift system is depicted in a 1969 drawing as a twin-post lift system constructed of metal. The below-grade system consists of a cast-in-concrete L- shaped pit measuring approximately 12-ft-long by 4-ft-long by 3-ft-wide by 4-ft-high. The pit is reportedly buried at depths ranging from 4 to 8 feet below ground surface (bgs). The twin-post lift reportedly has a clearance of 6 feet between the floor surface and the bottom of the lift (height in the air). The floor lift system remains in place and has reportedly exhibited a slow leak of hydraulic fluids for an extended period of time. The COPCs associated with the floor lift system are total petroleum hydrocarbons (TPH), PAHs, and PCBs.

3.14.8 George Road STP Mercury Spill

This CR site (CC RVAAP-75) is a sewage treatment plant (STP) that was closed in 1993. It was used to treat industrial and residential effluent, including pink water from the production lines. Mercury from equipment bearings in the treatment plant leaked into the sewage stream. At least a quart of mercury from a collection jar that was dropped onto the floor was also released through the floor drain of the plant. There is a high probability that mercury contamination still persists in the soils at the outfalls and possibly at other leak points in the system. Likely points of contamination will be located and sampled based upon existing drawings.

The STP maintained Ohio NPDES permit (#31000000BD), which allowed discharge to Outfall No. 002 (to the adjacent receiving stream). The STP was gravity-fed and consisted of two Imhoff tanks, two trickling filters, and a clarifier. Sludge was dried in a greenhouse structure and spread over the ground surface at the old hay fields located at the corner of Slagle and Newton Falls Roads. The design capacity was 350,000 gallons per day (gpd). It was reported that approximately 1,200-cu-ft of sludge was spread every 3 years. The NPDES permit was maintained until 1993 when the facility ceased operations.

3.14.9 Depot Area

The Depot Area of RVAAP (CC RVAAP-76) consists of buildings used for demilitarization in the 1950s and a waste oil storage tank. The steel 400-gal aboveground storage tank (AST) sat on crushed slag next to the motor oil storage shed located between Depot Buildings U-5 and U-4. Waste oil from the motor pool area was stored in the AST pending periodic removal by an oil reclaimer. The AST was in operation from 1983 through 1993. In 1993, the contents of the AST were removed, and the tank remained inactive until its removal (after 1996). The soils are stained beneath and around the former tank location.

According to a document found in the historical records in January 2009, demilitarization of a variety of munitions occurred in buildings at the Depot Area in the 1950s. Although the document only provided the dates and types of munitions that were demilitarized, it was common for such work at other locations on the installation to result in the release of explosives and propellants outside of the doors and at the outfalls of floor drains. These contamination points can be easily located at the existing buildings and from drawings of buildings that have been demolished.

3.14.10 Building 1037 Laundry Wastewater Sump

This CR site (CC RVAAP-77) comprises a former 5,765-gal below ground concrete sump located on the north side of Building 1037. The unit was previously used as a settling tank for the discharge of laundry rinse water. Wash water was emptied approximately 12 times during every 8 hours of operation and rinsed three times each 8 hours. The wash water entering the tank prior to the rinse water discharge had sufficient settling time so that the increase in rate from the rinse water did not disturb the settled matter on the tank bottom. Rinse water was then sent to CC RVAAP-75 (George Road Sewage Treatment Plant). Wastes of concern are TNT and RDX. The concrete wastewater sump was removed in 2009.

3.14.11 Quarry Pond Surface Dump

The Quarry Pond Surface Dump (CC RVAAP-78) contains an approximately 8,750-sq-ft (250-ft by 35-ft) area where dumping had previously taken place along a small topographic ridge located north and northeast of the northern-most quarry pond within the Fuze and Booster Quarry. The debris pile appears to have an average thickness of about 5 ft (where present). Contents of the debris pile appear to contain potential asbestos-containing materials (ACM), construction debris, scrap metal, and other unknown materials. One 55-gal metal drum (contents unknown) is located on the ground surface within this area. A former burn location is also present along the northeastern portion of the surface dump and is characterized by ground charring.

The Quarry Pond Surface Dump appears to be a possible northern extension of the existing Fuze and Booster Quarry AOC (RVAAP-16), which operated from 1945 through 1993. Prior to 1976, the quarry was reportedly used for open burning and as a landfill. The debris from the burning/landfill was reportedly removed during pond construction. In 1998, the Fuze and Booster Quarry site expanded to include three other shallow settling ponds and two debris piles. Constituents of concern include explosives, propellants, VOCs, SVOCs, metals, asbestos, and PCBs in soil and groundwater. A site investigation was conducted at the Quarry Pond Surface Dump in November 2011, and a written report of findings will be available in 2012.

3.14.12 DLA Ore Storage Sites

Various ores were historically stored (stockpiled) at this facility for the GSA. The DLA, Defense National Stockpile Center (DNSC), leased space at the Ravenna facility for the storage of the ore materials on the ground and in ASTs, which are addressed by CC RVAAP-79. The ASTs were referred to as strategic material tanks. Many of the ASTs were constructed without floors; therefore, the ores were allowed to make direct contact with the underlying soils. The GSA materials stored in strategic material tanks included the following: magnesium, kyanite, antimony sulfide, asbestos (raw), cobalt rutile sand, cobalt zircon sand, monazite sand, nickel cathodes, rutile sand, silicon carbide, talc, and zircon sand ore. The monazite sand contained radioactive element thorium 232. The following GSA materials were stockpiled on the ground surface: brass ingots, chemical chrome ore, copper ingots, ferrochrome ore, ferromanganese ore, and metallurgical manganese ore.

Ore storage occurred at the following primary locations on the Ravenna property: DLA Load Line 3 Tank Storage and Building 803, DLA Route 80 Tank Farm, DLA Main Ore Pile Storage Area, DLA Area 8 Inert Storage, Building 841, and DLA Area 2 Ammunition Storage Area. Approximately 333,582-sq-yds (about 68.92 acres) of potentially impacted media are associated with the ore storage. Available aerial photographs and site observations indicate that ores still remain on the ground surface at several locations. As such, the surface soils may be impacted by these materials, as well as sediment, surface water, and groundwater. Metals are the primary COPCs.

This site also includes the former Ore Pile Retention Pond (RVAAP-31) constructed in the mid 1950s. The pond was constructed to control potentially-contaminated surface water runoff from the adjacent manganese and chrome stockpiles from entering a receiving stream. There remains the potential for releases of contaminants from this unit to the surrounding soils, groundwater, surface water, and sediment.

3.14.13 Group 2 Propellant Can Tops

Propellant can tops were identified at the ground surface at the southern end of the former Group 2 Ammunition Storage Area. The approximately 539,572-sq-ft area (12.4 acres) is addressed by CC RVAAP-80. The ground surface has been disturbed and contains hummocks (mounds) ranging in height from 1 to 2 feet throughout. Historical knowledge and photographs indicate the site was formerly a level-graded area used for the storage of inert materials. The can tops were observed by OHARNG trainees in fall 2008 in the vegetative area located immediately south of the ammunition storage magazines in the vicinity of the railroad spur lines.

As a result, the Louisville District USACE performed an initial geophysical survey of the southern area ground surface. Results of the initial investigation revealed multiple magnetic anomalies in the surface and near surface soils. On-site UXO personnel visually identified the surface anomalies as propellant can lids or tops. A site investigation was conducted at the Group 2 Propellant Can Tops Area in 2011, and a written report of findings titled "*Final Investigation Report for the Compliance Restoration Site CC-RVAAP-80, Group 2 Propellant Can Tops and Other Environmental Services*" will be available in February 2012.

3.14.14 Former Buildings 1031 and 1039

Former Buildings 1031 and 1039 (CC RVAAP-83) consist of the former Hospital Building and former Laboratory Building, respectively. Both buildings were located within the Administration Area of the former RVAAP facility.

Building 1031 - Former Hospital Building

The west end of the Hospital Building included a gauge lab. The gauge lab was used for the development of large scale photos for a period of about 1.5 years in the early 1970s after the laboratory at Building 1039 was closed.

Site-related constituents (SRCs) of concern are related to the former generation of x-ray acid/silver mix solutions and common hospital wastes. The composition of x-ray acids is unknown; however, they likely contain lead and radioactive materials. The hospital wastes typically consist of infectious materials containing pathogens, sharps, pathological tissues, and pharmaceuticals. The potential historical disposal of these materials through the sanitary waste system is of environmental concern. The historical sanitary lines were constructed of clay pipe, and failure of clay pipe is common. Potential SRCs for the sanitary system at the former Hospital Building are VOCs, SVOCs, and Target Analyte List (TAL) metals.

Building 1039 - Former Laboratory Building

The approximately 16,500-sq-ft former Laboratory Building contained three powder test rooms for the routine analyses of lead azide, mercury fulminate, and percussion element mixes. The laboratory was used for the testing of Load Line materials. During operations, the building contained and operated a photography laboratory, a chemistry laboratory, and a medical x-ray facility. The photo laboratory was historically used for all large-scale photo development activities until its closure in the early 1970s.

Waste x-ray acid/silver mix solutions were reportedly treated as described above. The Defense Property Disposal Organization (DPDO)/Defense Reutilization and Marketing Office (DRMO) termed the waste as a reclaimed precious metal resource.

The laboratory building was demolished by Lakeshore Engineering Services, Inc., between May 2006 and July 2007. Following demolition, all unpainted and uncontaminated brick and concrete was crushed and recycled offsite. The basement of Building 1039 was filled with clean soil and was then seeded with grass seed. There was no regulatory review of the work conducted.

Site-related constituents of concern are related to the former generation of x-ray acid/silver mix solutions, and the laboratory analysis of powder test room materials (lead azide, mercury fulminate), percussion element mixes, paints, shellac, metals, fuels, and tapes or adhesives. The potential historical disposal of these materials through the sanitary waste system is of environmental concern. Potential SRCs for the sanitary system at the former Laboratory Building are VOCs, SVOCs, TAL metals, explosives, and propellants.

SECTION 4
RI/FS TASKS

4.1 Project Planning

Scoping is the initial planning phase of site remediation, and is begun, at least informally, as part of the funding allocation and planning process. Paramount to the success of the project is consensus among the lead and support agencies to 1) identify the types of actions that may be required to address site problems; 2) identify whether interim actions are necessary or appropriate to mitigate potential threats, prevent further environmental degradation, or rapidly reduce risks; and 3) identify the optimal sequence of site actions and investigative activities.

Once a general site management approach has been agreed upon, the next step is to scope the project and develop specific project plans related directly to the establishment of DQOs, such as:

- Determining the types of decisions to be made.
- Identifying the type and quality of DQOs needed to support those decisions.
- Describing the methods by which the required data will be obtained and analyzed.
- Preparing project plans to document methods and procedures.

Specific activities conducted during project planning include:

- Meeting with lead agency, support agency, and contractor personnel to discuss site issues and assign responsibilities for RI/FS activities.
- Collecting and analyzing existing data to develop/refine the conceptual site model (CSM).
- Initiating limited field investigations to address data gaps to the CSM.
- Identifying preliminary RAOs.
- Preliminarily identifying Applicable or Relevant and Appropriate Requirements (ARARs) that apply to site characterization and site remediation.
- Determining data needs and the level of analytical and sampling certainty.
- Identifying the need for treatability studies.
- Designing a data collection program.
- Developing a work plan.
- Identifying and documenting health and safety protocols.
- Developing a community relations plan.

4.1.1 Project Meeting

A meeting will be held at RVAAP involving key management from the Ohio EPA, USACE, EQM, OHARNG, and BRAC to allow key personnel to become involved in initial planning decisions and give them the opportunity to discuss any special concerns that may be associated with the site. Furthermore, this meeting shall set a precedent for the involvement of key personnel periodically throughout the project. Additional attendees may include contractor personnel who will be involved with the RI/FS activities and may perform risk assessment or modeling tasks.

4.1.2 Evaluation of Existing Data

As mentioned previously, the RVAAP has been the focus of multiple environmental-related investigations during the past 30 years. A brief summary of these investigations is provided in Section 1.3 of the *Facility-Wide Sampling and Analysis Plan for Environmental Investigations at the Ravenna Army Ammunition Plant, Ravenna, Ohio* (SAIC, 2001) and Section 1.4 of the *Facility-Wide Groundwater Monitoring Program Plan* (USACE, 2004). Additional investigation activities will be conducted at the site in support of the RI/FS in 2011 and 2012.

EQM will conduct a review of historical studies and monitoring activities at RVAAP in order to coordinate the facility groundwater investigation with all other relevant investigations conducted to date. This will include the review of documents such as the *FY2011 RVAAP Installation Action Plan* (USACE, 2011) and the *Draft 2010 Addendum to the Facility-Wide Groundwater Monitoring Program Plan*. EQM will also work with other facility contractors, as appropriate, to review data that they may have generated during past or recent investigation/remediation activities. EQM will prepare isoconcentration maps for key COPCs at the site to illustrate the extent of impact, potential source areas, and plume configurations in the affected aquifers.

In addition, EQM will consider risk management methods to address common contaminants in groundwater that may be attributable to natural sources, such as arsenic and manganese. These methods will include the use of updated facility-wide groundwater background values and research into other state of Ohio studies on quality of potable groundwater supplies. Furthermore, EQM will assess the work conducted by the Shaw Group for the geochemical evaluation of metals and the ongoing study being conducted by the U.S. Geological Survey (USGS) on anions, cations, trace elements, and isotopes in groundwater. Although the Shaw study was not accepted by the Ohio EPA and USACE, the Shaw and USGS studies may provide input into the origination of certain common contaminants in groundwater (i.e., naturally occurring contaminants versus those generated from site operations). No data from the Shaw study will be incorporated into the RI without prior concurrence from the Ohio EPA and USACE.

EQM will also investigate the impact and potential origin of bis(2-ethylhexyl)phthalate in some monitoring wells at the site. Specifically, groundwater samples will be collected from a newly installed stainless steel monitoring well and compared to groundwater samples collected from a polyvinyl chloride (PVC) well with known phthalate contamination in the same area to assess whether the presence of phthalates may be the result of leaching from the PVC screen and casing or from other causes. EQM will prepare isoconcentration maps presenting the extent of phthalate impact at the site.

4.1.3 Development of Conceptual Site Model

The CSM is the cornerstone for planning a field sampling effort. It reflects an understanding of the known or suspected site conditions and serves as the basis for making decisions about sample locations, frequencies, and required analytes. A preliminary CSM for RVAAP has been developed using available information and is presented in Section 4.2.1 of the *Final Facility-Wide Sampling and Analysis Plan for Environmental Investigations, Ravenna Army Ammunition Plant, Ravenna, Ohio* (FWSAP; SAIC, 2011). The key elements of the preliminary CSM are:

- Surface geology across RVAAP is highly variable with overburden thicknesses ranging from 5 feet in the east to 40 feet in the west. Bedrock outcroppings have been noted in the southeastern portion of RVAAP. The till is reported to be somewhat impermeable with hydraulic conductivities of 10^{-6} cm/sec or greater.
- A buried glacial valley filled with sand and gravel potentially exists in the central portion of the property, trending from southwest to northeast.
- The variable nature of the till combined with the topography results in a complex surface water system comprising several water courses and ponds.
- Because of the relatively impermeable nature of the till, a large percentage of storm water is expected to exit the facility via the surface drainages.
- Groundwater is present in the unconsolidated sediment and underlying bedrock with an overall generalized flow to the east; however, the unconsolidated zone shows numerous local variations that are influenced by topography and drainage patterns.
- Sand and gravel aquifers associated with buried valleys are a major source of potable water. Local variations in flow direction suggest groundwater in the unconsolidated deposits is generally in direct hydraulic communication with surface water, and surface water drainage ways may act as discharge locations. In addition, topographic ridges between drainage features serve as groundwater divides for shallow groundwater.
- Bedrock formations in the area are also a source of potable water, with the Sharon Conglomerate being the best producer. Other water-producing formations include the Connoquenessing Sandstone (where present) and Homewood Sandstone.
- Major COPCs include explosive-related chemicals, propellants, and metals. Additional chemicals, including PCBs, VOCs, PAHs, phthalates, pesticides, and manganese, have been identified at some AOCs. With the exception of some VOCs and pesticides, most of the COPCs are relatively insoluble, tend to adsorb to soil particles rather than dissolve into water, and are relatively long-lived.
- Currently, public access to the facility is controlled and may include annual controlled deer hunts, wildlife trapping, firewood permits, and occasional guided public tours. OHARNG uses more than 20,000 acres of RVAAP as a training site. The most likely pathway of exposure to offsite receptors is via chemical migration through the surface water and groundwater systems.

Figure 4-1 presents a graphical representation of the CSM for RVAAP and shows the potential sources, release mechanisms, pathways, and receptors at the site.

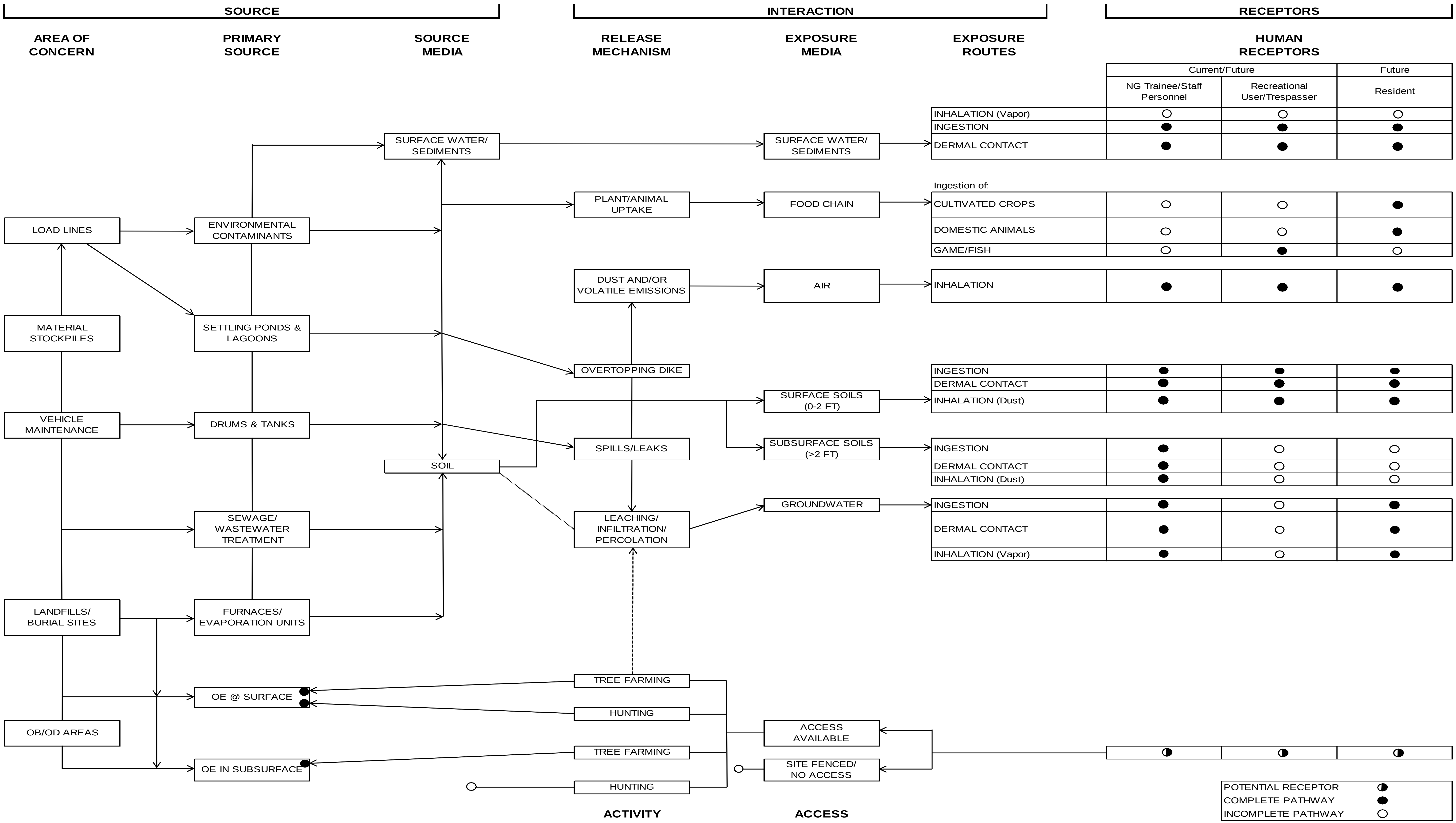


Figure 4-1. Conceptual Site Model for RVAAP

4.1.4 Key Assumptions

Based on the site-wide groundwater CSM, potential contaminant transport via the groundwater pathway can occur in the shallow unconsolidated deposits and/or the bedrock aquifer(s). Generalized groundwater flow is easterly in the till and bedrock aquifers; however, flow in the unconsolidated sediments is influenced by topography and surface water drainage. As a result, groundwater occurring in the unconsolidated deposits near surface water drainageways eventually discharges to the surface streams and may have local flow directions that vary from the regional hydraulic gradient.

It is reported for a large portion of the site that the hydraulic heads in the underlying bedrock aquifer are greater than the hydraulic heads in the unconsolidated deposits. This indicates that there is little potential for downward migration of contaminants to the bedrock aquifer. The exception to this observation occurs in the eastern portion of the RVAAP where the potentiometric surfaces of the unconsolidated and bedrock aquifers are nearly identical, suggesting potential hydraulic communication. A key assumption of the FWGWMP is that both unconsolidated wells and bedrock wells are available to detect groundwater impacts in the far eastern portion of RVAAP.

Several of the AOCs are monitored exclusively by bedrock wells. The following AOCs are monitored exclusively by bedrock wells: Load Lines 1, 2, 3, 7, 9, Building 1200, C Block, and Ramsdell Quarry Landfill. For these areas it is assumed that the unconsolidated deposits do not yield sufficient quantities of water to justify well completion in this zone. It is further assumed that the bedrock wells are adequate to detect potential groundwater impacts from historical activities at the AOCs.

Because of low permeability and lack of areal extent, the unconsolidated aquifer is important only on a localized scale, with the exception of the glacial outwash in the eastern portion of RVAAP. Consequently, unconsolidated wells selected for site-wide monitoring focus on local areas immediately downgradient of potential AOCs.

The potentiometric surfaces for the unconsolidated and Sharon aquifers merge just east of Load Line 1. Following the installation of additional monitoring wells at RVAAP, static water levels and flow directions will be further evaluated to determine whether potential offsite migration pathways have been captured by the perimeter wells in this area of the site.

4.1.5 Identification of Data Needs and Data Quality Objectives

Data quality objectives are qualitative and quantitative statements that specify the overall quality of data required in support of the various remedial action response activities (e.g., RI, FS, risk assessments, and preliminary design). They vary based on site conditions and data uses; therefore, it is undesirable to establish uniform DQOs for all RI/FS work. The DQOs are established as part of project scoping and planning.

Data quality objectives should be specified for each data collection activity associated with the remedial investigation. Most of these activities will take place during the RI, including the collection of supplemental data for the FS, such as treatability studies. As revised data needs are identified during the RI process, new DQOs are developed. In fact, the establishment of DQOs is an interactive and iterative process, whereby all DQOs are continually reviewed and reevaluated during the remedial process. All investigation activities should be conducted and documented in a manner that ensures sufficient data of known and acceptable quality are collected to support sound, defensible decisions governing remedial action selection.

The DQOs for this RI/FS project were developed prior to conducting investigative activities to ensure that the data generated during the execution of the analytical program are of appropriate quality to support the anticipated end use of the data. Data quality objectives seek to ensure that the right type, amount, and quality of data are collected to accomplish the objectives of the project.

The USEPA has a seven-step process for establishing DQOs as published in *Guidance for the Data Quality Objective Process* (USEPA, 2000). Each of the seven steps was applied in determining the DQOs for the RI/FS as described below.

Step 1: Problem Statement - The first step in developing DQOs is to define the problem that has initiated the study. For the purposes of this RI/FS, the problem statement is: "Do COPCs in groundwater pose a risk to future land users or potential offsite receptors?"

Step 2: Identify the Decision - The second step in establishing DQOs is to identify the decision statement that the study will attempt to resolve. The potential for human health risk depends upon the presence of three elements: a source (presence of COPC); a receptor or person; and an interaction between the source and receptor (such as contact or ingestion). There is no risk if any one of these three elements is missing. Risk will be assessed by identifying and quantifying (where applicable), each of the three elements. Are COPCs present? Are receptors present? Is there a possible interaction? Potential contaminant concentrations detected in groundwater will be compared to background levels, Regional Screening Levels (RSLs), Facility-Wide Cleanup Goals (FWCUGs), and/or Maximum Contaminant Levels (MCLs) as a screening level indication of risk. Based on site-specific data, response alternatives will be identified, evaluated, and selected for the protection of human health at the site.

Step 3: Identify Inputs to the Decision - The primary data inputs for the RI/FS evaluation include the types, locations, contaminant levels, and affected water-bearing zones identified at the site and the anticipated future land use of the site.

Step 4: Define the Study Boundaries - RI study boundaries are the geographical boundaries of the RVAAP where review of the historical data indicated potential past operational activity. For Facility-Wide groundwater, the perimeter fence defines the current RI study boundary; however, the actual RVAAP property boundary extends beyond (and outside) the perimeter fence line.

Anthropogenic constraints (such as fences, roads, buildings, and power lines) and non-anthropogenic constraints (such as cultural and environmentally sensitive areas, terrain, and geologic materials) may limit access throughout RVAAP, although, historically, these obstacles have generally been overcome.

Step 5: Develop a Decision Rule - The purpose of the decision rule is to define the parameter of interest, specify the action level, and integrate DQO outputs into a single statement that describes a logical basis for choosing among alternative response actions.

- Chemicals of Potential Concern - If COPCs are present, receptors are present, and there is possible interaction, then appropriate response alternatives must be evaluated. Response alternatives will then be selected based on considerations of effectiveness, implementability, and cost.

Step 6: Specify Tolerable Limits on Decision Errors - Appropriate COPC analytical quality levels are identified in detail in the Quality Assurance Project Plan (QAPP).

Step 7: Optimize the Design for Obtaining Data - The purpose of this step is to identify a resource-effective data collection design for generating data that are expected to satisfy the DQOs. The identification of sampling requirements involves specifying the sampling design; the sampling method; sample numbers, types, and locations; and the level of sampling quality control. This information is provided in the *Final Facility-Wide Field Sampling Plan for Environmental Investigations, Ravenna Army Ammunition Plant, Ravenna, Ohio* (SAIC, 2011) and supplemental addenda specific to Sections 4.3.3 and 4.3.5. Data quality requirements specified for sampling and analysis include precision, accuracy, representativeness, completeness, and comparability and are presented in the *Facility-Wide Quality Assurance Project Plan for Environmental Investigations, Ravenna Army Ammunition Plant, Ravenna, Ohio* (FWQAPP; SAIC, 2011).

Facility-wide data quality objectives have been developed for the site and are discussed in more detail in Section 3.1.1 of the FWGWMP Plan. The FWGWMP-specific DQOs are:

- Assess hydrogeologic conditions and groundwater quality in shallow and deep groundwater using monitoring wells of known integrity.
- Provide a comparative assessment of hydrogeologic characteristics and groundwater quality in both unconsolidated and bedrock monitoring wells to evaluate potential hydraulic connectivity.
- Characterize groundwater chemical quality and examine potential contaminant migration via the facility-wide monitoring well network.
- Conduct analysis of chemical data from the network to form a basis for remedial decision-making.

4.1.6 Identification of Data Uses and Data Types

Data use categories for Facility-Wide groundwater at RVAAP include the following:

Site Characterization: Data are used to determine the nature and extent of contamination and site conditions. This use is usually very data intensive. The goal is to maximize the quality, including completeness of the data, while minimizing the collection of superfluous data.

Risk Assessment: Data are used to evaluate the threat posed by the site to human health and the environment. This task tends to require data of the highest quality, and often of the lowest detection limits.

Fate-and-Transport Modeling: Data from the RI/FS process will be used to assess the migration of contaminants through the pathways presented in the CSM.

Evaluation of Alternatives: Data are used to evaluate various remedial technologies and alternatives for site remediation. The data must be good enough to distinguish between different alternatives, to evaluate the likely effectiveness of the alternatives, and to cost the alternatives for comparison purposes.

Engineering Design of Alternatives: Data from the RI/FS can be used to develop conceptual and actual remedial designs. Although that task is beyond the scope of the current work plan, collection of data useful to that task should be considered throughout the RI/FS process, especially if the data can be collected for significantly less cost during the RI/FS.

Health and Safety: Monitoring data from the field during RI/FS data collection activities is used to establish and assure compliance with a level of protection necessary for on-site contractors. Since these contractors often have a high potential for directly contacting contaminants during the investigation, it is critical that the health and safety of their environment be monitored.

4.1.7 Data Quality Needs

As part of the RI process and following review of the existing data, evaluation of the CSM, and a preliminary risk evaluation, EQM will identify key data gaps to be addressed for developing a strategy to mitigate facility-wide groundwater impacts. Potential data gaps include:

- Evaluation of preferential flow zones/exit pathways in the unconsolidated zone and Sharon Member, via the Hinkley Creek area off of RVAAP, via an unnamed tributary through Load Line 4, and via key watershed or sub-watershed exit zones (e.g., Sand Creek and major tributaries).
- Potential fracture/aperture density analysis on existing bedrock cores to evaluate the leakage potential of the aquifer.
- Evaluation of potential source areas that have not previously been assessed and their contribution to facility-wide contaminant loading, if any.
- Additional geochemical and geotechnical analyses in support of the hydrogeologic system and fate-and-transport models, including permeability tests on unconsolidated and bedrock cores, short-term pump tests to identify early attainment zones and hydraulic connectivity between aquifers, and assessment of hexavalent chromium and chemical warfare breakdown products in groundwater to fully characterize groundwater quality beneath the facility.

4.1.8 Identification of Preliminary Remedial Action Objectives and Potential Remedial Alternatives

Work conducted pursuant to the ROD will include development of remedial action objectives. These RAOs may be a combination of applicable federal and state ARARs, published guidelines, and/or risk-based cleanup levels. The Groundwater Stakeholder Working Group will participate in developing these RAOs.

In identifying RAOs, the following will be considered:

1. Evaluation and analysis of information and data.
2. All actions to be evaluated shall consider current and reasonably foreseeable future land uses.

Remedial action objectives for Facility-Wide groundwater at RVAAP will comprise medium-specific goals for protecting human health and the environment. The RAOs will be developed based on the contaminants of concern, potential exposure route(s) and receptor(s), and an acceptable contaminant level or range of levels for each exposure route.

Once existing site information has been analyzed and an understanding of the potential site risks has been reached, EQM, with input from the stakeholders, will review and, if necessary, refine the remedial action objectives that have been identified by Ohio EPA for groundwater. The revised RAOs will be documented in a technical memorandum and subject to Ohio EPA approval. EQM will then identify a preliminary range of broadly defined potential remedial action alternatives and associated technologies. The range of potential alternatives shall encompass, where appropriate, alternatives in which treatment significantly reduces the toxicity, mobility, or volume of the waste; alternatives that involve containment with little or no treatment; and a no action alternative. This analysis will be presented in a RAO technical memorandum. Presently, the anticipated RAO(s) for Facility-Wide groundwater at RVAAP is Long-Term Monitoring (LTM)/MNA or groundwater resource use controls. However, it should be noted that all RAOs will be considered with respect to Facility-Wide Groundwater.

The memorandum will include a preliminary identification of potential state and federal ARARs (chemical-specific, location-specific, and action-specific) to assist in the refinement of RAOs. EQM will also identify other advisories, criteria, guidance, and other “to be considered” initiatives. EQM will update ARAR identification in the technical memorandum during implementation of the DFFOs as site boundaries, conditions, contaminants of concern, and RAOs become better defined.

4.1.9 Identification of Treatability Studies

If remedial actions involving treatment are identified for the Facility-Wide groundwater at RVAAP, then the need for treatability studies will be evaluated as early as possible in the RI/FS process due to the potential length of time required to complete pilot testing or alternative studies.

The initial activities of treatability testing include researching other potentially applicable data, designing the study, and procuring vendors and equipment. As appropriate, these activities shall occur concurrently with site characterization efforts so that if it is determined that a potential technology is not feasible, planned treatability activities for this technology can be terminated.

4.1.10 Preliminary Identification of ARARs

A preliminary identification of potential ARARs and To Be Considered (TBC) information in the scoping phase can assist in initially identifying remedial alternatives and is useful for initiating communications with the support agency to facilitate the identification of ARARs. Due to the iterative nature of the RI/FS process, ARAR identification continues throughout the RI/FS as a better understanding is gained of site conditions, site contaminants, and RAOs.

ARARs may be categorized as chemical-specific requirements that may define acceptable exposure levels and be used in establishing preliminary remediation goals; as location-specific requirements that may set restrictions on activities within specific locations such as floodplains or wetlands; and as action-specific, which may set controls or restrictions for particular treatment and disposal activities related to the management of hazardous wastes.

Potential chemical- and location-specific ARARs are identified on the basis of the compilation and evaluation of existing site data. Preliminary chemical-specific ARARs are presented in Tables 4-1 and 4-2 and are primarily tied to the Safe Drinking Water Act and the Clean Water Act, and preliminary location-specific ARARs are described in Table 4-3. A preliminary evaluation of potential action-specific ARARs may also be made to assess the feasibility of remedial technologies being considered. Other federal and state criteria, advisories, and guidance and local ordinances will also be considered, as appropriate, in the development and refinement of RAOs. A list of action-specific ARARs and TBCs will be identified during development of remedial alternatives in the Feasibility Study.

4.1.11 Preparation of Plans

There are several deliverables required for all RI/FS projects in which field investigations are planned including a Work Plan, Sampling and Analysis Plan (SAP), HASP, and a Community Relations Plan (CRP).

4.1.11.1 Work Plan

The work plan documents the decision and evaluation made during the scoping process and presents anticipated future tasks. This work plan was prepared in general accordance with the RI/FS Guidance and follows the key elements ascribed in the guidance document.

Table 4-1. Clean Level Lists For RVAAP

	unit	MCL	Reg9 PRG	RSL
Explosive/Propellants				
1,3,5-Trinitrobenzene	µg/L	NS	1100	1100
1,3-Dinitrobenzene	µg/L	NS	3.6	3.7
1,4-Dithiane	µg/L	NS	360	150
1,4-Oxathiane	µg/L	NS	NS	NS
2,4,6-Trinitrolouene	µg/L	NS	2.2	2.2
2,4-Dinitrotoluene	µg/L	NS	73	0.22
2,6-Dinitrotoluene	µg/L	NS	36	37
2-Amino-4,6-dinitrotoluene	µg/L	NS	NS	73
2-Nitrotoluene	µg/L	NS	0.049	0.31
3-Nitrotoluene	µg/L	NS	120	3.7
4-Amino-2,6-Dinitrotoluene	µg/L	NS	NS	73
4-Nitrotoluene	µg/L	NS	0.66	4.2
HMX	µg/L	NS	1800	1800
Nitrobenzene	µg/L	NS	3.4	0.12
Nitrocellulose	mg/L	NS	NS	110000
Nitroglycerin	µg/L	NS	4.8	3.7
Nitroguanidine	µg/L	NS	NS	3700
PETN	µg/L	NS	NS	NS
RDX	µg/L	NS	0.61	0.61
Tetryl	µg/L	NS	360	150
Thiodyglycol	µg/L	NS	NS	1100
Inorganics				
Aluminum	µg/L	200	36000	37000
Antimony	µg/L	6	15	15
Arsenic	µg/L	10	0.045	0.045
Barium	µg/L	2000	2600	7300
Beryllium	µg/L	4	73	73
Cadmium	µg/L	5	18	18
Calcium	µg/L	NS	NS	NS
Chromium	µg/L	100	55000	16000
Cobalt	µg/L	NS	730	11
Copper	µg/L	1300	1500	1500
Cyanide	mg/L	0.2	0.73	0.73
Hexavalent Chromium	µg/L	NS	110	0.031
Iron	µg/L	300	11000	26000
Lead	µg/L	15	NS	NS
Magnesium	µg/L	NS	NS	NS
Manganese	µg/L	50	880	880

Table 4-1 (continued). Clean Level Lists For RVAAP

	unit	MCL	Reg9 PRG	RSL
Mercury	µg/L	2	11	0.57
Nickel	µg/L	NS	730	730
Nitrate as Nitrite	mg/L	1	1	3
Potassium	µg/L	NS	NS	NS
Selenium	µg/L	50	180	180
Silver	µg/L	100	180	180
Sodium	µg/L	NS	NS	NS
Thallium	µg/L	2	2.4	NS
Vanadium	µg/L	NS	36	180
Zinc	µg/L	5000	11000	11000
Pesticides & PCBs				
4,4'-DDD	µg/L	NS	0.28	0.28
4,4'-DDE	µg/L	NS	0.2	0.2
4,4'-DDT	µg/L	NS	0.2	0.2
Aldrin	µg/L	NS	0.004	0.004
alpha-BHC	µg/L	NS	0.011	0.011
alpha-Chordane	µg/L	NS	NS	NS
beta-BHC	µg/L	NS	0.037	0.037
delta-BHC	µg/L	NS	NS	NS
Dieldrin	µg/L	NS	0.0042	0.0042
Endosulfan I	µg/L	NS	0.022	0.022
Endosulfan II	µg/L	NS	0.022	0.022
Endosulfan sulfate	µg/L	NS	NS	NS
Endrin	µg/L	2	11	11
Endrin aldehyde	µg/L	NS	NS	NS
Endrin ketone	µg/L	NS	NS	NS
Gamma-BHC	µg/L	0.2	0.052	0.061
gamma-Chlordane	µg/L	NS	NS	NS
Heptachlor	µg/L	0.4	0.015	0.015
Heptachlor epoxide	µg/L	0.2	0.0074	0.0074
Methoxychlor	µg/L	40	180	180
Toxaphene	µg/L	3	0.061	0.061
PCB- 1016	µg/L	0.5	0.96	0.96
PCB- 1221	µg/L	0.5	0.034	0.0068
PCB- 1232	µg/L	0.5	0.034	0.0068
PCB- 1242	µg/L	0.5	0.034	0.034
PCB- 1248	µg/L	0.5	0.034	0.034
PCB- 1254	µg/L	0.5	0.034	0.034

Table 4-1 (continued). Clean Level Lists For RVAAP

	unit	MCL	Reg9 PRG	RSL
PCB- 1260	µg/L	0.5	0.034	0.034
VOCs				
1,1,1-Trichloroethane	µg/L	200	3200	9100
1,1,2,2-Tetrachloroethane	µg/L	NS	0.052	0.067
1,1,2-Trichloroethane	µg/L	5	0.2	0.24
1,1-Dichloroethane	µg/L	NS	810	2.4
1,1-Dichloroethene (total)	µg/L	7	340	340
1,2-Dibromoethane	µg/L	NS	0.0056	0.0065
1,2-Dichloroethane	µg/L	5	0.12	0.15
1,2-Dichloroethene (total)	µg/L	NS	NS	330
1,2-Dichloropropane	µg/L	5	0.16	0.39
2-Butanone	µg/L	NS	7000	7100
2-Hexanone	µg/L	NS	NS	47
4-Methyl-2-pentanone	µg/L	NS	NS	2000
Acetone	µg/L	NS	5500	22000
Benzene	µg/L	5	0.35	0.41
Bromochloromethane	µg/L	NS	NS	NS
Bromodichloromethane	µg/L	NS	0.18	0.12
Bromoform	µg/L	NS	8.5	8.5
Bromomethane	µg/L	NS	8.7	8.7
Carbon disulfide	µg/L	NS	1000	1000
Carbon tetrachloride	µg/L	5	0.17	0.44
Chlorobenzene	µg/L	10	110	91
Chloroethane	µg/L	NS	4.6	21000
Chloroform	µg/L	NS	0.17	0.19
Chloromethane	µg/L	NS	160	190
cis-1,2-dichloroethene	µg/L	70	61	370
cis-1,3-Dichloropropene	µg/L	NS	0.4	0.43
Dibromochloromethane	µg/L	NS	0.13	0.15
Ethylbenzene	µg/L	700	1300	1.5
m&p-xylenes	µg/L	NS	NS	1200
Methylene chloride	µg/L	5	4.3	4.8
o-xylene	µg/L	NS	NS	1200
Styrene	µg/L	100	1600	1600
Tetrachloroethene	µg/L	5	0.1	0.11
Toluene	µg/L	1000	720	2300
Total Xylenes	µg/L	10000	210	200
trans-1,2-dichloroethene	µg/L	100	120	110

Table 4-1 (continued). Clean Level Lists For RVAAP

	unit	MCL	Reg9 PRG	RSL
trans-1,3-Dichloropropene	µg/L	NS	0.4	0.43
Trichloroethene	µg/L	5	0.028	2
Vinyl chloride	µg/L	2	0.02	0.016
SVOCs				
1,2,4-Trichlorobenzene	µg/L	70	7.2	2.3
1,2-Dichlorobenzene	µg/L	600	370	370
1,3-Dichlorobenzene	µg/L	NS	180	NS
1,4-Dichlorobenzene	µg/L	75	0.5	0.043
2,2-oxybis (1-chloropropane)	µg/L	NS	NS	NS
2,4,5-Trichlorophenol	µg/L	NS	3600	3700
2,4,6-Trichlorophenol	µg/L	NS	3.6	6.1
2,4-Dichlorophenol	µg/L	NS	110	110
2,4-Dimethylphenol	µg/L	NS	730	730
2,4-Dinitrophenol	µg/L	NS	73	73
2,4-Dinitrotoluene	µg/L	NS	73	0.22
2,6-Dinitrotoluene	µg/L	NS	36	37
2-Chloronaphthalene	µg/L	NS	490	2900
2-Chlorophenol	µg/L	NS	30	180
2-Methylnaphthalene	µg/L	NS	NS	150
2-Methylphenol	µg/L	NS	1800	1800
2-Nitroaniline	µg/L	NS	110	370
2-Nitrophenol	µg/L	NS	NS	NS
3,3'-Dichlorobenzidine	µg/L	NS	0.15	0.15
3,4-Methylphenol	µg/L	NS	180	180
3-Nitroaniline	µg/L	NS	3.2	NS
4,6-Dinitro-2-methylphenol	µg/L	NS	NS	NS
4-Bromophenyl phenyl ether	µg/L	NS	NS	NS
4-Chloro-3-methylphenol	µg/L	NS	NS	NS
4-Chloroaniline	µg/L	NS	150	0.34
4-Chlorophenyl phenyl ether	µg/L	NS	NS	NS
4-Nitroanaline	µg/L	NS	3.2	3.4
4-Nitrophenol	µg/L	NS	NS	NS
Acenaphthene	µg/L	NS	370	2200
Acenaphthylene	µg/L	NS	NS	NS
Anthracene	µg/L	NS	1800	11000
Benzo(a)anthracene	µg/L	NS	0.092	0.029
Benzo(a)pyrene	µg/L	0.2	0.0092	0.0029
Benzo(b)fluoranthene	µg/L	NS	0.092	0.056

Table 4-1 (continued). Clean Level Lists For RVAAP

	unit	MCL	Reg9 PRG	RSL
Benzo(g,h,i)perylene	µg/L	NS	NS	NS
Benzo(k)fluoranthene	µg/L	NS	0.92	0.029
Benzoic acid	µg/L	NS	150000	150000
Benzyl alcohol	µg/L	NS	11000	3700
bis(2-Chloroethoxy)methane	µg/L	NS	NS	110
bis(2-Chloroethyl)ether	µg/L	NS	0.001	0.012
bis(2-Ethylhexyl)phthalate	µg/L	6.0	4.8	4.8
Butyl benzyl phthalate	µg/L	NS	7300	35
Carbazole	µg/L	NS	3.4	NS
Chrysene	µg/L	NS	9.2	2.9
Dibenzo(a,h)anthracene	µg/L	NS	0.0093	0.0029
Dibenzofuran	µg/L	NS	12	NS
Diethyl phthalate	µg/L	NS	29000	29000
Dimethyl phthalate	µg/L	NS	360000	NS
Di-n-butyl phthalate	µg/L	NS	NS	NS
Di-n-octyl phthalate	µg/L	NS	1500	NS
Fluoranthene	µg/L	NS	NS	1500
Fluorene	µg/L	NS	NS	1500
Hexachlorobenzene	µg/L	1	0.042	0.042
Hexachlorobutadiene	µg/L	NS	0.86	0.86
Hexachlorocyclopentadiene	µg/L	50	220	220
Hexachloroethane	µg/L	NS	4.8	4.8
Indeno(1,2,3-cd)pyrene	µg/L	NS	0.092	0.029
Isophorone	µg/L	NS	71	71
Naphthalene	µg/L	NS	6.2	0.14
Nitrobenzene	µg/L	NS	3.4	0.12
N-Nitroso-di-n-propylamine	µg/L	NS	9600	9600
N-Nitrosodiphenylamine	µg/L	NS	14	14
Pentachlorophenol	µg/L	1	0.56	0.56
Phenanthrene	µg/L	NS	NS	NS
Phenol	µg/L	NS	11000	11000
Pyrene	µg/L	NS	NS	1100
Perchlorates	µg/L	*	3.6	26

* On February 18, 2005, the USEPA established a Drinking Water Equivalent Level (DWEL) for Perchlorate, which is set at 24.5 ug/L.
MCL = Maximum Contaminant Level
PRG = Preliminary Remediation Goal. Note that PRGs are provided for historical information purposes only. The RSLs were developed to replace the PRGs in their entirety. PRGs have not been updated since 2004 and no longer represent the current technical and toxicological understanding of the chemical constituents.
RSL = Regional Screening Level
µg/L = microgram per liter.; NS = no standard/

Table 4-2. RVAAP Facility-Wide Background Criteria (SAIC, 2001b)

Media Units	Surface Soil (mg/kg)	Subsurface Soil (mg/kg)	Sediment (mg/kg)	Surface Water (µg/L)	Groundwater Bedrock Zone - Filtered (µg/L)	Groundwater Bedrock Zone - Unfiltered (µg/L)	Groundwater Unconsolidated Zone - Filtered (µg/L)	Groundwater Unconsolidated Zone - Unfiltered (µg/L)
Analyte								
Cyanide	0	0	0	0	0	0	0	0
Aluminum	17,700	19,500	13,900	3370	0	9410	0	0
Antimony	0.96	0.96	0	0	0	0	0	0
Arsenic	15.4	19.8	19.5	3.2	0	19.1	11.7	11.7
Barium	88.4	124	123	47.5	256	241	82.1	82.1
Beryllium	0.88	0.88	0.38	0	0	0	0	0
Cadmium	0	0	0	0	0	0	0	0
Calcium	15,800	35,500	5510	41,400	53,100	48,200	115,000	115,000
Chromium	17.4	27.2	18.1	0	0	19.5	7.3	7.3
Cobalt	10.4	23.2	9.1	0	0	0	0	0
Copper	17.7	32.3	27.6	7.9	0	17	0	0
Iron	23,100	35,200	28,200	2560	1430	21,500	279	279
Lead	26.1	19.1	27.4	0	0	23	0	0
Magnesium	3030	8790	2760	10,800	15,000	13,700	43,300	43,300
Manganese	1450	3030	1950	391	1340	1260	1020	1020
Mercury	0.036	0.044	0.059	0	0	0	0	0
Nickel	21.1	60.7	17.7	0	83.4	85.3	0	0
Potassium	927	3350	1950	3170	5770	6060	2890	2890
Selenium	104	105	107	0	0	0	0	0
Silver	0	0	0	0	0	0	0	0
Sodium	123	145	112	21,300	51,400	49,700	45,700	45,700
Thallium	0	0.91	0.89	0	0	0	0	0
Vanadium	31.1	37.6	26.1	0	0	15.5	0	0
Zinc	61.8	93.3	532	42	52.3	193	60.9	60.9

mg/kg = milligram per kilogram
µg/L = microgram per liter

Table 4-3. Selected Location-Specific Potential Applicable or Relevant and Appropriate Requirements

Location	Requirement	Prerequisite	Citation
Wetlands a/	Action to prohibit discharge of dredged or fill material into wetlands without permit.	Wetland as defined in U.S. Army Corps of Engineers regulations.	Clean Water Action Section 404; 40 CFR Part 230; 33 CFR Parts 320-330.
Within floodplain a/	Action to avoid adverse effects, minimize potential harm, restore and preserve natural and beneficial values.	Action that will occur in a floodplain, i.e., lowlands, and relatively flat areas adjoining inland and coastal waters and other flood prone areas.	Protection of floodplains, a/ (40 CFR 6, Appendix A); Fish and Wildlife Coordination Act (16 USC 661 et seq.); 40 CFR 6.302.
Within area where action may cause irreparable harm, loss, or destruction of significant artifacts	Action to recover and preserve artifacts.	Alteration of terrain that threatens significant scientific, prehistorical, historical, or archaeological data.	National Historical Preservation Act (16 USC Section 469); 36 CFR Part 65; NAGPRA (25 U.S.C. 3001 et seq); 43 CFR 10; state burial laws.
Area affecting stream or river	Action to protect fish or wildlife.	Diversion, channeling, or other activity that modifies a stream or river and affects fish or wildlife.	Fish and Wildlife Coordination Act (16 USC 661 et seq.); 40 CFR 6.302.
Critical habitat upon which endangered species or threatened species depends	Action to conserve endangered species or threatened species, including consultation with the Department of Interior.	Determination of presence of endangered or threatened species.	Endangered Species Act of 1973 (16 USC 1531 et seq.); 50 CFR Part 200; 50 CFR Part 402; Fish and Wildlife Coordination Act (16 USC 661 et seq.); 33 CFR Parts 320-330.

a/ 40 CFR Part 6 Subpart A sets forth EPA policy for carrying out the provisions of Executive Order 11988 (Floodplain Management) and 11990 (Protection of Wetlands). Executive orders are binding on the level (e.g., Federal, State) or government for which they are issued.

4.1.11.2 Sampling and Analysis Plan

The purpose of the SAP is to ensure that sample data collection activities will be comparable to and compatible with previous data collection activities performed at the site while providing a mechanism for planning and approving field activities. Currently, groundwater sampling activities are performed in accordance with the *Facility-Wide Groundwater Monitoring Program Plan* (FWGWMPP; USACE, 2004). The *Facility-Wide Field Sampling Plan for Environmental Investigations, Ravenna Army Ammunition Plant, Ravenna, Ohio* (SAIC, 2011) supplements the FWGWMPP and describes the procedures and protocols for various sampling activities performed at the site. Two addendums to these documents have been prepared to describe proposed activities and procedures to be conducted as part of this RI. These addendums include the *Final Facility-Wide Groundwater Monitoring Program Plan RVAAP-66 Facility-Wide Groundwater Addendum* (EQM, January 2012) and the *Final Facility-Wide Groundwater Monitoring Program Plan RVAAP-66 Facility-Wide Groundwater Semiannual Monitoring Addendum* (EQM, January 2012).

In addition, the *Facility-Wide Quality Assurance Project Plan for Environmental Investigations, Ravenna Army Ammunition Plant, Ravenna, Ohio* (SAIC, 2011) describes the QA and QC procedures for site sampling activities. An addendum to the FWQAPP, the *Final Facility-Wide Groundwater Monitoring Program RVAAP-66 Facility-Wide Groundwater Quality Assurance Project Plan Addendum* (QAPP; EQM, January 2012), has been prepared to address the well installation and semiannual monitoring activities proposed under this RI/FS work plan.

4.1.11.3 Health and Safety Plan

The *Facility-Wide Safety and Health Plan for Environmental Investigations, Ravenna Army Ammunition Plant, Ravenna, Ohio* (FWSHP; SAIC, 2011) details the health and safety procedures for the field activities to be conducted in support of the RI. An addendum to this document, the *Final Facility-Wide Groundwater Monitoring Program RVAAP-66 Facility-Wide Groundwater Site Safety and Health Plan Addendum* (SSHP; EQM, January 2012),has been prepared pursuant to the proposed activities in this work plan.

4.1.11.4 Community Relations Plan

The Community Relations Plan documents the community relations history and the issues of community concern. The CRP describes the techniques that will be needed to achieve the objectives of the program. A CRP dated September 2003 was previously prepared and submitted by USACE for the RVAAP facility.

4.2 Community Relations

This task incorporates all efforts related to the preparation and implementation of the community relations plan for the site and is initiated during the scoping process. This task does not include work on the responsiveness summary in the ROD. Typical elements included in this task are:

- Conducting community interviews
- Preparing a community relations plan
- Preparing fact sheets
- Providing public meeting support
- Providing technical support for community relations
- Implementing community relations
- Managing tasks and conducting quality control

4.3 Field Investigation

As mentioned previously, numerous field investigations have previously been conducted at RVAAP to evaluate site conditions at identified AOCs and in support of human health risk evaluations at these potential source areas. The nature and extent of contamination at the various AOCs has essentially been defined. Consequently, the RI for Facility-Wide groundwater is designed to provide additional information in support of the hydrogeologic and fate-and-transport models to be performed under this work plan. As discussed in Section 4.3.3, EQM has identified the need for 39 additional wells at the site and subsequent sampling of these wells for four consecutive quarters. In order to meet the timeline established for completion of the RI Report in the PWS, an addendum to the existing FWGWMPP has been submitted to expedite installation of these wells prior to finalization of this RI/FS work plan. In addition, EQM has also prepared and submitted another addendum to the FWGWMP proposing modifications to the current groundwater monitoring program. Again, it is anticipated that the new monitoring approach will begin prior to finalization of the RI/FS work plan. Section 4.3.5 summarizes the proposed modifications to the current monitoring program. Details describing the approach, rationale, and procedures for the well installation and modified groundwater sampling activities are presented in the respective addendums.

Other field investigation activities that are included under this RI include permeability testing, which will be performed during installation of the new wells, and aquifer testing, which is discussed in Section 4.3.4.

4.3.1 Develop Site Screening Levels

The analytical data generated from the monitoring wells will be screened using the previously approved decision process as follows:

1. **1st Screen: Screen data against the established Facility-Wide background values** – If chemical concentrations are less than the established background values, then these chemicals do not qualify as COPCs. If the chemical concentrations are equal to or greater than the background values, or there are no background values, then the chemicals qualify for further screening under Step 2.

2. **2nd Screen: Screen data against the Facility-Wide Clean-Up Goals (FWCUGs) –** Under current and future planned land use scenarios for the site, the following human receptors have been identified for which FWCUGs have been established: Security

and Maintenance Personnel, National Guard – Fire/Dust Suppression Worker, National Guard Trainee, Resident Farmer, Trespasser Adult/Juvenile, Recreators – Hunter/Trapper/Fisherman, National Guard Engineering School Instructor, and National Guard Range Maintenance Soldier. If chemical concentrations are less than the restrictive and applicable FWCUGs, then these chemicals do not qualify as COPCs. However, if the FWCUG is less stringent than the USEPA's corresponding MCL, then the MCL will take precedence. If the chemical concentrations are equal to or greater than the most restrictive and applicable FWCUGs (or MCLs), then these chemicals qualify as COPCs. If there are no chemical-specific FWCUGs, then the chemicals qualify for further screening under Step 3.

3. **3rd Screen: Screen data against the USEPA RSLs –** If chemical concentrations are less than the RSLs, then these chemicals do not qualify as COPCs. If the chemical concentrations are equal to or greater than the RSLs, then these chemicals qualify as COPCs. If there are no chemical-specific RSLs, then the chemicals qualify as COPCs.

The FWCUGs will be used to address groundwater remedial actions. In addition, the USEPA's MCLs will be used to assist in the identification of COPCs and will serve as alternate cleanup goals for groundwater contaminants (as applicable and appropriate). The more conservative of the FWCUGs and MCLs will be used to address groundwater mitigation efforts.

As mentioned in Step 3, groundwater analytical results will also be compared to the USEPA RSL Summary Table (May 2010). This table was developed by the USEPA to replace the Region 9 PRGs and the Region 3 Risk Based Cleanup (RBC) table. Use of the former Region 9 Preliminary Remediation Goals (PRGs) will be discontinued during the RI/FS for Facility-Wide Groundwater (RVAAP-66) and for screening groundwater quality during future groundwater monitoring events at RVAAP. It should be further noted that the RSLs were developed to replace the PRGs in their entirety. Region 9 PRGs have not been updated since 2004 and no longer represent the current technical and toxicological understanding of the chemical constituents.

4.3.2 Procurement of Subcontractors

The EQM Team will include several subcontractors selected for their experience with the groundwater investigations/CERCLA activities to be completed at RVAAP. EQM will use formal subcontracting mechanisms (i.e., subcontract agreement or Purchase Order) through which subcontract direction will be implemented. EQM will meet the contract requirements of the Federal Acquisition Regulation (FAR) relative to procuring and managing federal contracts requiring multiple subcontractors.

As part of subcontractor management, EQM will:

- Facilitate subcontractor communication with the USACE and RVAAP.
- Direct subcontractor preparation of written materials (e.g., project work plan sections, completion report section, etc.).

- Coordinate mobilization and demobilization plans.
- Provide oversight of subcontracted field activities.
- Review and coordinate schedules.
- Include subcontractors in partnering.
- Review and approve all payment requests.
- Close out subcontracts promptly and obtain signed releases.

EQM's approach to budgeting and controlling subcontractor costs and field schedules will begin at the planning stage. At that time, subcontractor activities will be defined and converted to quantifiable and measurable tasks. This forms the basis for the subcontractor's cost and schedule estimate, which is then rolled up into the overall schedule. The resulting cost-loaded schedule becomes the baseline against which the subcontractor's performance is monitored and measured for the life of the project.

Monitoring subcontractor progress and costs will begin with daily field reporting and associated documentation. The Field Geologist will oversee subcontractor activities, including material and equipment deliveries and on-site labor resources. The Field Geologist will document these activities in a daily report to the EQM Project Manager. Progress payment requests will be reviewed against the progress documented in the field. This information (i.e., field reports, employee time cards, subcontractor reports, etc.) is reviewed by the Project Manager in the context of the planned schedule and costs for that activity. Subcontractor progress will be measured against the baseline schedule to assess and quantify any potential variance and the need for any corrective action.

4.3.3 Hydrogeologic Investigation

EQM reviewed the currently available groundwater data, including the *Draft 2010 Addendum to the Facility-Wide Groundwater Monitoring Program Plan RVAAP-66 Facility-Wide Groundwater* (USACE, November 15, 2010). Based on this review, EQM determined that additional monitoring wells are needed at the facility to complete the RI/FS and eventual ROD. EQM believes that additional wells are necessary to complete hydrogeologic system modeling and to conduct contaminant fate-and-transport modeling for a Facility-Wide groundwater approach. The additional wells include, but are not limited to, several wells that were also recommended by the USACE in the *Draft 2010 Addendum* for characterizing the nature and extent of Facility-Wide groundwater impacts in shallow and deep groundwater aquifers beneath the site. This task is on a separate track from the RI/FS work plan.

To achieve the objectives, EQM has identified 39 new wells to be installed at the facility. As mentioned previously, the additional wells are necessary to complete hydrogeologic system modeling and to conduct contaminant fate-and-transport modeling for a facility-wide groundwater approach. In this regard, permeability testing will be performed on test cores obtained from 20 of the new wells. Twelve (12) of these wells also will be used to further evaluate potential exit pathways, especially along the southern and eastern borders. Although the primary focus of the new wells is to provide additional input in support of the Facility-Wide groundwater models, 13 of the new wells have been placed in the vicinity of current CR sites to secondarily assess potential groundwater impacts from these units. One stainless steel well will be installed to assess whether the occurrence of bis(2-ethylhexyl)phthalate is the result of leaching from PVC well materials. Lastly, placement of many of the new wells within the RVAAP is proximate to AOCs to evaluate vertical contaminant distribution and/or particle inflow/outflow through the central portion of the facility. Nineteen (19) wells will be completed in the first water-bearing zone encountered, which is expected to be in the unconsolidated overburden; five (5) wells in the western portion of the site are expected to be completed in the Homewood Member; and 15 wells will be completed in the Sharon Member (Sharon). Completion depths of the wells will vary based on the topographic changes across RVAAP and the depth at which the water-bearing strata are encountered. EQM predicts that the Homewood Member will be the first bedrock aquifer encountered in the western portion of the property based on well data from nearby AOCs (e.g., C Block, and Fuze and Booster). In general terms, the Homewood is the shallowest bedrock to the west, and the Sharon is the shallowest bedrock to the east at RVAAP (i.e., the Homewood is missing in the eastern half of the site). There is a small potential that the shallowest bedrock unit to be encountered in the western portion of RVAAP may be the Mercer Member or the Connoquenessing Sandstone, which are exposed on the flanks of pre-glacial valley walls. These two units are depositionally between the Homewood and Sharon. If no groundwater is encountered in the upper portion (i.e., the upper 20 feet) of the Sharon Conglomerate, the boring will be terminated and considered a dry hole. The next water-bearing unit below the top of the Sharon Conglomerate is located at the base of this formation. Six wells (SCFmw-001 through SCFmw-006) were previously installed at the base of the Sharon and provide facility-wide coverage for this lowermost aquifer; consequently, installation of additional wells to the base of the Sharon Member is unwarranted. Due to the lack of hydrogeologic information in the western third of the site, some of the overburden wells may be completed in bedrock, if the overburden material is thin (less than 5 feet thick) or absent or the groundwater yield is negligible (i.e., less than 1 gpm) in the unconsolidated material. Table 4-4 provides justification for the new wells, and Table 4-5 presents the well locations, estimated well depths, and further rationale for each selected location. Figures 4-2 through 4-4 show the proposed well locations in reference to current site features and existing well locations.

The new wells will be installed in accordance with Section 5.4 of the FWSAP and as described herein and in the *Final Facility-Wide Groundwater Monitoring Program Plan RVAAP-66 Facility-Wide Groundwater Addendum* (EQM, January 2012). On January 11, 2012, EQM met with stakeholders to obtain stakeholder approval of the placement and location of the proposed wells. Where necessary, well locations were adjusted to the satisfaction of the stakeholders.

Further information regarding the rationale for this investigation, as well as the sampling procedures for accomplishing this task, are provided in the *Final Facility-Wide Groundwater Monitoring Program Plan RVAAP-66 Facility-Wide Groundwater Addendum* (EQM, January 2012), which includes three parts: Part I) Environmental Investigation Services Addendum (EIS Addendum), Part II) Quality Assurance Project Plan Addendum, and Part III) Site Safety and Health Plan Addendum.

4.3.3.1 Utility Clearance

As described in Section 5.3 of FWSAP, prior to all subsurface activities EQM will notify and coordinate a utility clearance with the RVAAP Operation and Maintenance (O&M) Contractor

Table 4-4. Justification for New Wells

Map I.D.	Vertical Delineation	Horizontal Delineation	Used in Groundwater Model	Exit Pathway	CR Site Evaluation	First-water Bearing Zone Well	Bedrock Well[a]	Initial Investigation of GW Quality at AOC/Area	Permeability Testing
1	x		x	x			Sharon		x
2	x		x	x			Sharon		x
3		x	x	x		x			
4		x	x	x		x			x
5	x		x				Sharon		x
6	x	x	x	x			Sharon		x
7	x	x	x				Sharon		
8	x		x				Sharon		x
9			x		CR-79, CR-80	x		x	
10		x	x				Sharon		
11	x		x	x			Sharon		x
12			x		CR-73	x		x	
13		x	x			x			x
14	x		x				Sharon		x
15	x		x				Sharon		
16	x		x				Sharon		
17		x	x			x			x
18	x		x				Sharon		x
19	x		x				Sharon		
20			x	x	CR-83	x		x	
21			x		CR-73, CR-76	x		x	
22			x			x		x	
23			x	x		x		x	
24			x		CR-73, CR-76	x		x	
25			x		CR-73, CR-76	x		x	x
26	x		x				Homewood		x
27		x	x			x			x
28	x		x				Homewood		x
29		x	x			x			
30	x		x				Homewood		x
31			x		CR-79	x		x	
32			x	x	CR-70, CR-73	x		x	
33			x	x	CR-70, CR-73		Sharon	x	x
34			x		IRP-45		Sharon	x	
35			x		CR-79	x		x	
36		x	x				Homewood		x
37			x	x	CR-69, CR-73, CR-74, CR-77, & CR-83	x		x	x
38			x	x	CR-69, CR-73, CR-74, CR-77, & CR-83		Homewood	x	x
39			x			x			

[a] Rock coring will be performed on all bedrock wells.

Table 4-5. Proposed Wells and Rationale.

Map ID*	RVAAP Area	Well Location	Est. Depth (ft)	Rationale/Comments
1	SE/Load Line 1	Between LL1mw-064 & LL1mw-065	30	Groundwater samples from the Sharon wells located within Load Line 1 have been identified as containing elevated concentrations of metals, explosives, and pesticides. The downgradient wells (LL1mw-064 and LL1mw-065) are screened in the shallower unconsolidated aquifer. A Sharon well installed between downgradient wells LL1mw-064 and LL1mw-065 will be used to assess GW impact vertically at this location, to monitor the potential GW exit pathway off of RVAAP, and for permeability testing.
2	Erie Burning Grounds	Paired with EBGmw-125	30	Groundwater samples collected within the Erie Burning Grounds have been identified as containing elevated concentrations of metals and phthalates. The wells in this AOC are completed in the unconsolidated aquifer. A Sharon well will be installed near well EBGmw-125 to assess GW impact vertically at this location, to monitor the potential GW exit pathway off of RVAAP, and for permeability testing.
3	SE	Paired with SCFmw-004	15-20	Well SCFmw-004 is completed at the base of the Sharon Conglomerate Member. Groundwater samples from wells in Load Line 1 and Load Line 2 have been found to contain elevated concentrations of metals, explosives, pesticides, and/or PCBs. The wells in these AOCs are completed in the upper part of the Sharon. A well installed near SCFmw-004 will be used to assess first GW downgradient of Load Lines 1 and 2, and to monitor the potential GW exit pathway off of RVAAP.
4	SE	Paired with SCFmw-002	15-20	Well SCFmw-002 is completed at the base of the Sharon Conglomerate Member. Groundwater samples from wells in Load Lines 1, 2, 3, 4, and 12 have been found to contain elevated concentrations of metals, explosives, pesticides, nitrate, and/or PCBs. The wells in these AOCs are completed in the first water-bearing zone encountered. A well installed near SCFmw-002 will be used to assess first GW downgradient of these load lines, to monitor the potential GW exit pathway off of RVAAP, and for permeability testing.
5	S/Load Line 4	Paired with LL4mw-199	35	Groundwater samples collected within Load Line 4 have been identified as containing elevated concentrations of metals. All the wells in this area are screened in the unconsolidated aquifer. A Sharon well will be installed downgradient of focus well LL4mw-193 and paired with well LL4mw-199 to assess GW impact vertically and for permeability testing.
6	Load Line 3	South-southwest of LL3mw-243	25	Groundwater samples collected within Load Line 3 have been identified as containing elevated concentrations of metals, explosives, and pesticides. A Sharon well will be installed downgradient of Load Line 3 and potentially downgradient of Load Line 12 near South Perimeter Road to assess GW impact vertically and horizontally, to monitor the potential GW exit pathway, and for permeability testing.

Table 4-5 (continued). Proposed Wells and Rationale.

7	Load Line 3	Southwest of LL3mw-241	25	Groundwater samples collected within Load Line 3 have been identified as containing elevated concentrations of metals, explosives, and pesticides. The west adjoining AOC (Load Line 12) only has wells screened in the unconsolidated aquifer and the Sharon Shale interval. Consequently, an additional downgradient well is needed west of LL3mw-241 to assess the extent of groundwater impact in the Sharon. A Sharon well will be installed southwest of well LL3mw-241 between Load Lines 3 and 12 to assess GW impact vertically and horizontally.
8	Central Burn Pits	Near CBPmw-001	50	Groundwater samples collected at the Central Burn Pits have been identified as containing elevated concentrations of metals. All the wells in this AOC are screened in the unconsolidated formation. A Sharon well will be installed between CBPmw-001 and CBPmw-002 to assess GW impacts vertically and for permeability testing.
9	Group 2 DLA Ore Storage Area	-	25	No GW data has been generated in this area of the site, which formerly housed two ore pile storage areas and propellant can tops. Brass ingots were historically stored on the ground surface of the ore pile storage sites. A well will be installed on the downgradient side of these CR units to assess potential impact to first groundwater in this area.
10	Building 1200	Near B12mw-012	25	Groundwater samples collected within the Building 1200 Area have been identified as containing elevated concentrations of metals. The wells are screened in the Sharon aquifer. The horizontal extent of impact has not been fully defined. A Sharon well will be installed north-northwest of focus wells B12mw-010/012 to assess downgradient GW impacts.
11	North Perimeter	Paired with BKGmw-21	40	A Sharon well paired with BKGmw-021 will be installed to provide additional coverage in this unit along the northern perimeter of the site. This location has also been selected for permeability testing.
12	North Line Road Coal Tipple	-	45-50	This area was formerly used as a coal tipple. Coal dust and particles are currently present at the ground surface. No GW data has been generated in this area of the site. One well will be installed to assess GW quality in the first water-bearing zone encountered in this area located just south of North Line Road.
13	Winklepeck	Near WBGmw-007	20	Groundwater samples collected at Winklepeck Burning Grounds have been identified as containing elevated concentrations of metals and explosives. The wells are screened in the unconsolidated aquifer. The extent of GW impact is not defined east of WBGmw-007. An unconsolidated well will be installed east of well WBGmw-007 and south of WBGmw-016 to assess the horizontal and downgradient extent of affected GW and for permeability testing.
14	Winklepeck	Near WBGmw-007	40-45	To evaluate the vertical extent of impact in GW in this AOC, a Sharon well will be installed east of well WBGmw-007 and south of WBGmw-016. This well will be paired with the new unconsolidated well. Permeability testing will also be performed on this well.

Table 4-5 (continued). Proposed Wells and Rationale.

15	Winklepeck	Paired with WBGmw-009	40-45	A Sharon well will be installed and paired with well WBGmw-009 to assess the vertical extent of GW impact in this area of the AOC.
16	Winklepeck	Paired with WBGmw-006	40-45	A Sharon well will be installed and paired with well WBGmw-006 to assess the vertical extent of GW impact in this portion of the AOC.
17	Demo. Area 2	Near DA2mw-108	15-20	Groundwater samples collected at Open Demolition Area 2 have been identified as containing elevated concentrations of hexavalent chromium and PCBs. The wells are screened in the unconsolidated aquifer. The extent of GW impact is not defined east of well DA2mw-108. An unconsolidated/ Sharon well pair will be installed east of wells DA2mw-108/DA2mw-110 to assess the horizontal, vertical, and downgradient extent of GW impact. We understand the proximity to Rocket Ridge Removal activities and will coordinate as necessary. Permeability testing will be performed on both wells.
18	Demo. Area 2	Near DA2mw-108	40-45	
19	Demo. Area 2	Paired with DETmw-003	40	To assess the vertical of impact in GW in this AOC, a Sharon well will be installed and paired with well DETmw-003.
20	Admin/ George Road	Post 1/ fence line area	20-30	This location is near the south property line and downgradient of several Compliance Restoration sites. A well will be installed to intercept first groundwater south-southwest of the administration and Post 1 areas to assess the potential GW exit pathway off of the RVAAP.
21	West NW	-	30	Several depots and coal storage facilities were previously located along State Route 80 Freedom Road immediately south of Newton Falls Road. No wells have been installed in this area. A well will be completed in the first water-bearing zone to assess potential GW impacts near Newton Falls Road to the northwest of these facilities.
22	West SW	-	25	The westernmost portion of the RVAAP has not been evaluated for potential GW impact. A well will be completed in the first water-bearing zone to assess the extent of western GW impact near McCormick Road.
23	South SW	-	15	A well will be completed in the first water-bearing zone to assess the extent of GW impact about 1000 meters east of SR80/Charlestown Road in alignment with the Sharon Conglomerate bedrock surface low and the Hinkley Creek exit pathway.
24	Depot Area	-	25	Several depots and coal storage facilities were previously located along State Route 80 Freedom Road. No wells have been installed in this area. A well will be completed in the first water-bearing zone to assess potential GW impacts near Route 80 to the east of the southernmost depot facility.
25	Depot Area	-	25	A second well will be completed in the first water-bearing zone to assess potential GW impacts near Route 80 to the east of the northernmost depot facility. Permeability testing will be performed at this location.

Table 4-5 (continued). Proposed Wells and Rationale.

26	NACA Test	Paired with NTAmw-109	40-45	Groundwater samples collected at the NACA Test Area have been identified as containing elevated concentrations of metals and PCBs. The wells are screened in the unconsolidated aquifer. Deeper groundwater has not been evaluated. A Homewood well will be installed and paired with well NTAmw-109 to assess the vertical extent of GW at this location and for permeability testing.
27	Load Line 6	Near LL6mw-002	15-20	Groundwater samples collected within Load Line 6 have been identified as containing elevated concentrations of metals. All the wells are screened in the unconsolidated or Homewood units. A well pair will be installed in the unconsolidated and Homewood units southeast of Load Line 6 to assess the horizontal and vertical GW quality downgradient of this AOC. Permeability testing will be conducted on both wells.
28		Near LL6mw-002	45-50	
29	Load Line 11	Near LL11mw-007	25	Groundwater samples collected within Load Line 11 have been identified as containing elevated concentrations of SVOCs and metals. All the wells are screened in the unconsolidated formation. A well pair will be installed in the unconsolidated and Homewood formations north-northwest and downgradient of well LL11mw-007 (along Newton Falls Road) to assess the horizontal and vertical GW quality. Permeability testing will be performed on the deeper well.
30		Near LL11mw-007	45	
31	DLA Main Ore Storage Yard Area	-	15-30	One well will be installed to assess GW quality in the first water-bearing zone encountered in the DLA Main Ore Storage Yard area, which is a CR site located in the eastern portion of the facility.
32	East Classification Yard	-	15	The East Classification Yard is a Compliance Restoration site. Groundwater has not been evaluated in this area. A well pair will be installed in the first water-bearing zone and in the underlying Sharon formation east and downgradient of this AOC (near East Patrol Road) to assess GW quality. Permeability testing will be performed on the Sharon well.
33		-	30	
34	Wet Storage	-	30	A Sharon well will be installed near Powerhouse No. 5 to evaluate groundwater quality near this former coal storage unit. This well will also be side-gradient to Demolition Area 2.
35	Route 80 Tank Farm	-	45-50	This area was formerly used as a DLA Ore Storage Area. Aboveground storage tanks reportedly existed in this area. Gamma radiation has also been identified in soils in this area. One well will be installed to assess GW quality in the first water-bearing zone encountered near the former Route 80 Tank Farm located just south of North Line Road.
36	C Block	S of CBLmw-002	50	Groundwater samples collected at the C Block Quarry have been identified as containing elevated concentrations of SVOCs and PCBs. The wells are screened in the Homewood aquifer. The extent of groundwater impact has not been defined to the south. One Homewood well will be installed south-southeast of well CBLmw-002 at Newton Falls Road to assess the extent of GW impact and for permeability testing.

Table 4-5 (continued). Proposed Wells and Rationale.

37	Admin/ George Road	Post 1/ fence line area	20-30	This location is near the south property line and downgradient of several Compliance Restoration sites. One well will be installed to intercept the first water-bearing zone. This well will be positioned southeast of the administration and Post 1 areas to assess the potential GW exit pathway off of the RVAAP and for permeability testing.
38	Admin/ George Road	Post 1/ fence line area	45-50	This well will be paired with well #37 to intercept the underlying bedrock aquifer (Homewood). This well will be positioned southeast of the administration and Post 1 areas to assess potential vertical contaminant distribution, the potential GW exit pathway off of the RVAAP, and for permeability testing.
39	Load Line 12	Near LL12mw-182	35	Well LL12mw-182 has been found to contain bis(2-ethylhexyl) phthalate above site screening criteria on four separate occasions. A stainless steel well will be installed near this location to verify whether the presence of bis(2-ethylhexyl)phthalate is leaching from the PVC well materials.

*Map ID # is correlated to proposed location on site map.

The Sharon Conglomerate wells will not be completed as basal wells for the formation (refer to Section 2).

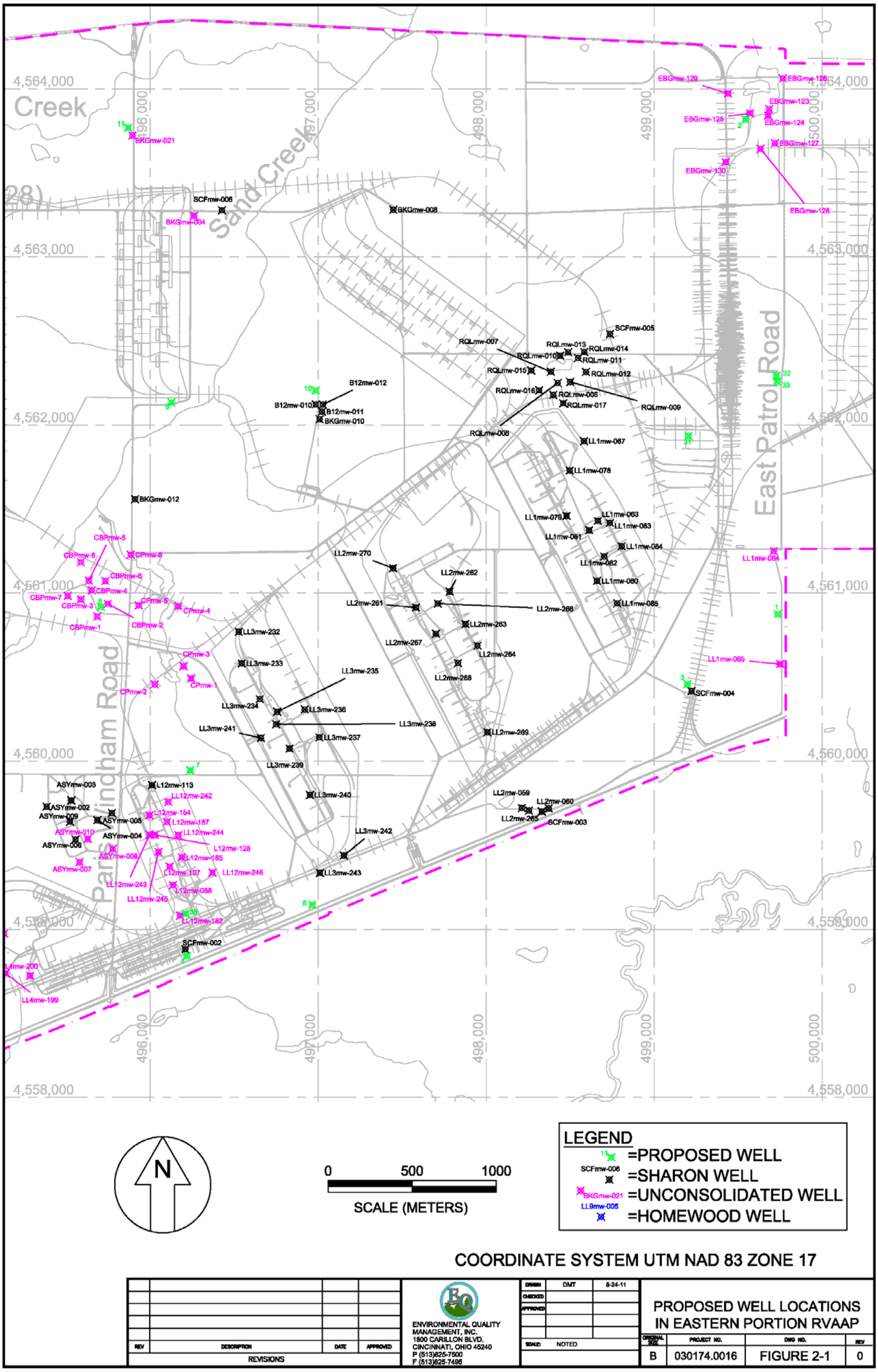


Figure 4-2. Proposed Well Locations in Eastern Portion of RVAAP

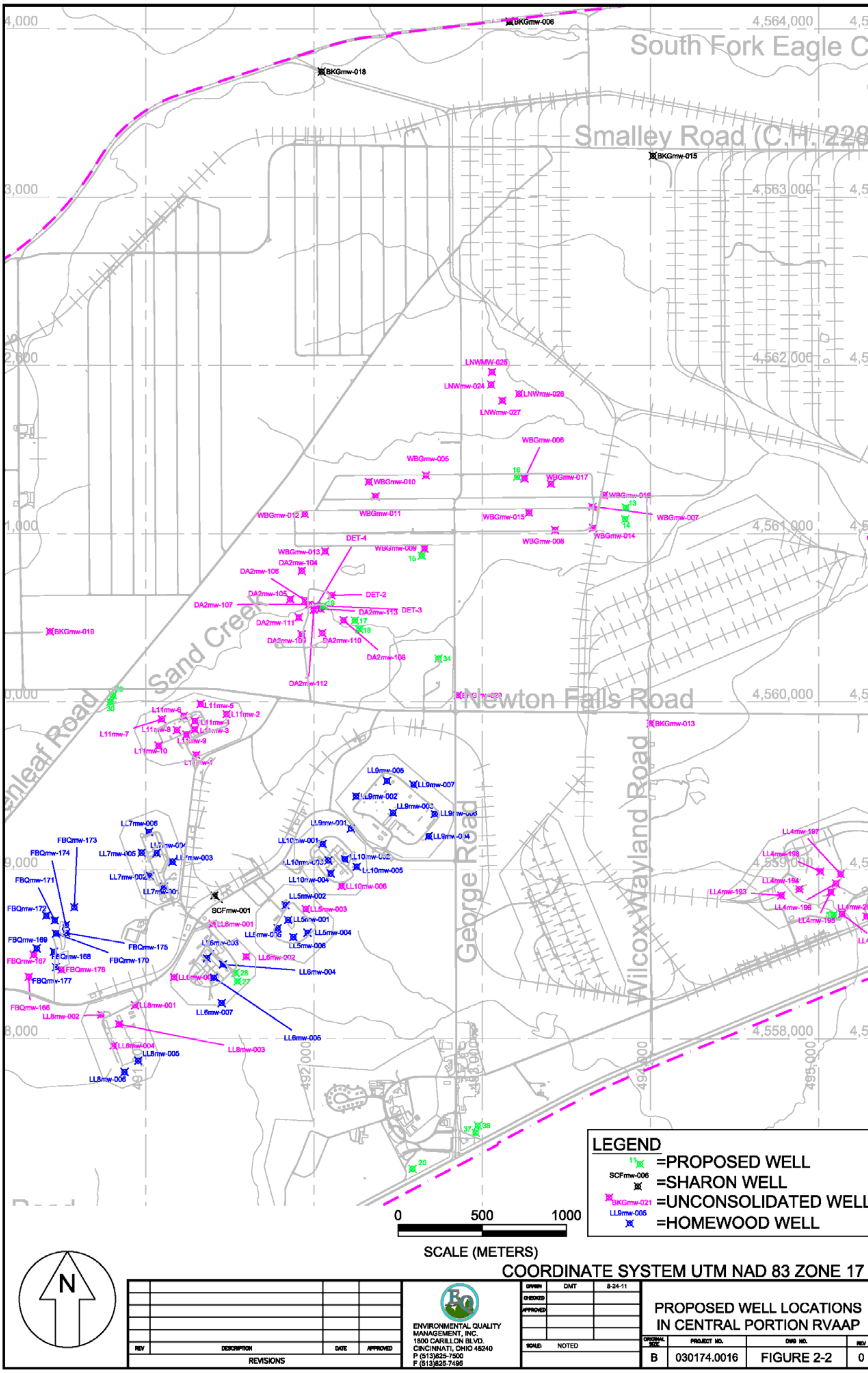


Figure 4-3. Proposed Well Locations in Central Portion of RVAAP

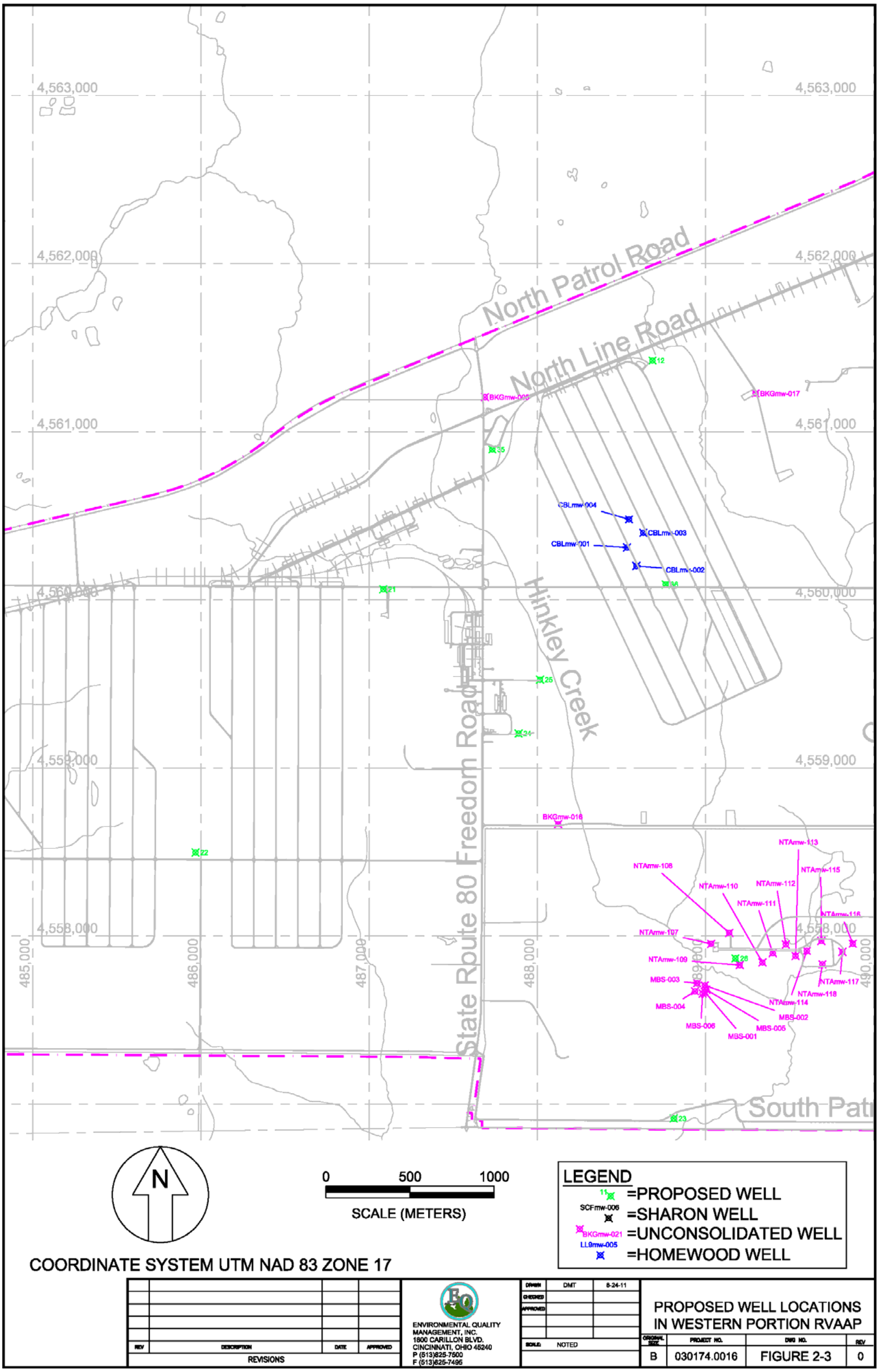


Figure 4-4. Proposed Well Locations in Western Portion of RVAAP

and RVAAP Environmental Manager. Ten (10) business days prior to subsurface activities on site, a request for utility clearance will be submitted in writing to the RVAAP O&M Contractor, OHARNG Environmental Coordinator, and the RVAAP Environmental Manager. The request will describe and illustrate sample locations and activities to be performed so utilities can be adequately marked or cleared prior to drilling. To expedite this effort, EQM personnel will mark the well locations at least one (1) week prior to mobilization of the drilling crew. EQM will mark the locations using painted wood slats, stakes, and or pin flags. Well locations positioned in paved areas will be marked using spray paint.

In addition, EQM will also use an UXO-Qualified Technician to conduct surface clearance and borehole clearance for UXO at each of the proposed wells positioned in the MR sites, AOCs, and/or other areas where requested by the Army or where site conditions are encountered that warrant surface/borehole clearance. If buried utilities or UXO are present at the selected sample location, the boring will be field adjusted to ensure the safety of the sampling team. Additional details concerning UXO clearance and avoidance are presented in Section 10.2 of the Site Safety and Health Plan (SSHP) Addendum located in Part III of this amendment.

4.3.3.2 Clearing and Grubbing

Several of the proposed well locations are located in portions of the property that are overgrown with small trees and underbrush. Consequently, access to these locations may require clearing and grubbing. EQM will coordinate all brush/vegetation clearing with OHARNG personnel.

After the well locations have been marked in the manner described in Section 4.3.3.1, EQM personnel will identify those areas that will require clearing for drill rig access. EQM has a subcontract in place with Frank’s Maintenance to perform clearing and grubbing at the site. They have all the necessary equipment to fulfill this function and will be used to provide access to the various well locations, as needed. However, every effort will be made to leave larger trees (i.e., greater than 6-in. diameter) in place. EQM will not proceed with any brush/vegetation clearing without prior approval from the OHARNG.

4.3.3.3 Drilling Methods

Drilling through the overburden will be accomplished using 4.25-in.-I.D. or 6.25-in.-I.D. hollow stem augers. Soil samples will be collected continuously from the surface to the total depth of the boring or bedrock by driving a clean 2-in. by 24-in. split-spoon sampling device in advance of the auger string using a 140-lb drop hammer [American Society for Testing and Materials (ASTM) Method D-1586]. Upon retrieval of the sampling device, the percentage of recovery will be recorded and the contained soil core will be split in half, lengthwise, using a stainless steel knife. Each split-spoon sample will be screened using a photoionization detector (PID) for gross measurement of volatile organic compounds in the vapor headspace. Soil samples will be placed in zipper-sealed bags and allowed to warm to ambient temperatures prior to screening. Soil clumps will be broken down using a gloved hand. The tip of the PID probe will be inserted into the bag, and the result will be recorded on the boring log at the time of screening. The onsite geologist will log and describe the soil cores in a field logbook or Soil Boring Log as the boring is advanced. No chemical analysis of the soil samples is proposed.

At six of the proposed overburden well locations, 3-in.-I.D. by 24-in.-long, thin-walled Shelby Tube samples will be collected from the approximate center of the water-bearing zone to be monitored. The well locations subject to Shelby Tube testing will be selected in the field. The Shelby Tube will be attached to the sampling rods and hydraulically pushed the length of the tube. The thin-wall sampler will be extracted through the auger string and immediately capped at both ends upon retrieval pursuant to ASTM Method D-1587. The tube will be labeled and marked to orientation (i.e., top of core). The Shelby Tubes will be submitted to a geotechnical laboratory for permeability testing using ASTM Method D-5084, "Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter." Table 4-4 shows the wells (4, 13, 17, 25, 27, and 37) that have been selected for Shelby Tube (i.e., permeability) testing. The six unconsolidated wells were selected to provide permeability data in the eastern (well 4), central (wells 13, 17, 27, and 37), and western (well 25) portions of RVAAP, along potential exit pathways (proposed wells 4 and 37), and for comparison with permeability data from paired Sharon (proposed wells 13 and 17) and/or Homewood (proposed wells 27 and 37) wells.

Wells to be completed into bedrock will be advanced from the top of the bedrock surface using rock coring and air rotary methods. Initially, the upper 3 to 5 feet of bedrock will be drilled, and a steel surface casing extending from the ground surface to the bottom of the borehole will be installed. The annulus between the casing and borehole will be sealed using a grout mixture comprising Portland cement and 6 percent bentonite. After the seal has cured for a minimum of 12 hours, drilling of the bedrock portion of the borehole will be completed. The surface casing will remain in place following installation of the monitoring well. Each of the well borings to be completed into bedrock will be cored using an "N" series or 2-in.-diameter core to assess the lithologies and the degree and nature of weathering and fracturing in bedrock. Rock cores will be screened for gross volatiles at the time of extraction by passing the PID wand over the core. N-series coring will be performed prior to reaming the borehole using air rotary methods to install the well. Overdrilling of the borehole will be accomplished with air rotary drilling using a truck-mounted air rotary rig. The rig will advance a tricone roller bit to the required drilling depth.

Rock cores will be stored in 10-ft intervals in covered wooden core boxes to preserve their relative position by depth. Intervals of lost core will be noted in the core sequence. Boxes will be marked on the cover (both inside and outside) and on the ends to provide project name, borehole number, cored interval, and box number. The core within each completed box will be photographed using a 35-mm digital camera after the core surface has been cleaned and wetted. The core will be oriented so that the top of the core will be at the top of the photograph. A legible scale will be placed along the core during filming, and each photograph will document the project name, well/borehole number, core box number, cored depths, and date. The cores will be retained and stored at the site. The onsite geologist will record the lithologic description of each core in the field logbook or boring log.

Fifteen field-selected rock core segments from the well screen interval will be removed and submitted to a geotechnical laboratory for permeability testing using ASTM Method D-5084. The selected core segments will range from 1 to 3 feet in length. Five of these cores will be obtained from wells completed in the Homewood Member, and the remaining 10 cores will be obtained from wells completed in the Sharon Formation. The cores will be labeled and marked for orientation, secured in bubble wrap, and placed in a protective cylinder (e.g., Lexan tube, map cylinder). The cylinder will be sealed at both ends and secured with packing tape and custody seals. The outside of the cylinder will be labeled with the core information. The packed core will then be placed in a cooler for transport to the geotechnical laboratory for permeability testing.

If a proposed monitoring well location does not encounter water during drilling, it will be abandoned in accordance with Army and Ohio EPA requirements and the location moved to a suitable alternate drilling location determined by RVAAP stakeholders (anticipated to be within a 50-ft radius of the original location). Drilling will continue until either 1) a well can be installed at the desired water-bearing depth, or 2) no water-bearing zone has been encountered at the desired depth at three locations, including the original sample point, within the 50-ft radius.

Soil and bedrock cuttings will be removed from the borehole during drilling via augering or high-pressure air. In the latter case, the drill cuttings will be directed into a diverter and then through a discharge vent directly into a container next to the borehole. Soil and rock cuttings will be containerized in Department of Transportation (DOT)-approved 55-gal drums, labeled, and staged on site pending future characterization and disposal.

Should newly installed wells produce formation fluids during drilling activities, the fluids will be captured, where possible, and containerized in DOT-approved 55-gal drums. The drummed fluids will be staged on site pending proper characterization and disposal.

4.3.3.4 Monitoring Well Installation

In general, monitoring wells will be constructed of new, 2-in.-diameter Schedule 40 PVC casing and screen. However, a 2-in.-diameter stainless steel well will be installed at location 39 (see Table 4-5) to assess whether the presence of bis(2-ethylhexyl)phthalate in well LL12mw-182 at Load Line 12 is an artifact from the PVC wells. The well screens will be commercially fabricated with 0.010-in. slotted openings. The well screens will be 5 to 10 feet in length depending on the subsurface conditions and flush-threaded to the solid casing. Granular filter pack (Global Supply No. 7) will be inserted into the annular space around the screen and extend at least 3 feet above the top of the screen interval unless subsurface conditions (e.g., overburden thickness) dictate that this qualification be field modified. In addition, approximately 6 inches of filter pack will be placed under the bottom of the well screen to provide a firm footing.

A bentonite seal will be placed atop the filter pack in accordance with Section 5.4.3.2.6 of the FWSAP. The bentonite seal will be a minimum of 3-ft-thick unless subsurface conditions require that the thickness of this seal be field modified. The top of the bentonite seal will be measured with a weighted tape immediately after placement. A minimum of 2 gallons of potable water will be used to hydrate the bentonite following placement. In accordance with FWSAP, the hydration time for the pellets will be a minimum of 60 minutes prior to inserting the grout seal. A grout mixture of cement and bentonite will be inserted via tremie pipe above the bentonite seal to near surface as described in Sections 5.4.2.2.2 and 5.4.2.3.7 of the FWSAP.

The well will be completed at the surface with a locking 6-in.-diameter steel protective casing set in a concrete pad measuring approximately 30-in. square. The wells will extend approximately 3 feet above the ground surface and be protected by three to four steel bollards as described in Section 5.4.2.3.8 of the FWSAP. Flush-mount covers may be substituted for the above-grade well installations where requested by OHARNG.

4.3.3.5 Well Development

Development of the newly installed monitoring wells will be performed no sooner than 48 hours after nor longer than 7 days beyond final installation of the wells. Prior to well development, the depth to water and well depth will be measured using a decontaminated water level indicator in accordance with the procedure presented in Section 5.4.3.1 of the FWSAP. Monitoring well development will be accomplished using a non-dedicated bottom discharge/filling stainless steel bailer, a submersible pump, or a peristaltic pump. Development will proceed until the criteria specified in the FWSAP are met:

- The water is clear to the unaided eye;
- The sediment thickness in the well is less than 1% of the screen length or <3.0 cm (0.1 ft);
- A minimum of five times the standing water volume in the well (to include the well screen and casing plus saturated annulus, assuming 30% porosity) has been removed; and
- Indicator parameters (pH, temperature, and specific conductance) have stabilized according to procedures presented in Section 4.1.1 of the *Facility-Wide Groundwater Monitoring Program* (USACE, 2004) over three successive well volumes. Groundwater parameters will be obtained using a combination meter with flow-through cell designed to measure these parameters. The readings will be recorded when the meter reading reaches equilibrium. Groundwater field parameters will be collected in accordance with Section 5.4.3.2 of the FWSAP. Additional parameters, such as turbidity, may also be obtained, where required.
- In addition to the “five times the standing water volume” criteria, five times the amount of any unrecovered water used during well installation will also be removed. Under specific circumstances, such as bedrock coring in dry rock, potable water may be introduced to the formation.

For each monitoring well developed during the field investigation a record will be prepared to include information specified in Section 5.4.2.3.10.2 of the FWSAP. Well development activities shall be completed at least 14 days before groundwater sampling.

All well development water will be containerized, characterized, stored, and disposed of pursuant to Section 8.0 of the FWSAP for investigative-derived waste (IDW).

4.3.3.6 Well Survey

A topographical survey for horizontal and vertical locations will be prepared for all new wells. The survey will be conducted by a currently licensed individual in the State of Ohio. Top-of-casing and ground surface elevations will be surveyed to the nearest 0.01 feet, and horizontal control will be established to within 1.0 feet of the appropriate coordinate system. The new wells will also be located using a GPS with sub-meter accuracy.

4.3.3.7 Groundwater Purging and Sampling

The 39 new wells will be sampled and analyzed as part of the normal quarterly monitoring event. The new wells will be sampled and analyzed for the parameters presented in Table 4-6 for four consecutive quarters except where noted. In this latter regard, all of the new wells will be sampled for hexavalent chromium (EPA Method 7196A) and perchlorate (EPA Method 6860) during one monitoring event only. The new well (#35) installed near the Route 80 Tank Farm Area and the upgradient background well (BKGmw-005) to this location will also be sampled and analyzed for alpha/beta and gamma radionuclides since gamma radiation was previously identified in soil in this area of the site. The new stainless steel well (#39) will be sampled for bis(2-ethylhexyl)phthalate only.

Static water-level measurements will be made using an electronic water-level indicator prior to well purging. The distance between the top of the casing and the groundwater surface will be recorded in the field logbook or Groundwater Sampling Log to within 0.01 feet. Relative groundwater elevations for each well will be calculated by deducting the depth to groundwater from the top-of-casing elevation. This information will be used to estimate flow direction. A map presenting this information and interpretation will be generated for the sampling event.

Purging

Prior to sampling, each well will be purged using bailing or micropurge techniques following those procedures specified in the FWSAP. The bailing method will be used for those wells that have poor yields or contain minimal water (i.e., less than 2 feet). For this method a disposable Teflon™ bailer will be used to purge and sample. The well will be purged to dryness and allowed to recover prior to sampling. The bailer will be attached to new polyethylene rope and slowly lowered until it contacts the groundwater surface. The bailer will be allowed to sink and fill with a minimum of surface disturbance and then raised slowly to the surface. The sample will be transferred from the bailer to the appropriate sample bottles. A minimum of one set of water quality indicators [e.g., pH, specific conductance, turbidity, dissolved oxygen (DO), oxidation reduction potential (ORP), and temperature] will be obtained during this procedure.

For micropurging, the purge rate will be between 100 and 500 ml/min; however, the higher rate will only be used if it can be shown that the increased rate will not disturb the stagnant water column above the well screen (i.e., will not result in drawdown greater than 1 foot). The maximum flow rate shall not exceed 500 ml/min. Water quality indicators will be collected every 3 to 5 minutes to monitor stabilization of the water quality parameters. A minimum of three readings will be collected from each well during purging. Each parameter is consistent

Table 4-6. Current Analytical Suite of Chemicals

Constituents	Method[1]
Polychlorinated biphenyls (PCBs)	Gas Chromatograph (GC) – Semivolatile Organics (SVOCs) (8082)
Pesticides	GC Semivolatile Organics (8081A)
Base/Neutrals and Acids (SVOCs)	GC/Mass Spectrograph (MS) Semivolatile Organics (8270C)
Volatile Organic Compounds (VOCs)	GC/MS Volatile Organics (8260B)
Nitroguanidine (Propellant)	Organic compounds by UV/HPLC (8330 modified)
Nitroaromatics & Nitramines (Explosives)	GC Semivolatile Organics Explosives (8330)
Nitrocellulose as N (Propellant)	General Chemistry (WS-WC-0050)
Nitrate/Nitrites	General Chemistry (353.2)[2]
Cyanide (Total)	General Chemistry (9012A)
Metals (Magnesium, Manganese, Barium, Nickel, Potassium, Silver, Sodium, Vanadium, Chromium, Calcium, Cobalt, Copper, Arsenic, Lead, Selenium)	Inductively Coupled Plasma (6010B)
Metals (Antimony, Iron, Beryllium, Thallium, Zinc, Cadmium, Aluminum)	Inductively Coupled Plasma Mass Spectrometry (6020)
Perchlorates	Method 6860 (1 quarter only)
Hexavalent Chromium	Method 7196A (1 quarter only)
Mercury	(7470A, Cold Vapor) - Liquid
Alpha/beta screen	Method 900.0[3] – Route 80 Tank Farm Area only.
Gamma radionuclides	Method 901.1[3] – Route 80 Tank Farm Area only.

1 = USEPA SW846
2 = EPA Methods for Chemical Analysis of Water and Waste
3 = Prescribed Test Procedures for Measurement of Radioactivity in Drinking Water, EPA-600/4-80-032, August 1980

with the requirements of the FWSAP, with the exception of ORP and turbidity. Oxidation reduction potential and turbidity are required as additional field parameters to assist in the geochemical study for groundwater.

Water generated during purging activities and decontamination fluids will be containerized in a DOT-approved 55-gal drum or poly tank for future treatment and disposal. Purging activities will be recorded on the Groundwater Sampling Log or equivalent for each well. Immediately following purging, each well will be sampled. (If separate-phase liquid is present, no purging or sampling of the groundwater will be performed.)

Sampling

Once purging activities are complete, groundwater samples will be collected from below the top of the well screen using a bladder pump (or bailer if there is low yield). Samples will be transferred directly to laboratory precleaned sample containers. EQM's field personnel will wear new, disposable nitrile gloves during sample collection. The gloves will be changed between wells and the used gloves will be discarded appropriately. Sample aliquots will be placed in the appropriate sample containers, pre-preserved (if required), sealed with Teflon-lined septa, and labeled with a unique sample identification number. Samples will then be placed in a cooler with ice and submitted to an offsite laboratory for analysis. A chain-of-custody form will accompany the sample shipment. Groundwater sampling activities will be documented on a Groundwater Sampling Log or equivalent for each monitoring well.

Each well (except the stainless steel well) will be sampled for filtered metals. The list of metals to be analyzed is consistent with Table 4.8 of the FWQAPP. The wells identified for hexavalent chromium analysis will also be field filtered. Sampling and analysis procedures will follow the FWSAP. A 0.45-micron in-line filter will be used to filter samples. The filtered sample will be transferred directly into pre-preserved sample containers supplied by the laboratory.

4.3.3.8 Field Quality Control Sampling Procedures

Since no soil or groundwater samples are being collected for chemical analysis during installation of the 39 new wells (groundwater sampling will be performed as part of the quarterly monitoring program), no quality control samples will be collected during well installation activities. However, quality control samples will be collected during quarterly groundwater monitoring of the new and existing monitoring wells. These quality control samples will include duplicates and split groundwater samples (10 percent of total field samples), matrix spike and matrix spike duplicates (5 percent of total field samples), equipment rinsates (daily), and trip blanks (with each cooler containing samples for VOC analysis) as described in Section 5.4.7 of the FWSAP. Split samples will be submitted to the approved USACE contract laboratory for independent analyses.

4.3.3.9 Equipment Decontamination

Soil sampling equipment (e.g., split spoons, augers, shovels, trowels, and mixing bowls) will be cleaned using steps 1, 2, and 4 below since no soil chemical analysis is being performed for this investigation. Drilling equipment will be pressure washed between well locations. Well development equipment (e.g., bailers and pumps) and portable groundwater sampling equipment (e.g., bladder pumps) will be cleaned prior to collecting each sample to prevent cross-contamination using the following eight-step procedure:

1) Scrub and wash with laboratory-grade detergent.
2) Rinse with approved potable water.
3) Rinse thoroughly with hydrochloric acid (2% solution) or nitric acid (10% solution).
4) Rinse with ASTM Type I or equivalent deionized/distilled water.
5) Rinse with pesticide-grade isopropanol or methanol (wash bottle).
6) Rinse with ASTM Type I or equivalent deionized/distilled water.
7) Allow equipment to air dry.
8) Place equipment on clean, dry plastic if it is to used immediately or wrap in aluminum foil if storage is required.

Field measurement equipment (e.g., water level indicators, pH meters, etc.) will also be decontaminated between well locations. Due to the sensitive nature of these measuring devices, the decontamination procedure will involve a non-phosphate detergent wash, followed by a potable water rinse, and a final rinse using ASTM Type I or equivalent water.

4.3.4 Aquifer Testing

EQM will conduct single-well, constant-rate pump (i.e., aquifer) tests in order to demonstrate the effects of pumping to identify early attainment use zones and cross connection between the unconsolidated water-bearing strata and the production zone of key bedrock aquifers (Sharon and Homewood). The aquifer tests would include two short-term pump tests (e.g., 24 hour) to address this data need, with one pump test to be conducted on the Homewood aquifer and the other on the Sharon aquifer. Existing monitoring wells will be used to the extent possible as observation wells. However, at least one piezometer will be installed in the western RVAAP in support of the pump test on the Homewood aquifer. Water-level readings will be obtained during the pump test from the test well and nearby monitoring wells and/or piezometers using electronic water-level meters or pressure transducers attached to a programmed data logger. Since the majority of the drawdown will occur in the first portion of the test, sufficient water level readings shall be taken to define the drawdown curve. After the pump has been turned off, the pump will be left in the well, and water-level readings will be collected in the test well and observation wells until the wells have reestablished equilibrium. Water generated during the pump test will be containerized in 55-gallon drums, a poly tank, or a fractionation tank pending waste characterization and disposal. The size of the containment vessel will depend on the predicted pumping rate of the well and the anticipated amount of generated fluid. An appropriate model or solution to the groundwater flow equation (e.g., Theis equation) will be chosen to fit the observed data.

4.3.5 Semiannual Groundwater Sampling

The current FWGWMP schedule involves quarterly sampling of a subset of all wells present at RVAAP. From an historical perspective, the quarterly sampling schedule has been used to complete a minimum of four quarters of sampling for the 243 existing wells at the facility, thereby providing a baseline for all of the facility groundwater monitoring wells, including seasonal fluctuations of water levels and contaminant levels. It appears from these data that the initial investigative phase for the existing wells has been completed (i.e., there is an understanding of the impacts of specific AOC sources to individual wells at the facility). As a result, USACE and the Ohio EPA desire that the site move from an AOC-based approach to a facility-wide approach for groundwater. Based on this perspective, EQM has proposed that the facility-wide groundwater monitoring schedule be modified from a quarterly to semiannual basis, which would still be sufficient to assess potential adverse effects to human health and the environment during the RI/FS process. In making the transition from an AOC approach to a facility-wide evaluation, it is important to realize that the proposed monitoring well network is not intended to assess each AOC individually but rather their composite contributions to groundwater quality in the unconsolidated and bedrock aquifers. Since there are numerous wells at the site, the approach used was to select wells that have exhibited COPCs and eliminate wells that provide redundancy or provide minimal information on groundwater quality or fate-and-transport migration. To this end, EQM prepared the *Final Facility-Wide Groundwater Monitoring Program Plan RVAAP-66 Facility-Wide Groundwater Semiannual Monitoring Addendum* (EQM, January 2012) describing the rationale for the proposed semiannual monitoring well network and the sampling and analysis procedures. Key elements of this modified program are:

- Sample the 39 proposed new wells for four successive quarters beginning in 2012. The new wells are not included in the semiannual sampling network, although they will be sampled at the same time as the July 2012 semiannual sampling event. Beginning in 2013, some or all of the new wells will be incorporated into the semiannual monitoring program, as determined jointly by the Army, Ohio EPA, and stakeholders.
- Sample the former RCRA/solid waste wells specified by the DFFOs in conjunction with the proposed semiannual sampling events for the FWGWMP wells (i.e., January and July). The RCRA wells will be sampled using the same protocols and procedures used for the FWGWMP wells.
- Sample 35 wells (including the five RCRA wells) during the semiannual events in 2012. Selection of existing wells for semiannual site-wide monitoring was made based on consideration of the following criteria:
    - Detect/monitor potential groundwater contamination near the downgradient facility boundary, which is also downgradient of AOCs.
    - Identify/quantify occurrence of COPCs in the unconsolidated aquifer.
    - Identify/quantify occurrence of COPCs in the bedrock aquifer(s).
    - Evaluate potential hydraulic connection between unconsolidated and bedrock aquifers. Use existing wells paired with or near proposed new wells.

    - Sample well LL12mw-182 for bis(2-ethylhexyl)phthalate for comparison with the new stainless steel well (#39).
    - Include all currently monitored RCRA wells for the RQL and DA2.
- Sample the six suspected MBS wells for chemical analysis of thiodiglycol and chemical warfare breakdown products (1,4-dithiane and 1,4-oxathiane) during one sampling event.
- Sample the proposed new wells and seven semiannual wells for hexavalent chromium during one sampling event.
- Sample the proposed new wells for perchlorate during one sampling event.
- Perform annual well maintenance, as needed, including painting well identification numbers, repairing concrete pads and posts, repairing well casings, and replacing well caps and locks. EQM will also perform redevelopment of any wells due to excessive silting.

The wells selected for semiannual monitoring will not change between monitoring events in 2012. Table 4-7 identifies the proposed semiannual wells and rationale for selection. Figures 4-5 through 4-7 show the wells to be sampled during the semiannual monitoring events.

Groundwater purging and sampling will be performed in the same manner described in Section 4.3.3.7. Field quality control samples are described in Section 4.3.3.8, and equipment decontamination procedures are presented in Section 4.3.3.9.

4.3.6 RI Waste Disposal

All IDW, including auger cuttings, personal protective equipment (PPE), disposable sampling equipment, and decontamination fluids, will be properly handled, labeled, characterized, and managed in accordance with Section 8.0 of the FWSAP. At the conclusion of field activities for the well installation (and for the subsequent pumping tests and groundwater sampling activities), a letter report will be submitted to USACE and the RVAAP Environmental Coordinator documenting the characterization and classification of the wastes. Upon approval of the IDW classification report, all solid and liquid IDW will be removed from the site and disposed of by a licensed waste disposal contractor. All shipments of IDW offsite will be coordinated through the RVAAP Environmental Coordinator.

- Four types of IDW are anticipated, which will be contained separately. The types and estimated quantities for each include: Soil, specifically drill cuttings from the unconsolidated surficial material;
- Development and purge water from monitoring wells;
- Decontamination fluids, including those derived from decontamination of sampling equipment and drilling equipment; and
- Expendables/solid wastes, including PPE and disposable sampling equipment.

1 **Table 4-7. Semiannual Monitoring Wells and Rationale.**

No.	RVAAP Area	Well Location	Rationale / Comments
1	SE/Load Line 1	LL1mw-064	Downgradient from Load Line 1, near proposed new Sharon well (#1), and serves as overburden monitoring well for the potential GW exit pathway off of RVAAP.
2	SE/Load Line 1	LL1mw-065	Downgradient from Load Line 1, near proposed new Sharon well (#1), and serves as overburden monitoring well for the potential GW exit pathway off of RVAAP.
3	SE	SCFmw-004	Downgradient of Load Lines 1 and 2, paired with proposed new Sharon well (#3), and serves as Sharon Conglomerate Member well for monitoring the potential GW exit pathway off of RVAAP in the deeper aquifer.
4	SE	SCFmw-002	Downgradient of Atlas Scrap Yard and Load Lines 1, 2, 3, 4, and 12, paired with proposed new Sharon well (#4), and serves as Sharon Conglomerate Member well for monitoring the potential GW exit pathway off of RVAAP in the deeper aquifer.
5	S/Load Line 2	LL2mw-059	Downgradient of Load Line 3 and serves as potential GW exit pathway off of RVAAP.
6	S/Load Line 2	LL2mw-265	Downgradient of Load Line 3 and serves as potential GW exit pathway off of RVAAP.
7	Load Line 3	LL3mw-241	Located upgradient of proposed new Sharon well (#7) to evaluate contaminant migration pathway between Load Lines 3 & 12.
8	Load Line 3	LL3mw-242	Downgradient of Load Lines 3 and 12 and serves as potential GW exit pathway off of RVAAP.
9	S/Load Line 4	LL4mw-199	Downgradient of well LL4mw-193; unconsolidated well paired with proposed new Sharon well (#5); potential GW exit pathway.
10	Load Line 6	LL6mw-002	Unconsolidated well near proposed new well pair (#27 and #28); comparison well for fate-and-transport model.
11	Load Line 6	LL6mw-005	Homewood well near proposed new well pair (#27 and #28); comparison well for fate-and-transport model.
12	Load Line 10	LL10mw-003	Homewood well that has had historically consistent occurrence of VOCs (specifically carbon tetrachloride).
13	Load Line 11	LL11mw-007	Near proposed new well pair (#29 and #30); unconsolidated comparison well for fate-and-transport model.
14	Load Line 12	LL12mw-182	Paired with new proposed stainless steel well (#39); unconsolidated comparison well for bis(2-ethylhexyl)phthalate evaluation.
15	Load Line 12	LL12mw-185	Unconsolidated well that has been found to contain elevated levels of nitrate and is downgradient of potential arsenic source.
16	Load Line 12	LL12mw-187	Unconsolidated well that has been found to contain elevated levels of nitrate.
17	Load Line 12	LL12mw-242	Unconsolidated well located downgradient of LL12mw-113, a potential arsenic source.
18	Load Line 12	LL12mw-245	Unconsolidated well located downgradient of potential nitrate source well LL12mw-185.

Table 4-7 (continued). Semiannual Monitoring Wells and Rationale.

No.	RVAAP Area	Well Location	Rationale / Comments
19	Load Line 12	LL12mw-246	Unconsolidated well located in southeast (downgradient) portion of Load Line 12. Downgradient of ASY wells and near two proposed new wells (#4 and #6).
20	North Perimeter	BKGmw-005	Unconsolidated background well located upgradient of C Block quarry, former Route 80 tank farm, and proposed new Sharon well (#35); upgradient well for hydrogeologic model.
21	North Perimeter	BKGmw-021	Unconsolidated background well paired with proposed new Sharon well (#11); upgradient well for hydrogeologic model.
22	C Block	CBLmw-002	Near proposed new Homewood well (#36); Homewood comparison well for fate-and-transport model.
23	Central Burn Pits	CBPmw-002	Unconsolidated well paired with proposed new Sharon well (#8); vertical distribution evaluation; fate-and-transport model.
24	Building 1200	B12mw-012	Sharon well with known contamination near proposed new Sharon well (#10); potential contaminant migration pathway evaluation.
25	Winklepeck	WBGmw-007	Unconsolidated well near proposed new well pair (#13 and #14); comparison well for fate-and-transport model.
26	Winklepeck	WBGmw-009	Unconsolidated well paired with proposed new Sharon well (#15); vertical distribution evaluation; fate-and-transport model.
27	Winklepeck	WBGmw-006	Unconsolidated well paired with proposed new Sharon well (#16); vertical distribution evaluation; fate-and-transport model.
28	Demo. Area 2	DA2mw-108	Unconsolidated well near proposed new well pair (#17 and #18); comparison well for fate-and-transport model.
29	Demo. Area 2	DETmw-003	RCRA well; unconsolidated well paired with proposed new Sharon well (#19); vertical distribution evaluation; fate-and-transport model.
30	Demo. Area 2	DETmw-004	RCRA well.
31	NACA Test	NTAmw-109	Unconsolidated well paired with proposed new Homewood well (#26); vertical distribution evaluation; fate-and-transport model.
32	Erie Burning Grounds	EBGmw-125	Unconsolidated well downgradient from Ramsdell Quarry; potential exit pathway.
33	Ramsdell Quarry	RQLmw-007	RCRA well.
34	Ramsdell Quarry	RQLmw-008	RCRA well.
35	Ramsdell Quarry	RQLmw-009	RCRA well.

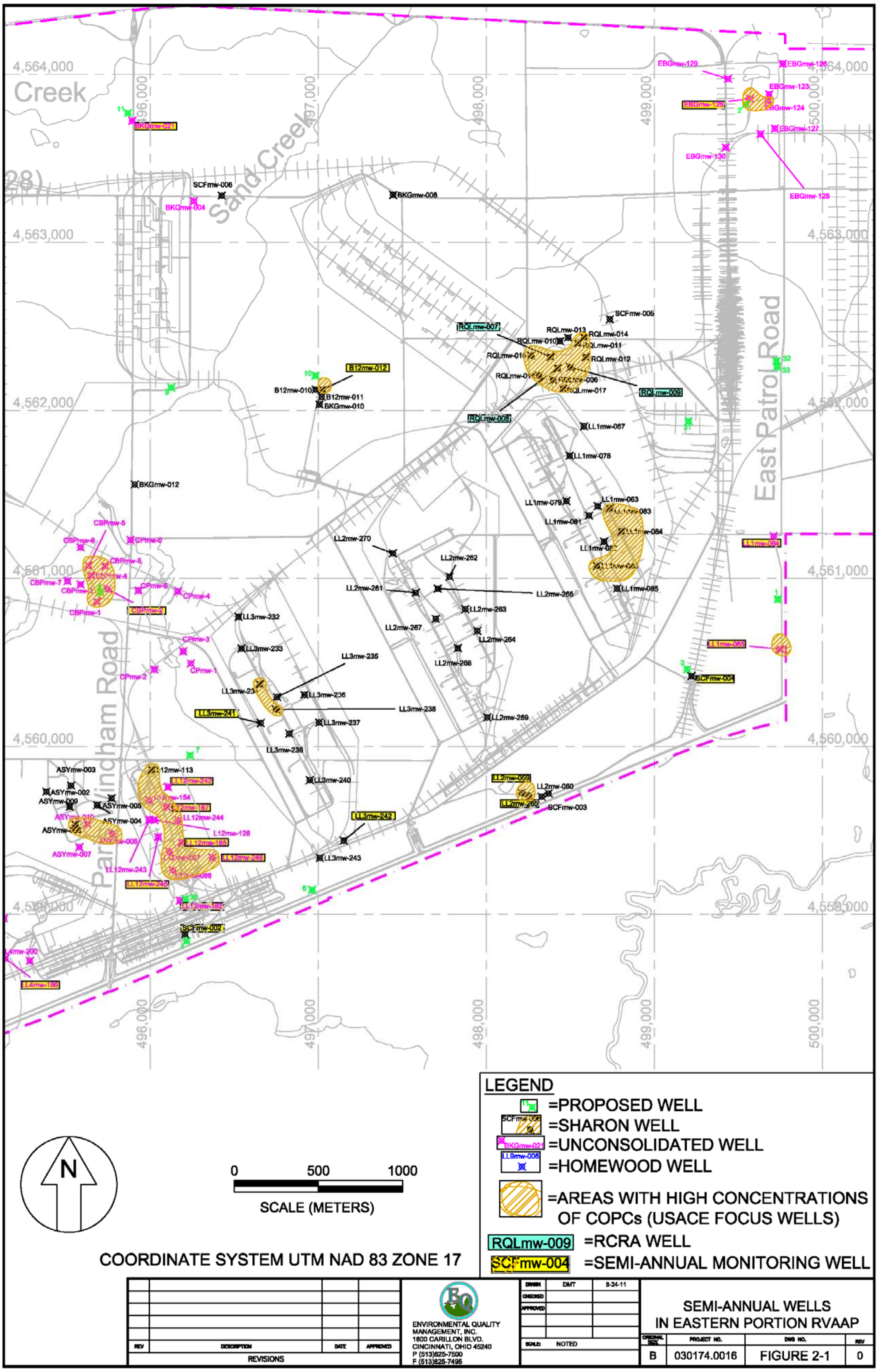


Figure 4-5. Semiannual Wells in Eastern Portion of RVAAP

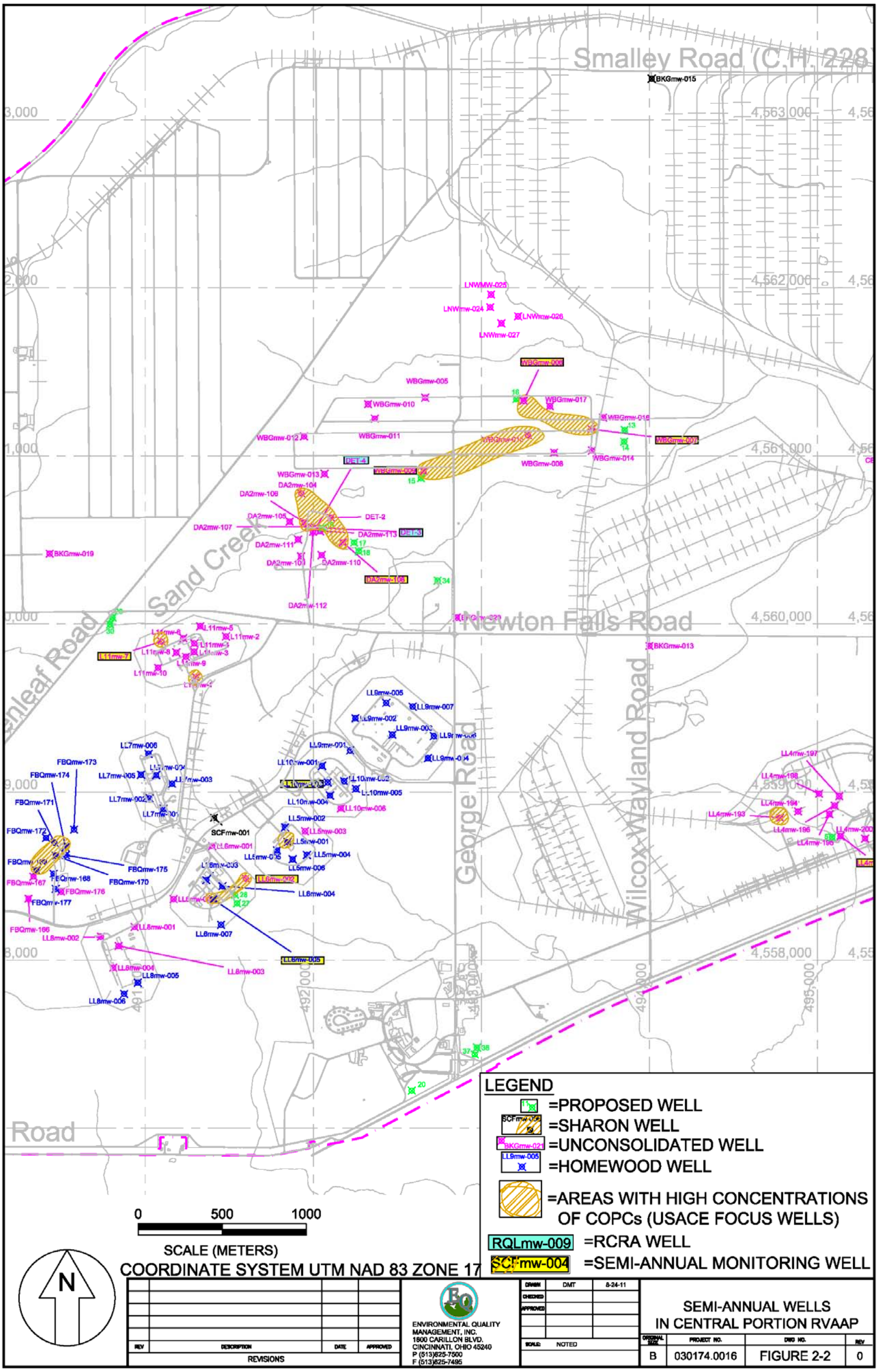


Figure 4-6. Semiannual Wells in Central Portion of RVAAP

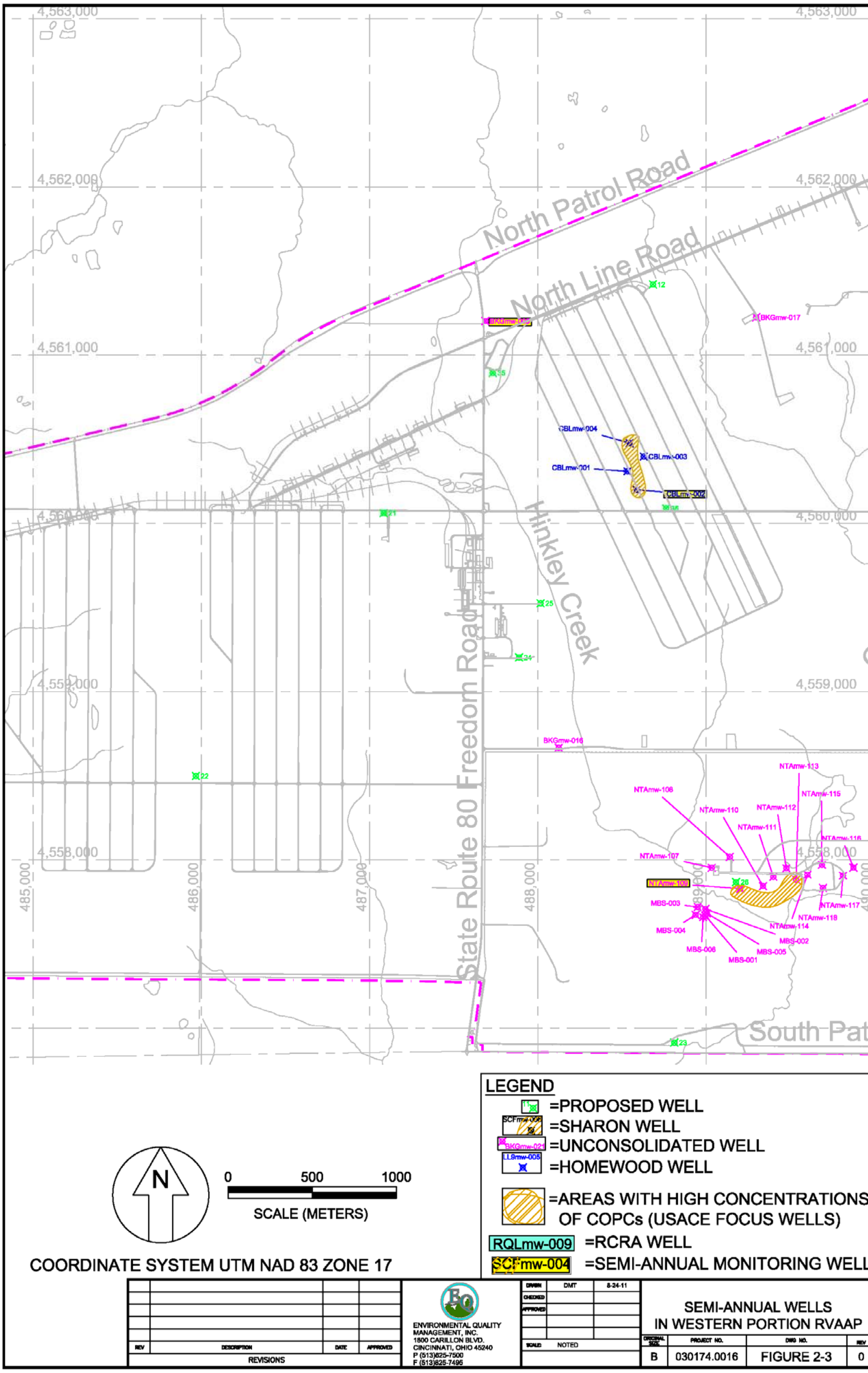


Figure 4-7. Semiannual Wells in Western Portion of RVAAP

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

- **Soil:** Drill cuttings will be placed in 55-gal drums. Soil cuttings generated from individual AOCs will be consolidated in the drums. Partial drums may be moved to a different AOC with similar COPCs (e.g., the various load lines). Composite samples will be collected from drums generated from similar AOCs (e.g., the load lines, the western facility wells). Disposition of the drummed soil will be based on analytical results from toxicity characteristic leaching procedure (TCLP) samples collected. Additional waste characterization parameters will be analyzed as required by the selected disposal facility.

- **IDW Water:** Development water from newly installed wells, purge water, and excess water not used for environmental samples will be placed in 55-gal drums. Water generated during pumping tests will be placed in 55-gal drums, poly tanks, and/or 20,000-gal fractionation tanks depending on the anticipated pumping rate and test duration. Disposition will be based on the analytical results of the environmental samples. If results indicate that IDW water is potentially hazardous, TCLP samples will be collected.

- **Decontamination Fluids:** Decontamination fluids will be placed in drums or a polytank up to 1,500 gallons in size as needed. Disposition of decontamination liquid will be based on the collection and analysis of TCLP liquid sample(s).

Drummed soil, sediment, and IDW water will be transported to a location designated by the RVAPP Environmental Coordinator, where it will be staged on wooden pallets. Decontamination fluids and field laboratory wastes will also be staged at the identified location within secondary containment structures. To avoid potential drum rupture due to freezing conditions, drums containing liquid IDW will be filled only to 75 percent capacity. Waste characterization samples will be collected in accordance with Section 5 of the *Final Facility-Wide Groundwater Monitoring Program RVAAP-66 Facility-Wide Groundwater Sampling and Analysis Plan for Environmental Investigation Services Addendum* (EQM, January 2012).

4.4 Sample Analysis/Validation

4.4.1 <u>Sample Analysis</u>

TestAmerica Laboratories, Inc. (TA) has been selected as the analytical subcontractor for this project. More specifically, the TA North Canton facility will perform the majority of the analytical methodologies and coordinate all logistical aspects associated with the analysis and reporting of samples. They will be supported by the TA Sacramento laboratory for the analysis of explosive, propellant, and mustard degradation constituents and the Denver laboratory for perchlorate analysis. This arrangement is consistent with the current analytical process at RVAAP.

During the 2012 sampling events, the new monitoring wells will be sampled and analyzed for the current analytical suite as presented in Table 4-6. This approach will both satisfy the Ohio EPA requirements for being protective of human health and the environment and reduce overall risk to the Army. For the remaining wells, the list of analytes will be reduced to reflect only those constituents identified above the applicable screening criteria within certain areas of the site. The refined analyte list for the semiannual wells is presented in Table 4-8. The analytical methods for these analytes are provided in Table 4-6.

During one sampling event in 2012, groundwater samples from seven selected wells in the semiannual monitoring well network, as well as the new wells, will also be submitted for analysis of hexavalent chromium. In addition, the new well installed near the Route 80 Tank Farm Area and the upgradient background well (BKGmw-005) to this location will also be sampled and analyzed for alpha/beta and gamma radionuclides since gamma radiation was previously identified in soil in this area of the site. Lastly, the new wells will also be sampled for perchlorate during one quarterly sampling event.

In addition, rock cores and Shelby tube samples collected during well installation activities will be submitted to a geotechnical laboratory for permeability testing using ASTM Method D-5084, “Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter.”

4.4.2 Data Validation

Data validation begins with the laboratory analyst and continues until the data are reported. Individual analysts will verify the completion of the appropriate data forms to ensure the completeness and correctness of data acquisition and reduction. All in-laboratory data validation will be conducted in accordance with methods delineated in the USEPA’s "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods" (SW-846), and “Manual for Chemical Analysis of Water and Wastes" (EPA 600/4-79-020).

Additional validation of analytical results will be performed by the Project Quality Assurance Manager. Qualified EQM project chemists will verify 100 percent of the data generated for this project as outlined in Section 4.3.2 (Step-2) of the Louisville DoD Quality Systems Manual Supplement, Version 1. Additionally, the data will be reviewed to ensure holding times are met, matrix spike recoveries are within acceptable ranges, and blank sample results do not exceed acceptable concentrations as presented in the project-specific QAPP presented and approved for the PBA-11 RVAAP-66 Facility-Wide Groundwater. If project-specific analytes are detected in the blanks, the data will be evaluated on a case-by-case basis to assess the effect on the project objective. When determined to be necessary, corrective actions, such as reanalysis or resampling and analysis, will be evaluated and implemented.

The QA objectives for precision, accuracy, representativeness, completeness, and comparability of the data for this project are specified in the *Final Facility-Wide Groundwater Monitoring Program RVAAP-66 Facility-Wide Groundwater Quality Assurance Project Plan Addendum* (QAPP; EQM, January 2012), which is Part II of the *Final Facility-Wide Groundwater Monitoring Program Plan RVAAP-66 Facility-Wide Groundwater Addendum*. Data validation

Table 4-8. Semiannual Analyte List

Well Location	Analytes										
	VOCs	SVOCs			Metals[d]	Explosives	Pesticides	PCBs	Nitrate	Cyanide	Hexavalent Chromium
		Nitroaromatics & Phthalates[a]	Phenols[b]	PAHs[c]							
SCFmw-002	x	x	x	x	x	x	x	x	x		x
SCFmw-004	x	x	x		x	x	x	x			
LL1mw-064	x	x			x	x	x				
LL1mw-065	x	x			x	x	x				
LL2mw-059	x	x	x		x	x	x	x			x
LL2mw-265	x	x	x		x	x	x	x			x
LL3mw-241	x	x			x	x	x				
LL3mw-242	x	x			x	x	x				
LL4mw-199	x	x			x	x	x				
LL6mw-002		x		x	x						
LL6mw-005		x		x	x						
LL10mw-003	x				x						
LL11mw-007	x	x			x	x	x				
LL12mw-182		x									
LL12mw-185					x (As only)				x		
LL12mw-187	x	x	x	x	x	x	x	x	x		
LL12mw-242	x	x	x	x	x	x	x	x	x		
LL12mw-245	x	x	x	x	x	x	x	x	x		
LL12mw-246	x	x	x	x	x	x	x	x	x		
BKGmw-005	x	x			x	x	x	x			
BKGmw-021	x	x			x	x	x	x			
CBLmw-002		x		x				x			x
CBPmw-002		x			x		x	x			
B12mw-012		x		x	x						
WBGmw-006	x	x			x	x					
WBGmw-007	x	x			x	x					
WBGmw-009	x	x			x	x					
DA2mw-108		x			x	x		x			x
DET-003	x	x	x	x	x	x	x	x		x	x
DET-004	x	x	x	x	x	x	x	x		x	x
NTAmw-109	x	x		x	x			x			
EBGmw-125		x			x						
RQLmw-007	x	x	x	x	x	x	x	x		x	
RQLmw-008	x	x	x	x	x	x	x	x		x	
RQLmw-009	x	x	x	x	x	x	x	x		x	

[a] Analyte list includes: 2,4-Dinitrotoluene, 2,6-Dinitrotoluene, Bis(2-ethylhexyl)phthalate, Butyl benzyl phthalate, Diethyl phthalate, Dimethyl phthalate, Di-n-butyl phthalate, Di-n-octyl phthalate, and Nitrobenzene

[b] Analyte list includes: 2,4,5-Trichlorophenol, 2,4,6-Trichlorophenol, 2,4-Dichlorophenol, 2,4-Dimethylphenol, 2,4-Dinitrophenol, 2-Chlorophenol, 2-Methylphenol, 2-Nitrophenol, 4,6-Dinitro-2-methylphenol, 4-Chloro-3-methylphenol, 3&4 Methylphenol, 4-Nitrophenol, Pentachlorophenol, and Phenol

[c] Analyte list includes: Acenaphthene, Acenaphthylene, Anthracene, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(g,h,i)perylene, Benzo(k)fluoranthene, Chrysene, Dibenz(a,h)anthracene, Fluoranthene, Fluorene, Indeno(1,2,3-cd)pyrene, Naphthalene, Phenanthrene, and Pyrene.

[d] Analyte list includes: Aluminum, Antimony, Arsenic, Barium, Beryllium, Cadmium, Calcium, Chromium, Cobalt, Copper, Iron, Lead, Magnesium, Manganese, Mercury, Nickel, Potassium, Selenium, Silver, Sodium, Thallium, Vanadium, and Zinc.

will be performed in accordance with the QAPP. Additional detail regarding data validation procedures are described in Section 4 of the QAPP.

Field data will be recorded on the appropriate field record form or in a bound field sample logbook or equivalent. All field data will be verified and reviewed by the Field Sampling Manager.

4.4.3 Data Reporting

All results will be reported by the laboratory to the Field Sampling Manager or his designee by sample batch and will be certified by the laboratory. Data reports will be forwarded to EQM from TA within 4 weeks following laboratory receipt of samples. All required reports and documentation, including quality control results, will be clearly labeled with the laboratory sample number and associated field sample number.

Analytical results will be given in units of µg/L or mg/L for liquid samples. In addition to the analytical results and quality control data, details regarding the corrective actions taken and a discussion of any necessary modifications of the protocols established in the referenced methods will be included in the final data report. The final data package submitted by the analytical laboratory will include a summary of the analytical results for each sample as well as all reports and documentation generated as required by analytical methods. The final data package will be compared to the preliminary results by the Field Sampling Manager. Any discrepancies affecting field activities will be reported to the Project QA Manager immediately. Analytical Level IV will be followed for all groundwater sampling for this project. Level IV data packages and an automated data review (ADR) compatible electronic data deliverable (EDD) will be provided by the analytical laboratory.

The ADR EDD supplied with each secure data group (SDG) will be processed by EQM using the project-specific library and ADR software. Each ADR EDD provided by TA will be compliance screened using the ADR software and project-specific library. The ADR report generated will be combined with any issues identified by EQM project chemists during the course of the manual verification into one report and submitted to the USACE.

4.5 Data Evaluation

Data collected during the RI will be evaluated relative to refinement of the CSM. Specifically, the new data will further characterize potential source areas, the nature and extent of groundwater impact, contaminant fate-and-transport pathways, and the effects on human health and the environment. Data collection and analysis for site characterization is complete when DQOs that were developed in scoping (including any revisions during the RI) are met, when the need (or lack thereof) for remedial actions is documented, and when the data necessary for the development and evaluation of remedial alternatives have been obtained.

4.5.1 Site Characteristics

The evaluation of site characteristics shall focus on the current extent of contamination and estimating the travel time to, and predicting contaminant concentrations at, potential exposure points. Data will be analyzed to describe 1) the site physical characteristics, 2) the source characteristics, 3) the nature and extent of contamination, and 4) important contaminant fate-and-transport mechanisms.

Information on site physical characteristics will be used to determine the environmental setting of the site such as surface features, soils, geology, hydrology, meteorology, and ecology. Physical characteristics for RVAAP are discussed in Sections 3.1 and 3.4 through 3.10. As additional data are gathered during the RI, the physical characteristics will be refined, where appropriate, including hydrogeologic properties (e.g., aquifer permeability, porosity) and extent of subsurface systems.

Data on source characteristics will be evaluated to determine inputs to the contaminant fate-and-transport model, including the mobility and persistence of source contaminants and the potential magnitude of releases at various AOCs.

An analysis of data collected across RVAAP will be performed to describe contaminant concentration levels in groundwater. Analyses that are important to the subsequent risk assessment and subsequent development of remedial alternatives will be evaluated including spatial and temporal trends and horizontal and vertical contaminant distribution patterns. For Facility-Wide groundwater, the horizontal extent of contaminant impacts has been essentially defined. However, additional investigation activities are planned under the FWGWMP Plan to complete hydrogeologic system modeling and to conduct contaminant fate-and-transport modeling for a Facility-Wide groundwater approach (see Section 4.3). These activities, which are addressed in the *Final Facility-Wide Groundwater Monitoring Program RVAAP-66 Facility-Wide Groundwater Sampling and Analysis Plan for Environmental Investigation Services Addendum* (EQM, January 2012), include installation of 39 new wells and permeability testing on 20 soil/rock cores. The proposed wells were optimally placed to further evaluate potential exit pathways along the southern and eastern boundaries of RVAAP, secondarily assess potential groundwater impacts from CR sites, and evaluate vertical contaminant distribution and/or particle inflow/outflow through the central portion of the facility.

Additional data needs for the model include: 1) water level data for wells screened at all hydrostratigraphic units; 2) elevations of each hydrostratigraphic layer; 3) spatial information related to domain boundaries (e.g., water bodies, significant streams); 4) source term data from individual AOCs; 5) analytical data used to define initial plumes for each aquifer; 6) available flow rates for streams included within the model boundaries; 7) facility-wide or area-specific flow parameters (e.g., permeability, porosity, recharge values); 8) facility-wide or area-specific transport parameters (e.g., sorption, ranges of transverse, longitudinal, and vertical dispersivity); 9) GIS coverage, including waste units, source areas, area footprints, topography, site cultural features, wetland areas, etc.; 10) long-term head values for flow model calibration; 11) precipitation data; and 12) pump test data (see Section 4.3.3). With the exception of the stream flow and pump test data and information from the planned wells and permeability tests, most of this information is currently available from existing RVAAP data and published studies.

4.5.2 Contaminant Fate-and-Transport Modeling

The revised CSM incorporating all the results of the site physical characteristics, source characteristics, and extent of contamination analyses will be utilized in the analyses of contaminant fate and transport. The complex nature of the hydrogeology and contaminants at the RVAAP precludes development of a single numerical computer model to describe the fate and transport of contaminants. Rather, several small-scale analytical and numerical transport models, along with simple estimates of contaminant attenuation and dilution along specific migration pathways, will be combined to develop the framework of the conceptual model for fate and transport analysis.

The primary purpose for applying fate-and-transport modeling to the RVAAP is to support the transition from an AOC-based approach to a facility-wide groundwater remedial evaluation. The overall objective of this effort will be to evaluate potential future problem areas in which contaminant concentrations in groundwater may exceed FWCUGs/MCLs, support the human health risk assessment, and support developing remedial alternatives in the FS. The following tasks will be performed to achieve these objectives.

Task 1. Revise/Update the CSM

The CSM describes the flow and contaminant transport behavior of the hydrogeologic system. It is translated into a mathematical/numerical model for predicting future behavior of the system under changing conditions in both space and time. The flow model identifies the flow field (i.e., gradient, porosity, and hydraulic conductivity), geology, and hydrologic boundaries such as drains, ditches, or creeks. The transport model identifies the contaminant plume and its behavior (e.g., migration rate, degradation, and dispersion).

The CSM depicts the expected site conditions and serves as a paradigm against which observations can be compared and within which predictions can be made. The predictive function of the CSM, of primary importance to groundwater flow-and-contaminant transport modeling, relies on known information and informed assumptions about the site. The existing CSM will be revised/updated through extensive review and assimilation of available data and additional information to be collected during this RI. This task is elaborated in Section 4.1.3 and is not repeated here.

Task 2. Selection of Analytical and Numerical Models

Groundwater flow and transport models are used as tools for predicting groundwater levels and contaminant concentrations at various locations as deemed necessary and for evaluating the effectiveness of remedial alternatives. Selection of a predictive model at a site must consider its performance, characteristics, and applicability to the site. Field data, observations, and process knowledge must be incorporated into mathematical formulations so that they accurately represent the system and can be used for their intended purposes. The following characteristics are considered in selecting an appropriate model for this site:

1. The model must be technically sound (i.e., the mathematical formulations of the selected models should properly describe the physics of the site being modeled).

2. The model should be a public domain model or should be readily available.

3. The model should have received adequate peer review and must be accepted by regulators, their representatives, and the general public.

4. The model should be able to provide the information necessary to make sound decisions.

5. The model input requirements should be identified, and those input parameters should either exist for the site being modeled or refer to local/literature estimates.

6. The model should be easy to use and must have high-quality technical support if problems are encountered or bugs are discovered in the model.

Based on the above characteristics, the following models are intended to be used in performing flow and transport modeling for the RI, assuming approval from the RVAAP stakeholders:

MODFLOW. MODFLOW is a 3-dimensional, finite-difference groundwater model used to simulate groundwater flow from the source to the surface water discharge point. It has a modular structure that allows it to be easily modified to adapt the code for a particular application. MODFLOW simulates steady and nonsteady flow in an irregularly shaped flow system in which aquifer layers can be confined, unconfined, or a combination of confined and unconfined. Flow from external stresses, such as flow to wells, areal recharge, evapotranspiration, flow to drains, and flow through river beds, can be simulated. Hydraulic conductivities or transmissivities for any layer may differ spatially and be anisotropic (restricted to having the principal directions aligned with the grid axes), and the storage coefficient may be heterogeneous. Specified head and flux boundaries can be simulated, as can a head-dependent flux across the model's outer boundary that allows water to be supplied to a boundary block in the modeled area at a rate proportional to the current head difference between a "source" of water outside the modeled area and the boundary block. MODFLOW was developed by the USGS (McDonald and Harbaugh, 1988).

MODPATH. MODPATH is a 3-dimensional, particle-tracking model capable of using the steady-state, head distribution generated by MODFLOW to track flowpaths of particles released in the groundwater flow field modeled by MODFLOW. MODPATH was developed by the USGS (Pollock, 1989). MODPATH was run to identify the locations for predicting future concentrations based on the fastest flow path from the source boundary to the point of groundwater discharge to surface water.

MT3DMS. MT3DMS is a transport model used to simulate advection, dispersion, and chemical reactions of contaminants in groundwater flow systems in either two or three dimensions (Zeng and Wang 1999). The model is developed for use with any block-centered finite-difference flow model, such as MODFLOW. The model is based on the assumption that changes in the concentration field will not affect the flow field significantly. The model accommodates the following spatial discretization schemes and transport boundary conditions: (1) confined, unconfined, or variably confined/unconfined aquifer layers, (2) inclined model layers and variable cell thickness within the same layer, (3) specified concentration or mass flux boundaries, and (4) solute transport effects of external hydraulic sources and sinks such as wells, drains, rivers, areal recharge, and evapotranspiration. The model accommodates the following chemical reactions: (1) equilibrium-controlled linear or non-linear sorption and (2) first-order irreversible decay or biodegradation.

AT123D. The AT123D is a well-known and commonly used analytical groundwater pollutant fate and transport model. This model was developed by Yeh (1992) and has since been updated by General Sciences Corporation (GSC, 1996). The model computes the spatial-temporal concentration distribution of chemicals in aquifer systems and predicts the transient spread of a chemical plume through a groundwater aquifer. The fate and transport processes accounted for in AT123D are advection, dispersion, adsorption/retardation, and decay. This model can be used as a tool for estimating the dissolved concentration of a chemical in three dimensions in groundwater resulting from a mass release (either continuous or instant or depleting source) over a source area (i.e., point, line, area, or volume source).

Task 3. Develop and Calibrate a Numerical Model

- Once the selected models have been approved by the RVAAP Groundwater End State Working Group, the EQM team will develop a 3-dimensional numerical groundwater flow model for the RVAAP facility-wide groundwater AOC that is consistent with the RVAAP CSM, regional hydraulic boundaries, and prior RVAAP modeling efforts by using Groundwater Vistas software (ESI, 2011) and MODFLOW.

- Reasonable calibration goals will be established and the groundwater flow model will be calibrated to match RVAAP long-term head values, measured/inferred groundwater flux rates, recharge rates, and flow trajectories. Groundwater discharge areas will be indicated and a water balance will be estimated that shows flux rates in/out of aquifers/aquitards and across model boundaries. The model will be considered calibrated when the lowest sum of squared residuals will be achieved and industry standard calibration goals are met. The industry standard calibration goals were as follows:

    1. Residual Mean/Observed Range in Head < or = 0.05 (5%);
    2. Standard Deviation/Observed Range in Head < or = 0.1 (10%);
    3. Absolute Residual Mean/Observed Range in Head < or = 0.1 (10%).

- Model boundary conditions will be derived from the existing groundwater boundaries where appropriate, taking advantage of any natural groundwater boundaries (streams, groundwater divides, etc.). The development of all boundary conditions used in this model will be fully documented in the RI/FS Report.

- Sensitivity Analysis will be performed on the key model input parameters to identify the uncertainty in the model predictions. Both quantitative and qualitative sensitivity analysis of flow parameters bill be conducted. In the quantitative analysis the parameters to vary will include: horizontal and vertical hydraulic conductivity (*Kh* and *Kv*), recharge, and porosity. Output to examine may include flux to streams, the difference in particle travel time, and calibrated head differences. In the qualitative analysis, EQM will perform forward and reverse particle tracking using MODPATH to determine flow direction and travel times for particles released at the source term locations to see if the calibrated flow model can approximate current conditions.

Task 4. Develop Transport Models for the Primary Contaminant Migration Chemicals of Potential Concern

- Groundwater contaminant migration chemicals of potential concern (CMCOPCs) will be identified by comparing the maximum constituent concentrations from the most recent sampling events (to be conservative, at least the maximum from two years of the most recent data) to the applicable comparative criteria (i.e.: MCLs, RSL, FWCUGs, etc).

- Identify the primary CMCOPCs from each chemical group.

- Using Groundwater Vistas software and MT3DMS, 3-dimensional transport models will be developed for primary CMCOPCs. For the remaining CMCOPCs simple calculations using dilution attenuation factor (DAF) that will be developed based on the primary CMCOPC will be performed. However, if necessary, simple analytical transport modeling using AT123D may also be performed.

- As applicable, plumes for primary CMCOPCs, based on the concentrations from well locations within AOCs across RVAAP, will be developed using a combination of professional judgment and SURFER software. For multiple events, multiple plumes will be developed for each primary CM COPC.

- A sensitivity analysis will be performed to identify transport model parameter uncertainty.

Task 5. Modeling in Support of FS Development

- Using the calibrated flow model, simulations will be performed to demonstrate the zones of influence in response to groundwater pumping to identify “early attainment” groundwater resource use zones. Simulations will be performed using the calibrated flow model to demonstrate the zones of influence in response to groundwater pumping to identify “early attainment” groundwater resource zones. Figure 4-8 shows an example model output for RVAAP illustrating what the potential early attainment zones (i.e., areas within RVAAP that may be available for groundwater use by OHARNG prior to signing the ROD) might look like. The figure shows the generalized source areas at RVAAP as reflected by current data and the potential areas for unrestricted groundwater usage outside these source areas. The conceptualized model output also illustrates groundwater exit pathways and key wells along these exit pathways, as well as maximum radii of influence for potential future groundwater resource production wells at the site. As evidenced by this simulated model, there could be several early attainment zones at

RVAAP that may be eligible for unrestricted groundwater usage. However, the final model output will reflect the groundwater quality results from the new and existing wells, as well as the aquifer test data and permeability test results. These data will aid in further refining the early attainment zones. Further discussion on the early attainment zones is presented in Section 4.9.

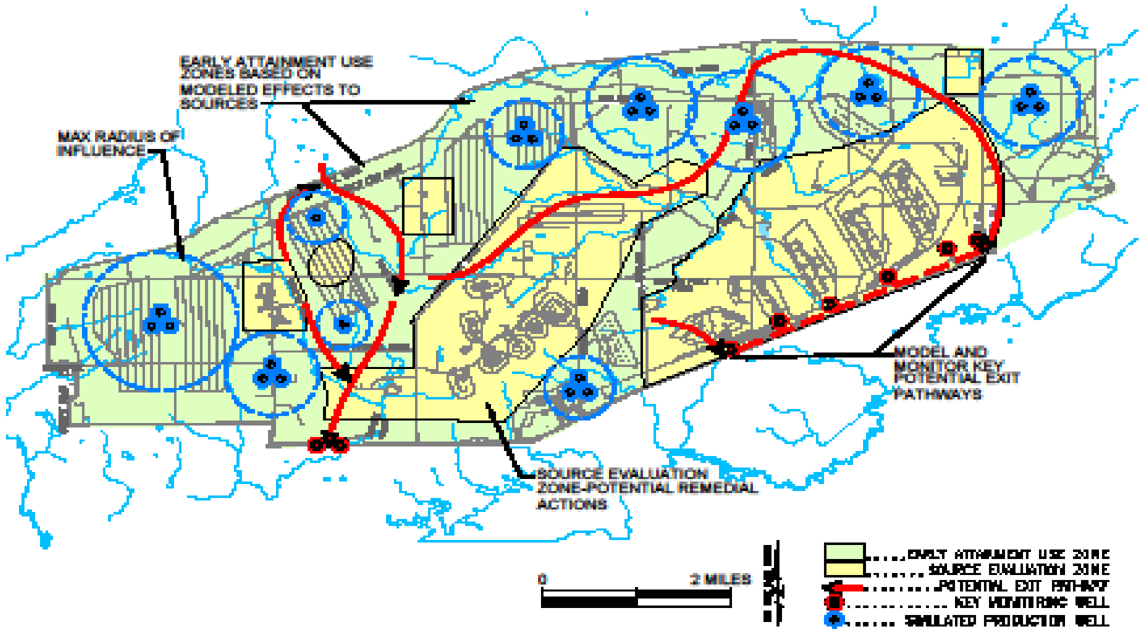


Figure 4-8. Example Model Output of Early Attainment Use Zones

- Model simulations will be performed to evaluate the effects of source remediation, combinations of remedial technologies, or changes in remedial system configurations. These simulations can help predict effectiveness and timelines for remedial alternatives to achieve cleanup objectives. Modeling results will be used to help evaluate and rank single or combined technologies based on predicted time to reach cleanup goals and reduction of peak concentrations and contaminant mass in aquifers and at surface water discharge points. Optimal simulations will also be conducted for active remedial technologies if selected (e.g., pump and treat or *in situ* technologies).

- For LTM and MNA technologies, the adequacy of the existing groundwater monitoring well network will be evaluated using statistical applications (e.g., MAROS, MCES, etc.) and modeling results to optimize proposed monitoring well locations, sampling frequency and duration, and target parameters.

Task 6. Post-processing Applications and Model Documentation

- The groundwater flow and contaminant transport model will be thoroughly documented, including the model development, model calibration processes, simulations performed, and evaluations and interpretations of results. Model documentation will be summarized in the RI/FS Report and independent technical reviews, engineering calculation reviews, and model QA/QC packages will be maintained as part of the permanent project files.

- EQM will work with the stakeholders to evaluate potential applications of post-processing tools, such as Surfer or EarthVision, to visualize, better understand, and communicate modeling results.

4.6 Assessment of Risks

The baseline risk assessment (BRA) will provide an evaluation of the potential threat to human health and the environment in the absence of any remedial action. This section discusses the approach to the human health BRA for the facility-wide groundwater AOC. Assessments of ecological risks at the facility are being performed as part of individual source area investigations. A full-scale ecological risk assessment will not be performed as part of the facility-wide groundwater AOC due to the lack of exposure pathways to ecological receptors. However, an ecological assessment will be made, from existing data, relative to potential groundwater impacts to receiving streams.

In general, the objectives of a baseline risk assessment may be attained by identifying and characterizing the following:

- Toxicity and levels of hazardous substances present in relevant media (e.g., air, groundwater, soil, surface water, sediment, and biota).
- Environmental fate and transport mechanisms within specific environmental media such as physical, chemical, and biological degradation processes and hydrogeological conditions.
- Potential human and environmental receptors.
- Potential exposure routes and extent of actual or expected exposure.
- Extent of expected impact or threat and the likelihood of such impact or threat occurring (i.e., risk characterization).
- Level(s) of uncertainty associated with the above items.

The risk assessment process can be divided into four components: contaminant identification, exposure assessment, toxicity assessment, and risk characterization.

4.6.1 BRA Methodology

In 2010, the Army and the regulators completed the Facility-Wide Human Health Cleanup Goals for the RVAAP (FWCUG Report, USACE, 2010), which laid out an accelerated approach to developing site-specific BRAs. The expedited approach is as follows:

1. Using the risk assessment process presented in the RVAAP Facility-Wide Human Health Risk Assessor's Manual, Amendment 1 (Risk Manual, USACE 2005), and appended by

information in the Final FWCUG Report), develop FWCUGs for all chemicals likely to be found at RVAAP.

2. Perform RI characterization sampling and analysis to establish the baseline chemical concentrations within an AOC.
3. Perform mapping and data analysis to determine exposure units (EUs) and to identify COPCs (Figure 3-2) and their related exposure point concentrations (EPCs), following the requirements for performing these tasks as spelled out in the Risk Manual and further clarified in the position paper developed by the Army Corps of Engineers.
4. Compare AOC-specific EPCs to the FWCUGs to determine AOC-specific COPCs.
5. Perform the FS, Proposed Plan, and ROD to address any identified COPCs.

The calculated FWCUGs were established based on the risk assessment inputs and decisions for RVAAP that were already agreed to by stakeholders through the application of the CERCLA and RCRA processes. Most of the agreed-to risk assessment methodology has been documented in the *Ravenna Army Ammunition Plan Facility-Wide Human Health Risk Assessor Manual, Amendment 1* (USACE, 2005), also referred to as the Risk Manual. The Risk Manual, along with the supplemental White Paper, provides the framework for the FWCUGs developed by SAIC and presented in the *Final Facility-Wide Human Health Cleanup Goals for the Ravenna Army Ammunition Plant, Ravenna, Ohio* (SAIC, March 23, 2010). The purpose of the baseline risk assessment will be to addend the FWCUGs, as needed, based on changes to risk assessment databases and methodologies, continual evolution of conditions and contaminant issues at RVAAP, and/or changes to current or future land use.

4.6.2 Contaminant Identification

The objective of contaminant identification is to screen the information that is available on hazardous substances or wastes present at the site and to identify contaminants of concern to focus subsequent efforts in the risk assessment process. Contaminants of concern may be selected because of their intrinsic toxicological properties, because they are present in large quantities, or because they are presently in or potentially may move into critical exposure pathways (e.g., drinking water supply).

Section 2.2 of the FWCUG Report (USACE, 2010) provides the approach to Step 1 for groundwater:

> *The groundwater data set in REIMS is quite extensive, containing over 800 sampling results for many chemicals. These results come from both CERCLA and RCRA characterization and permit efforts, as well as the facility-wide groundwater sampling that takes place semiannually. For this exercise, we evaluated over 800 filtered groundwater samples, which represent the actual dissolved-phase of a chemical in the groundwater, but did not include unfiltered data and well point results. Well point sampling was intended for Phase I reconnaissance. Because the well points were not installed and sampled using standard groundwater sampling requirements (e.g., filter pack, surface casings, etc.), the sample quality is questionable.*

Table 2-2 of the FWCUG Report provides the complete list of facility-wide COPCs for groundwater for which FWCUGs were developed. Anions and miscellaneous analytes for which no toxicity data exist are eliminated from consideration (e.g., nitrite, sulfate, sulfide, sulfite, alkalinity, ammonia, phenols, total petroleum hydrocarbons-diesel-range organics, total dissolved solids, and total organic carbon).

If additional containments are detected during the facility-wide groundwater RI, they will be included in the COPC list, as per the agreed to method in the FWCUG Report. Appendix B of the FWCUG Report provides guidance for identifying any new COPCs and for developing the groundwater exposure point concentrations in groundwater.

4.6.3 Exposure Assessment

The objectives of an exposure assessment are to identify actual or potential exposure pathways, to characterize the potentially exposed populations, and to determine the extent of the exposure. Identifying potential exposure pathways helps to conceptualize how contaminants may migrate from a source to an existing or potential point of contact. An exposure pathway may be viewed as comprising four elements: 1) a source and mechanism of chemical release to the environment; 2) an environmental transport medium (e.g., air, groundwater) for the released chemical; 3) a point of potential contact with the contaminated medium (i.e., exposure point); and 4) an exposure route (e.g., inhalation, ingestion) at the exposure point.

The analysis of the contaminant source and how the contaminants may be released involves characterizing the COPCs at the site and determining the quantities and concentrations of contaminants released to environmental media. This analysis is presented in the CSM.

Once the source(s) and release mechanisms have been identified, an analysis of the environmental fate and transport of the contaminants is conducted. This analysis considers the potential environmental transport (e.g., groundwater migration, airborne transport); transformation (e.g., biodegradation, hydrolysis, and photolysis); and transfer mechanisms (e.g., sorption, volatilization) to provide information on the potential magnitude and extent of environmental contamination. Next, the actual or potential exposure points for receptors are identified. The focus of this effort should be on those locations where actual contact with the COPCs will occur or is likely to occur. Last, potential exposure routes that describe the potential uptake mechanism (e.g., ingestion, inhalation) once a receptor comes into contact with contaminants in a specific environmental medium are identified and described. Environmental media that may need to be considered include air, groundwater, surface water, soil and sediment, and food sources.

After the exposure pathway analysis is completed, the potential for exposure shall be assessed. Information on the frequency, mode, and magnitude of exposure(s) shall be gathered. These data are then assessed to yield a value that represents the amount of contaminated media contacted per day. This analysis shall include not only identification of current exposures but also exposures that may occur in the future if no action is taken at the site. Because the frequency mode and magnitude of human exposures will vary based on the primary use of the area (e.g., residential, industrial, recreational), the expected use of the area in the future shall be evaluated.

The purpose of this analysis is to provide decision-makers with an understanding of both the current risks and potential future risks if no action is taken. Therefore, as part of this evaluation, a reasonable maximum exposure scenario will be developed, which reflects the type(s) and extent of exposures that could occur based on the likely or expected use of the site (or surrounding areas) in the future. The reasonable maximum exposure scenario is presented to the decision-maker so that possible implications of decisions regarding how to best manage uncertainties can be factored into the risk management remedy selection.

The final step in the exposure assessment is to integrate the information and develop a qualitative and/or quantitative estimate of the expected exposure level(s) resulting from the actual or potential release of contaminants from the site.

The FWCUG Report identifies the components of the Exposure Assessment for the development of the groundwater FWCUGs, including exposure pathways and parameters (USACE, 2010). In the report, the National Guard Trainee (assumed to be on-site) and the Resident Farmer (assumed to be offsite in the present and on-site in the future) are potentially exposed to groundwater via:

- Drinking water ingestion
- Dermal Contact while showering
- Inhalation

4.6.4 Toxicity Assessment

Toxicity assessment, as part of the Superfund baseline risk assessment process, considers 1) the types of adverse health or environmental effects associated with individual and multiple chemical exposures; 2) the relationship between magnitude of exposures and adverse effects; and 3) related uncertainties such as the weight of evidence for a chemical's potential carcinogenicity in humans. Dose-Response Assessment is the process of quantitatively evaluating the toxicity of a given chemical agent as a function of human exposure to that chemical agent. The relationship between the dose of the contaminant administered or received and the incidence of adverse health effects in the exposed population forms the basis for the quantitative dose-response relationship. From these relationships, toxicity values (e.g., reference doses and slope factors) are derived that can be used to estimate the incidence or potential for adverse effects in an exposed population.

Hazard Identification is the process of determining whether exposure to a chemical agent can cause an increase in the incidence of a particular adverse health effect (e.g., cancer, birth defects) and whether the adverse health effect is likely to occur in humans. The process examines the available scientific data for a given chemical (or group of chemicals) and develops a weight of evidence to characterize the link between the negative effects and the chemical agent.

Typically, the Superfund risk assessment process relies heavily on existing toxicity information and does not involve the development of new data on toxicity or dose-response relationships. Available information on many chemicals has already been evaluated and summarized by various EPA program offices or cross-agency work groups [e.g., Integrated Risk Information System (IRIS)]. These documents often estimate carcinogen exposures associated with specific lifetime cancer risks (e.g., risk-specific doses), and systemic toxicant exposures that are not likely to present appreciable risk or significant adverse effects to human populations over a lifetime.

The toxicity information for both carcinogens and non-carcinogens use to develop the groundwater FWCUGs is presented in Section 4 of the FWCUG Report. During the development of the facility-wide groundwater BRA, toxicity information for COPCs will be reviewed to determine if toxicity information has changed such that it would impact the outcome of the assessment. If more restrictive toxicity values have been published, the ratio of the old/new values will be used to scale the published groundwater FWCUGs.

4.6.5 Risk Characterization

In the final component of the risk assessment process, a characterization of the potential risks of adverse health or environmental effects for each of the exposure scenarios derived in the exposure assessment is developed and summarized. Estimates of risks are obtained by integrating information developed during the exposure and toxicity assessments to characterize the potential or actual risk, including carcinogenic risks, noncarcinogenic risks, and environmental risks. To estimate potential noncarcinogenic effects, comparisons are made between projected intakes of substances and toxicity values; to estimate potential carcinogenic effects, probabilities that an individual will develop cancer over a lifetime of exposure are determined from projected intakes and chemical-specific dose-response information. Major assumptions, scientific judgments, and to the extent possible, estimates of the uncertainties embodied in the assessment are also presented. The final analysis will include a summary of the risks associated with a site including each projected exposure route for contaminants of concern and the distribution of risk across various sectors of the population. In addition, such factors as the weight-of-evidence associated with toxicity information, and any uncertainties associated with exposure assumptions, shall be discussed.

The results of the baseline risk assessment may indicate that the site poses little or no threat to human health or the environment. In this event, the FS will either be scaled down, as appropriate, to the site and its potential hazard, or eliminated altogether. The results of the RI and the baseline risk assessment will therefore serve as the primary means of documenting a no-action decision and potentially reducing or eliminating the scope of the FS.

Section 5 and Appendix B of the FWCUG Report identifies for method for applying the FWCUGs to identify the potential risks at the site. In general, the site-specific groundwater exposure point concentrations will be compared to the FWCUGs to identify any EPC > FWCUGs that would qualify a containments to be a COPC in the FS.

The approach used to identify EPCs for the facility-wide groundwater is presented in Section 4.6.6.

4.6.6 Framework for Applying the FWCUGs to the Facility-Wide Groundwater Area of Concern

Exposure point concentrations for the groundwater will be identified using both groundwater data (and the standard statistical approaches for identifying 95% upper confidence limits on the mean), and by using the results of the quantitative fate and transport modeling described in Section 4.5.

The entire process will start with the RVAAP Groundwater End State Working Group. The Working Group will work with the technical team to identify the final land use end states for the AOC, assuming they may vary across the RVAAP. It is anticipated that areas already set aside for National Guard training will remain as such; however, the Working Group will perform additional delineation of areas where National Guard groundwater use may occur over time.

Once the end state for facility-wide groundwater has been established, the technical team will identify "early attainment" groundwater resource use zones by locating areas of no groundwater contamination based on historical and new groundwater data, and by using the groundwater models to ensure that no existing groundwater contamination would flow into these zones over time. These early attainment areas would be limited to areas within the current RVAAP boundaries.

For the final assessment of groundwater risk, the team will 1) identify areas of groundwater contamination and develop EPCs for those areas on-site, and 2) model the fate and transport of that contamination to determine if it will move off-site and calculate the potential off-site concentrations over time to develop EPCs.

All EPCs will be compared to National Guard and Resident Farmer groundwater FWCUGs to determine COPCs for the FS. However, it is assumed that through the FS, Proposed Plan, and ROD phases of the facility-wide groundwater process that decisions will focus on ensuring that groundwater levels meet the FWCUGs for the land use identified by the Working Group.

4.7 Treatability Study/Pilot Testing

Although not anticipated, treatability testing may be performed by EQM to assist in the detailed analysis of alternatives. In addition, if applicable, testing results and operating conditions will be used in the detailed design of the selected remedial technology. It is not anticipated that a treatability study will be required for Facility-Wide groundwater at RVAAP. However, if site conditions change, such that treatability testing is warranted, the following activities will be performed:

- **Determine Candidate Technologies –** EQM will prepare a Technical Memorandum that identifies candidate technologies for a treatability studies program.
- **Conduct Literature Survey –** EQM will conduct a literature survey to gather information of performance, relative costs, applicability, removal efficiencies, O&M requirements, and implementability of candidate technologies.

- **Evaluation of Treatability Studies –** if a decision to perform treatability studies has been made, EQM will decide on the type of treatability testing to use (e.g., bench versus pilot). The decision to perform pilot testing will be made as early as possible in the process to minimize potential delays of the FS.
- **Prepare Treatability Study Deliverables –** EQM will prepare a work plan, sampling and analysis plan, health and safety plan, and final treatability evaluation report over the course of the treatability study process.

4.8 Remedial Investigation Report

The preliminary draft RI Report will be prepared following completion of the baseline risk assessment and prior to completion of the FS. A draft RI Report documenting data collection and analysis will be produced by EQM for review by the Groundwater Stakeholder Working Group. The RI Report will include the results of the RI, sources of contamination, nature and extent of contamination, contaminant fate-and-transport, and baseline risk assessment. The RI Report will also offer conclusions and recommendations for additional work, if necessary, as well as refinements to the RAOs. EQM will refer to the RI/FS Guidance for an outline of the report format and contents.

4.9 Remedial Alternatives Development/Screening

The development and screening of remedial alternatives is performed to develop an appropriate range of waste management options to be evaluated. This range of alternatives shall include, as appropriate, options in which treatment is used to reduce the toxicity, mobility, or volume of wastes, but varying in the types of treatment, the amount treated, and the manner in which long-term residuals or untreated wastes are managed; options involving containment with little or no treatment; options involving both treatment and containment; and a no-action alternative. The following activities will be performed as a function of the development and screening of remedial alternatives:

- **Refine and document remedial action objectives –** based on the baseline risk assessment, the site-specific preliminary RAOs may be refined to further specify the contaminants and media of interest, exposure pathways and receptors, and an acceptable contaminant level or range of levels. Revised RAOs will be documented in a Technical Memorandum for review and approval by Ohio EPA.
- **Develop general response actions –** EQM will develop general response actions for each medium of interest defining containment, treatment, pumping, or other actions, singly or in combination, to satisfy the RAOs.
- **Identify volumes or areas of media –** EQM will identify areas or volumes of media to which general response actions may apply, taking into account requirements for protectiveness as identified in the RAOs. The chemical and physical characterization of RVAAP will also be taken into account.

- **Identify, screen, and document remedial technologies –** EQM will identify and evaluate technologies applicable to each general response action to eliminate those that cannot be implemented at the site. Technology process options for each of the technology types will be identified either concurrent with the identification of technology types, or following the screening of the considered technology types. Process options will be evaluated on the basis of effectiveness, implementability, and cost factors to select and retain one or, if necessary, more representative processes for each technology type. The technology types and process options will be summarized for inclusion in a technical memorandum. The reasons for eliminating alternatives shall be specified.

- **Assemble and document alternatives –** EQM will assemble selected representative technologies into alternatives for Facility-Wide groundwater at RVAAP. Together, all of the alternatives will represent a range of treatment and containment combinations that will address the site or individual operable units, if applicable. A summary of the assembled alternatives and their related action-specific ARARs will be prepared for inclusion in a technical memorandum. The reasons for eliminating alternatives during the preliminary screening process will be specified.

- **Refine alternatives –** EQM will refine the remedial alternatives to identify the contaminant volume addressed by the proposed process and sizing of critical unit operations as necessary. Sufficient information will be collected for an adequate comparison or alternatives. Remedial action objectives will also be modified as necessary to incorporate any new risk assessment information presented in the baseline risk assessment report. Additionally, action-specific ARARs will be updated as the remedial alternatives are refined.

- **Conduct and document screening evaluation of each alternative –** EQM may perform a final screening process based on short- and long-term aspects of effectiveness, implementability, and relative cost. In general, this screening process will only be needed when there are many feasible alternatives available for detailed analysis. If necessary, the screening of alternatives will be conducted to assure that only the alternatives with the most favorable composite evaluation of all factors are retained for further analysis. As appropriate, the screening will preserve the range of treatment and containment alternatives that was initially developed. The range of remaining alternatives will include options that use treatment technologies and permanent solutions to the maximum extent practicable. EQM will prepare a technical memorandum summarizing the results and reasoning employed in screening, arraying alternatives that remain after screening, and identifying the action-specific ARARs for the alternatives that remain after screening.

One of the goals of the FS is to identify “early attainment” groundwater resource use zones that could free those areas for use by the OHARNG prior to completion of the ROD. The focus for the remaining areas would then be on the remedial action zones requiring active remediation, LTM/MNA, or groundwater resource use controls. This approach would:

- Allow early attainment of unrestricted groundwater use for the OHARNG within as much of RVAAP as possible.

- Provide information to be presented and evaluated by RVAAP stakeholders.
- Allow monitoring wells to be targeted to exit pathways and to confirm the absence of contamination in previously uncharacterized areas. This will be completed to provide data to develop the resource use zones.

Groundwater flow and contaminant fate-and-transport modeling will be conducted to demonstrate zones of influence in response to groundwater pumping and where groundwater resources can be used now without affecting identified contaminated areas. Figure 4-8 shows an example model output of potential early attainment zones at RVAAP. Additionally, the FS will address optimization for remedial alternatives. Recommendations for additional optimization opportunities in the remedial action, remedial action operation (RA-O), and LTM phases will be included in the FS (e.g., future optimization based on performance monitoring).

EQM will prepare a technical memorandum summarizing the work performed and the results of each task above, including an alternatives array summary. These will be modified by EQM if required in Ohio EPA’s comments to assure identification of a complete and appropriate range of viable alternatives to be considered in the detailed analysis. This deliverable will document the methods, rationale, and results of the alternatives screening process. It is anticipated that the number of viable or appropriate alternatives for addressing Facility-Wide groundwater at RVAAP may be limited due to the type of COPCs present, the various aquifer zones affected, and the overall size of the affected area; thus, the screening effort may be minimized or eliminated if necessary.

4.10 Detailed Analysis of Remedial Alternatives

The detailed analysis will be conducted to provide Ohio EPA with the information needed to allow for the selection of the site remedy. This analysis is the final task to be performed by EQM during the FS. EQM will conduct a detailed evaluation of alternatives, which will comprise an analysis of each option against a set of nine evaluation criteria and a comparative analysis of all options using the same evaluation criteria as a basis for comparison.

EQM will apply nine evaluation criteria to the assembled remedial alternatives to ensure that the selected remedial alternative will be protective of human health and the environment; will be in compliance with, or include a waiver of, ARARs; will be cost-effective; will utilize permanent solutions and alternative treatment technologies, or resource recovery technologies, to the maximum extent practicable; and will address the statutory preference for treatment as a principal element. The evaluation criteria include: 1) overall protection of human health and the environment; 2) compliance with ARARs; 3) long-term effectiveness and permanence; 4) reduction of toxicity, mobility, or volume; 5) short-term effectiveness; 6) implementability; 7) costs; 8) state acceptance; and 9) community acceptance. For each alternative, EQM will provide: 1) a description of the alternative that outlines the waste management strategy involved and identifies the key ARARs associated with each alternative; and 2) a discussion of the individual criterion assessment.

EQM will perform a comparative analysis between the remedial alternatives. Identification of and selection of the preferred alternative is reserved by Ohio EPA. EQM will prepare a technical memorandum summarizing the results of the comparative analysis.

4.11 Feasibility Study Report

In addition to the technical memorandum summarizing the results of the comparative analysis, EQM will prepare and submit a draft Feasibility Study report to Ohio EPA. The FS report provides a basis for remedy selection by Ohio EPA and documents the development and analysis of remedial alternatives. EQM will refer to the RI/FS Guidance for an outline for the report format and required content. Once Ohio EPA's comments on the draft FS report have been satisfactorily addressed, the final FS report may be included with the final RI report.

In addition, as part of the CERCLA cleanup process, EQM will prepare the Proposed Plan prior to finalizing the ROD. The PP is a communications document required for the purpose of informing the general public about all alternatives analyzed and EPA's preferred remedy and notifying them of an opportunity to comment. This will be the key point in the process to involve and obtain buy-in from the general public, although the public will be kept informed throughout the process through participation with the Restoration Advisory Board.

4.12 Post RI/FS Support

This task includes all activities occurring after the release of the FS to the public via the PP. Under this task, the USACE may prepare the predesign report, prepare the conceptual design, attend public meetings, write and review the responsiveness summary, support ROD preparation and briefings, review and provide QC of the work effort, provide task management and QC, and close out the work assignment.

4.13 Enforcement Support

This task includes various efforts during the RI/FS associated with enforcement aspects of the project typically related to potentially responsible parties (PRPs). The following are typical activities under this task:

- Preparing briefing materials
- Assisting in the preparation of the ROD
- Providing task management and QC

SECTION 5
SCHEDULE

A resource load schedule is included in Appendix A. The schedule shows major activities leading to the milestones identified in the PWS as well as interim milestones. The Project Schedule milestones are summarized in Table 5-1. This schedule includes the assumption that the various document reviewers will take the maximum amount of time to complete their actions. The project schedule may be compressed if the reviews take less time.

Table 5-1. Proposed Milestones and Rationale

MILESTONE	DESCRIPTION
Milestone 1. *Approval of the Final PMP and QASP by 31 December 2011.*	Tasks completed under this milestone include the preparation and submittal of preliminary draft, draft, and final versions of both documents as well as preparation of response to comments from all stakeholders. It is understood that a preliminary draft of both documents is due within 30 days of contract award.
Milestone 2.1 & 2.2. *Modification to FWGWMP to Install New Wells*	Tasks to be completed under this milestone include the preparation of an amendment to the FWGWMP for the installation of new wells followed by the installation and development of the wells. The schedule presents an aggressive schedule for this milestone, resulting in installation and development of the wells by March 2012, and is on a separate track from the RI Work Plan. Additionally, this milestone includes the preparation of an amendment to the FWGWMP Plan to revise the groundwater monitoring schedule, wells to be sampled, and analytes.
Milestone 2.3. *Complete 4 Quarters of Sampling for the New Wells*	As required by the USACE, the new wells will require 4 consecutive quarters of sampling and analysis for the full suite of constituents presented in the FWGWMP. The four quarters will be in April, July, and October 2012 and January 2013 with associated reporting.
Milestone 2.4. *Approval of Final Remedial Investigation Report by 30 September 2013.*	Tasks to be completed under this milestone include: • Preparation and submittal of preliminary draft, draft, and final versions of the Remedial Investigation Work Plan (WP) by 30 April 2012, as well as preparation of response to comments from all stakeholders. The WP will be prepared in accordance with CERCLA requirements as well as the DFFOs. • Implementation of the remedial investigation. • Preparation and submittal of preliminary draft, draft, and final versions of the RI Report as well as preparation of response to comments from all stakeholders. The report will be prepared in accordance with CERCLA requirements as well as the DFFOs.
Milestone 2.5. *Approval of Final Feasibility Study Report by 30 April 2014.*	Tasks to be completed under this milestone include the preparation and submittal of preliminary draft, draft, and final versions of the FS Report as well as preparation of response to comments from all stakeholders. The report will be prepared in accordance with CERCLA requirements as well as the DFFOs.
Milestone 2.6. *Approval of Final Proposed Plan by 30 November 2014.*	Tasks to be completed under this milestone include the preparation and submittal of preliminary draft, draft, and final versions of the Proposed Plan (PP) as well as preparation of response to comments from all stakeholders. The report will be prepared in accordance with CERCLA requirements as well as the DFFOs.
Milestone 2.7. *Approval/Signature of final ROD by 31 December 2015.*	Tasks to be completed under this milestone include the preparation and submittal of preliminary draft, draft, and final versions of the ROD as well as preparation of response to comments from all stakeholders. The report will be prepared in accordance with CERCLA requirements as well as the DFFO.

Table 5-1 (continued). Proposed Milestones and Rationale

MILESTONE	DESCRIPTION
Milestone 3.1. *Submittal of Draft 2012 Annual FWGWMP report by 15 December 2012 (per DFFOs).*	Tasks associated with this milestone will be the completion of the groundwater monitoring activities conducted in support of the annual report. It is anticipated that sampling events from October 2011, January 2012, April 2012, and July 2012 will be included in this report. As described in this RI/FS Work Plan, EQM is proposing to change the sampling schedule from quarterly to semiannual beginning in January 2012. EQM understands the critical nature of meeting the December 15 deadline for submittal of the Draft report to the Ohio EPA (since 2007 EQM has consistently submitted the draft Annual FWGWMP prior to this deadline). This task includes the preparation and submittal of preliminary draft, draft, and final versions of all reports as well as preparation of response to comments from all stakeholders.
Milestone 3.2. *Submittal of Draft 2013 Annual FWGWMP Report by 15 December 2013 (per DFFOs)*	Tasks associated with this milestone include the completion of the groundwater monitoring activities conducted in support of the annual report. It is anticipated that sampling events from January 2013 and July 2013 will be included in this report. This task will include the preparation and submittal of preliminary draft, draft, and final versions of all reports as well as preparation of response to comments from all stakeholders.
Milestone 3.3. *Submittal of Draft 2014 Annual FWGWMP Report by 15 December 2014 (per DFFOs)*	Tasks associated with this milestone will be the completion of the groundwater monitoring activities conducted in support of the annual report. It is anticipated that sampling events January 2014 and July 2014 will be included in this report. This task will include the preparation and submittal of preliminary draft, draft, and final versions of all reports as well as preparation of response to comments from all stakeholders.
Milestone 3.4. *Completion of Groundwater Monitoring conducted in July 2015.*	This milestone has been added to include the completion and costs associated with groundwater monitoring conducted for the 2015 sampling event.

SECTION 6
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APPENDIX A

SCHEDULE

ID		Milestone	Task Name	Duration	Start	Finish	Predecessors
1			**Contract Award**	0 days	Wed 8/3/11	Wed 8/3/11	
2			**Kickoff Meeting**	0 days	Wed 9/14/11	Wed 9/14/11	
3		1	**Approval of Final PMP & QASP**	**135 days**	**Wed 8/3/11**	**Thu 12/15/11**	
4			Prepare and submit Draft of Project Management Plan & Quality Assurance Surveillance Plan	24 days	Wed 8/3/11	Fri 8/26/11	1
5			Stakeholder review of Draft Plans	45 days	Sat 8/27/11	Mon 10/10/11	4
6			Response to Comments & Submittal of Responses	15 days	Tue 10/11/11	Tue 10/25/11	5
7			Stakeholder Review of Responses	30 days	Wed 10/26/11	Thu 11/24/11	6
8			Prepare and Submit Final PMP & QASP	6 days	Fri 11/25/11	Wed 11/30/11	7
9			Ohio EPA Approval of Final PMP & QASP	15 days	Thu 12/1/11	Thu 12/15/11	8
10							
11		2	**New Well Installation and Revised Schedule Amendment**	**157 days**	**Wed 8/3/11**	**Fri 1/6/12**	
12			Prepare and Submit amendment to FWGWMP to Install New Wells	27 days	Wed 8/3/11	Mon 8/29/11	1
13			Army Review of Amendment	10 days	Tue 8/30/11	Thu 9/8/11	12
14			Response to Comments and Prepare Amendment	7 days	Fri 9/9/11	Thu 9/15/11	13
15			Stakeholder review	45 days	Mon 10/24/11	Wed 12/7/11	
16			Ohio EPA Approval of Final Amendment	15 days	Thu 12/8/11	Thu 12/22/11	15
17			Prepare and Submit Final RI Report	15 days	Fri 12/23/11	Fri 1/6/12	16
18							
19			Installation and Development of New wells	45 days	Sat 1/7/12	Mon 2/20/12	17
20							
21		4	**Approval of RI Work Plan**	**218 days**	**Thu 9/1/11**	**Thu 4/5/12**	
22			Review of Historical Data	30 days	Thu 9/1/11	Fri 9/30/11	
23			Identification of Data Gaps	30 days	Mon 9/12/11	Tue 10/11/11	
24			Determine the need for additional Analyses.Testing	30 days	Mon 9/12/11	Tue 10/11/11	
25			Prepare & Submit Preliminary Draft of RI Work Plan	50 days	Wed 10/12/11	Wed 11/30/11	24
26			Army Review	30 days	Thu 12/1/11	Fri 12/30/11	25
27			Response to Comments and Prepare Draft of RI Work Plan	7 days	Sat 12/31/11	Fri 1/6/12	26
28			Stakeholder review	45 days	Sat 1/7/12	Mon 2/20/12	27
29			Response to Comments & Submittal of Responses	15 days	Tue 2/21/12	Tue 3/6/12	28
30			Stakeholder Review of Responses	15 days	Wed 3/7/12	Wed 3/21/12	29
31			Prepare and Submit Final of RI Work Plan	15 days	Wed 3/7/12	Wed 3/21/12	
32		4.4	Ohio EPA Approval of Final RI Work Plan	15 days	Thu 3/22/12	Thu 4/5/12	31
33							
34		6	**Approval of Final RI Report**	**484 days**	**Fri 4/6/12**	**Fri 8/2/13**	
35			Field Activities in Support of the RI Report	60 days	Fri 4/6/12	Mon 6/4/12	32
36			Groundwater Modeling	100 days	Tue 6/5/12	Wed 9/12/12	35
37			Baseline Risk Assessment	75 days	Thu 9/13/12	Mon 11/26/12	36
38			Refine the Conceprual Model	60 days	Tue 11/27/12	Fri 1/25/13	37
39			Prepare & Submit Preliminary Draft of RI Report - includes field work	60 days	Sat 1/26/13	Tue 3/26/13	38
40			Army Review of Preliminary Draft	30 days	Wed 3/27/13	Thu 4/25/13	39
41			Response to Comments and Prepare Draft RI Report	14 days	Fri 4/26/13	Thu 5/9/13	40
42			Stakeholder review	45 days	Fri 5/10/13	Sun 6/23/13	41
43			Response to Comments & Submittal of Responses	15 days	Mon 6/24/13	Mon 7/8/13	42
44			Stakeholder Review	15 days	Tue 7/9/13	Tue 7/23/13	43
45			Prepare and Submit Final RI Report	15 days	Tue 7/9/13	Tue 7/23/13	
46			Ohio EPA Approval of Final RI Report	10 days	Wed 7/24/13	Fri 8/2/13	45
47							
48		8	**Approval of Feasibility Study Report**	**314 days**	**Wed 5/15/13**	**Mon 3/24/14**	
49			Prepare & Submit Preliminary Draft of FS Report	180 days	Wed 5/15/13	Sun 11/10/13	
50			Army Review of Preliminary Draft	30 days	Mon 11/11/13	Tue 12/10/13	49
51			Response to Comments and Prepare Draft of FS Report	14 days	Wed 12/11/13	Tue 12/24/13	50
52			Stakeholder review	45 days	Wed 12/25/13	Fri 2/7/14	51
53			Response to Comments & Submittal of Responses	15 days	Sat 2/8/14	Sat 2/22/14	52
54			Stakeholder Review	15 days	Sun 2/23/14	Sun 3/9/14	53
55			Prepare and Submit Final FS Report	15 days	Sun 2/23/14	Sun 3/9/14	
56			Ohio EPA Approval of Final FS Report	15 days	Mon 3/10/14	Mon 3/24/14	55
57							

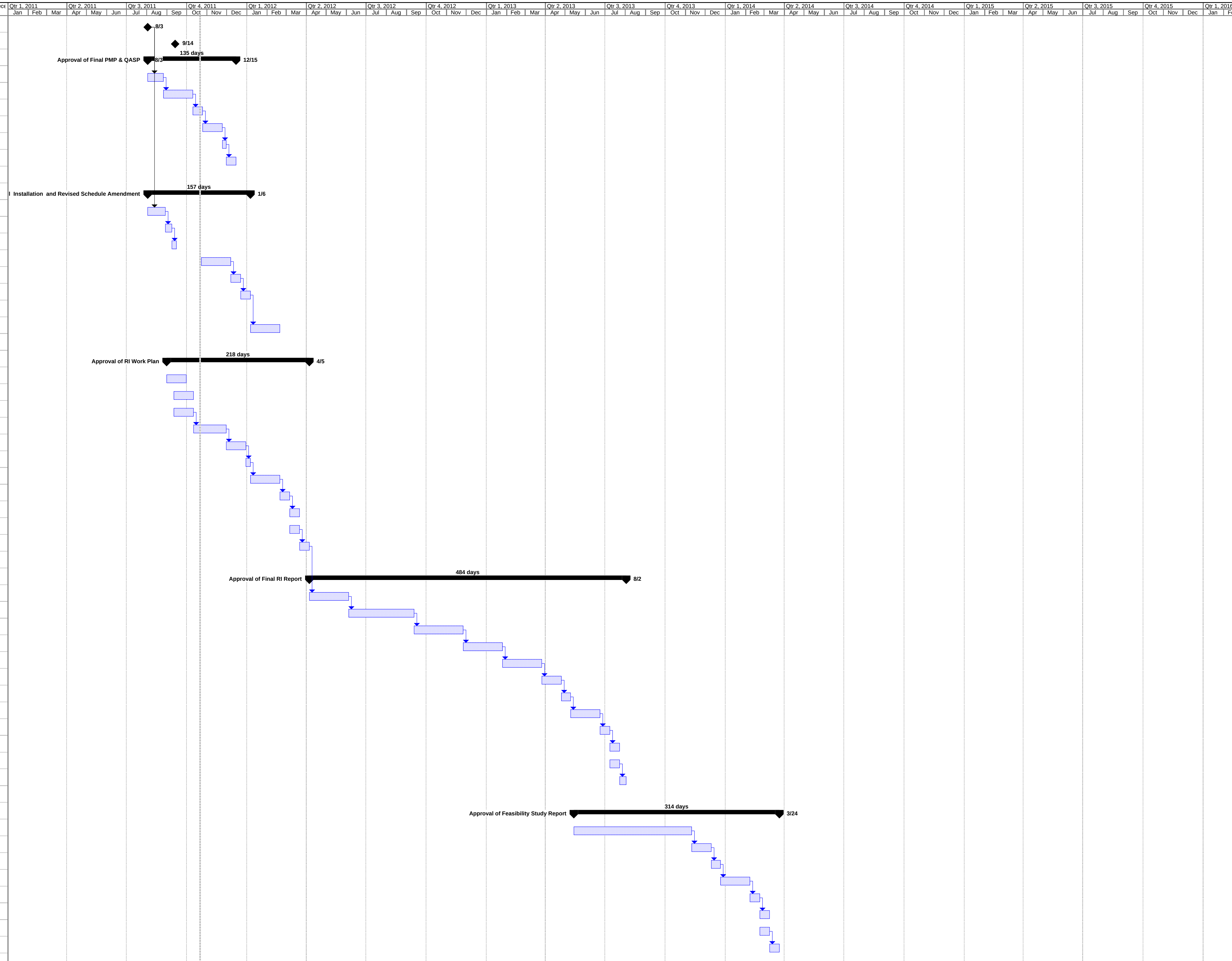


Figure II-1
Facility-Wide Groundwater Schedule - RVAAP

Task		Progress		Summary		Rolled Up Critical Task		Rolled Up Progress		External Tasks	
Critical Task		Milestone		Rolled Up Task		Rolled Up Milestone		Split		Project Summary	

Group By Summary
Deadline

ID	Milestone	Task Name	Duration	Start	Finish	Predece
58	9	**Approval of Final Proposed Plan**	**179 days**	**Wed 3/26/14**	**Sat 9/20/14**	
59		Prepare & Submit Preliminary Draft of PP	45 days	Wed 3/26/14	Fri 5/9/14	
60		Army Review of Preliminary Draft	30 days	Sat 5/10/14	Sun 6/8/14	59
61		Response to Comments and Prepare Draft of PP	14 days	Mon 6/9/14	Sun 6/22/14	60
62		Stakeholder review	45 days	Mon 6/23/14	Wed 8/6/14	61
63		Response to Comments & Submittal of Responses	15 days	Thu 8/7/14	Thu 8/21/14	62
64		Stakeholder Review	15 days	Fri 8/22/14	Fri 9/5/14	63
65		Prepare and Submit Final PP	15 days	Fri 8/22/14	Fri 9/5/14	
66		Ohio EPA Approval of Final PP	15 days	Sat 9/6/14	Sat 9/20/14	65
67						
68		Public Comment & Meeting	45 days	Wed 10/1/14	Fri 11/14/14	
69						
70	11	**Approval/Signature of Signed ROD**	**314 days**	**Mon 12/1/14**	**Sat 10/10/15**	
71		Prepare & Submit Preliminary Draft of ROD	120 days	Mon 12/1/14	Mon 3/30/15	
72		Army Review of Preliminary Draft	30 days	Tue 3/31/15	Wed 4/29/15	71
73		Response to Comments and Prepare Draft of ROD	14 days	Thu 4/30/15	Wed 5/13/15	72
74		Stakeholder review	45 days	Thu 5/14/15	Sat 6/27/15	73
75		Response to Comments & Submittal of Responses	15 days	Sun 6/28/15	Sun 7/12/15	74
76		Stakeholder Review	15 days	Mon 7/13/15	Mon 7/27/15	75
77		Response to Comments and Prepare Final of ROD	15 days	Mon 7/13/15	Mon 7/27/15	
78		Ohio EPA Approval of Final ROD	15 days	Tue 7/28/15	Tue 8/11/15	77
79		Signed ROD	60 days	Wed 8/12/15	Sat 10/10/15	78
80						
81	3, 5	**2012 FWGWMP Sampling, Analysis & Reporting**	**605 days**	**Thu 9/1/11**	**Sat 4/27/13**	
82		Prepare Amendment to the FWGWMP to revise frequency of sampling and analyte list for wells	104 days	Thu 9/1/11	Tue 12/13/11	
83		Completion of January 2012 Sampling Event	20 days	Mon 1/2/12	Sat 1/21/12	
84		Prepare Preliminary Draft of January Groundwater Report	60 days	Sun 1/22/12	Wed 3/21/12	83
85		Army Review of Preliminary Draft	30 days	Thu 3/22/12	Fri 4/20/12	84
86		Response to Comments and Prepare Draft of January Groundwater Report	14 days	Sat 4/21/12	Fri 5/4/12	85
87		Stakeholder Review	45 days	Sat 5/5/12	Mon 6/18/12	86
88		Response to Comments & Submittal of Responses	15 days	Tue 6/19/12	Tue 7/3/12	87
89		Stakeholder Review	15 days	Wed 7/4/12	Wed 7/18/12	88
90		Prepare Final of October Groundwater Report	15 days	Wed 7/4/12	Wed 7/18/12	
91		Ohio EPA Approval of Final January Report	15 days	Thu 7/19/12	Thu 8/2/12	90
92						
93		Completion of April 2012 Sampling Event (new wells only)	15 days	Mon 4/9/12	Mon 4/23/12	
94		Prepare Preliminary Draft of April Groundwater Report	60 days	Tue 4/24/12	Fri 6/22/12	93
95		Army Review of Preliminary Draft	30 days	Sat 6/23/12	Sun 7/22/12	94
96		Response to Comments and Prepare Draft of April Groundwater Report	14 days	Mon 7/23/12	Sun 8/5/12	95
97		Stakeholder Review	45 days	Mon 8/6/12	Wed 9/19/12	96
98		Response to Comments & Submittal of Responses	15 days	Thu 9/20/12	Thu 10/4/12	97
99		Stakeholder Review	15 days	Fri 10/5/12	Fri 10/19/12	98
100		Prepare Final of April Groundwater Report	15 days	Fri 10/5/12	Fri 10/19/12	
101		Ohio EPA Approval of Final April Report	15 days	Sat 10/20/12	Sat 11/3/12	100
102						
103		Completion of July 2012 Sampling Event (includes sampling of new wells)	20 days	Mon 7/2/12	Sat 7/21/12	
104		Prepare Preliminary Draft of July Groundwater Report	60 days	Sun 7/22/12	Wed 9/19/12	103
105		Army Review of Preliminary Draft	30 days	Thu 9/20/12	Fri 10/19/12	104
106		Response to Comments and Prepare Draft of July Groundwater Report	14 days	Sat 10/20/12	Fri 11/2/12	105
107		Stakeholder Review	45 days	Sat 11/3/12	Mon 12/17/12	106
108		Response to Comments & Submittal of Responses	15 days	Tue 12/18/12	Tue 1/1/13	107
109		Stakeholder Review	15 days	Wed 1/2/13	Wed 1/16/13	108
110		Prepare Final of July Groundwater Report	15 days	Wed 1/2/13	Wed 1/16/13	
111		Ohio EPA Approval of Final July Report	15 days	Thu 1/17/13	Thu 1/31/13	110
112						
113		Completion of October 2012 Sampling Event (new wells only)	15 days	Mon 10/1/12	Mon 10/15/12	
114		Prepare Preliminary Draft of October Groundwater Report	60 days	Tue 10/16/12	Fri 12/14/12	113

Figure II-1
Facility-Wide Groundwater Schedule - RVAAP

Task	Progress	Summary	Rolled Up Critical Task	Rolled Up Progress	External Tasks	Group By Summary
Critical Task	Milestone	Rolled Up Task	Rolled Up Milestone	Split	Project Summary	Deadline

ID	Milestone	Task Name	Duration	Start	Finish	Predecc
115		Army Review of Preliminary Draft	30 days	Sat 12/15/12	Sun 1/13/13	114
116		Response to Comments and Prepare Draft of October Groundwater Report	14 days	Mon 1/14/13	Sun 1/27/13	115
117		Stakeholder Review	45 days	Mon 1/28/13	Wed 3/13/13	116
118		Response to Comments & Submittal of Responses	15 days	Thu 3/14/13	Thu 3/28/13	117
119		Stakeholder Review	15 days	Fri 3/29/13	Fri 4/12/13	118
120		Prepare Final of October Groundwater Report	15 days	Fri 3/29/13	Fri 4/12/13	
121		Ohio EPA Approval of Final October Report	15 days	Sat 4/13/13	Sat 4/27/13	120
122						
123		Prepare Preliminary Draft of 2012 Annual Groundwater Report	60 days	Mon 8/27/12	Thu 10/25/12	
124		Army Review of Preliminary Draft	30 days	Fri 10/26/12	Sat 11/24/12	123
125		Response to Comments and Prepare Draft of 2012 Annual Groundwater Report	14 days	Sun 11/25/12	Sat 12/8/12	124
126		Stakeholder Review	45 days	Sun 12/9/12	Tue 1/22/13	125
127		Response to Comments & Submittal of Responses	15 days	Wed 1/23/13	Wed 2/6/13	126
128		Stakeholder Review	15 days	Thu 2/7/13	Thu 2/21/13	127
129		Prepare Final of 2012 Annual Groundwater Report	15 days	Sat 2/16/13	Sat 3/2/13	
130		Ohio EPA Approval of the Final 2012 Annual Groundwater Report	15 days	Sun 3/3/13	Sun 3/17/13	129
131						
132	**7**	**2013 FWGWMP Sampling, Analysis & Reporting**	**442 days**	**Mon 1/7/13**	**Mon 3/24/14**	
133		Completion of January 2013 Sampling Event	15 days	Mon 1/7/13	Mon 1/21/13	
134		Prepare Preliminary Draft of January Groundwater Report	60 days	Tue 1/22/13	Fri 3/22/13	133
135		Army Review of Preliminary Draft	30 days	Sat 3/23/13	Sun 4/21/13	134
136		Response to Comments and Prepare Draft of January Groundwater Report	14 days	Mon 4/22/13	Sun 5/5/13	135
137		Stakeholder Review	45 days	Mon 5/6/13	Wed 6/19/13	136
138		Response to Comments & Submittal of Responses	15 days	Thu 6/20/13	Thu 7/4/13	137
139		Stakeholder Review	15 days	Fri 7/5/13	Fri 7/19/13	138
140		Prepare Final of January Groundwater Report	15 days	Fri 7/5/13	Fri 7/19/13	
141		Ohio EPA Approval of Final January Report	15 days	Sat 7/20/13	Sat 8/3/13	140
142						
143	7.1	Completion of July 2013 Sampling Event	15 days	Mon 7/8/13	Mon 7/22/13	
144		Prepare Preliminary Draft of July Groundwater Report	60 days	Tue 7/23/13	Fri 9/20/13	143
145		Army Review of Preliminary Draft	30 days	Sat 9/21/13	Sun 10/20/13	144
146		Response to Comments and Prepare Draft of July Groundwater Report	14 days	Mon 10/21/13	Sun 11/3/13	145
147		Stakeholder Review	45 days	Mon 11/4/13	Wed 12/18/13	146
148		Response to Comments & Submittal of Responses	15 days	Thu 12/19/13	Thu 1/2/14	147
149		Stakeholder Review	15 days	Fri 1/3/14	Fri 1/17/14	148
150		Prepare Final of July Groundwater Report	15 days	Fri 1/3/14	Fri 1/17/14	
151	7.2	Ohio EPA Approval of Final July Report	15 days	Sat 1/18/14	Sat 2/1/14	150
152						
153		Prepare Preliminary Draft of 2013 Annual Groundwater Report	60 days	Wed 8/28/13	Sat 10/26/13	
154		Army Review of Preliminary Draft	30 days	Sun 10/27/13	Mon 11/25/13	153
155		Response to Comments and Prepare Draft of 2012 Annual Groundwater Report	14 days	Tue 11/26/13	Mon 12/9/13	154
156	7.3	Stakeholder Review	45 days	Tue 12/10/13	Thu 1/23/14	155
157		Response to Comments & Submittal of Responses	15 days	Fri 1/24/14	Fri 2/7/14	156
158		Stakeholder Review	15 days	Sat 2/8/14	Sat 2/22/14	157
159		Prepare Final of 2012 Annual Groundwater Report	15 days	Sun 2/23/14	Sun 3/9/14	158
160		Ohio EPA Approval of Final 2012 Annual Report	15 days	Mon 3/10/14	Mon 3/24/14	159
161						
162	**10**	**2014 FWGWMP Sampling, Analysis & Reporting**	**423 days**	**Wed 1/8/14**	**Fri 3/6/15**	
163	10.1	Completion of January 2014 Sampling Event	15 days	Wed 1/8/14	Wed 1/22/14	
164		Prepare Preliminary Draft of January Groundwater Report	60 days	Thu 1/23/14	Sun 3/23/14	163
165		Army Review of Preliminary Draft	30 days	Mon 3/24/14	Tue 4/22/14	164
166		Response to Comments and Prepare Draft of January Groundwater Report	14 days	Wed 4/23/14	Tue 5/6/14	165
167		Stakeholder Review	45 days	Wed 5/7/14	Fri 6/20/14	166
168		Response to Comments & Submittal of Responses	15 days	Sat 6/21/14	Sat 7/5/14	167
169		Stakeholder Review	15 days	Sun 7/6/14	Sun 7/20/14	168
170		Prepare Final of January Groundwater Report	15 days	Sun 7/6/14	Sun 7/20/14	
171	10.2	Ohio EPA Approval of Final January Report	15 days	Mon 7/21/14	Mon 8/4/14	170

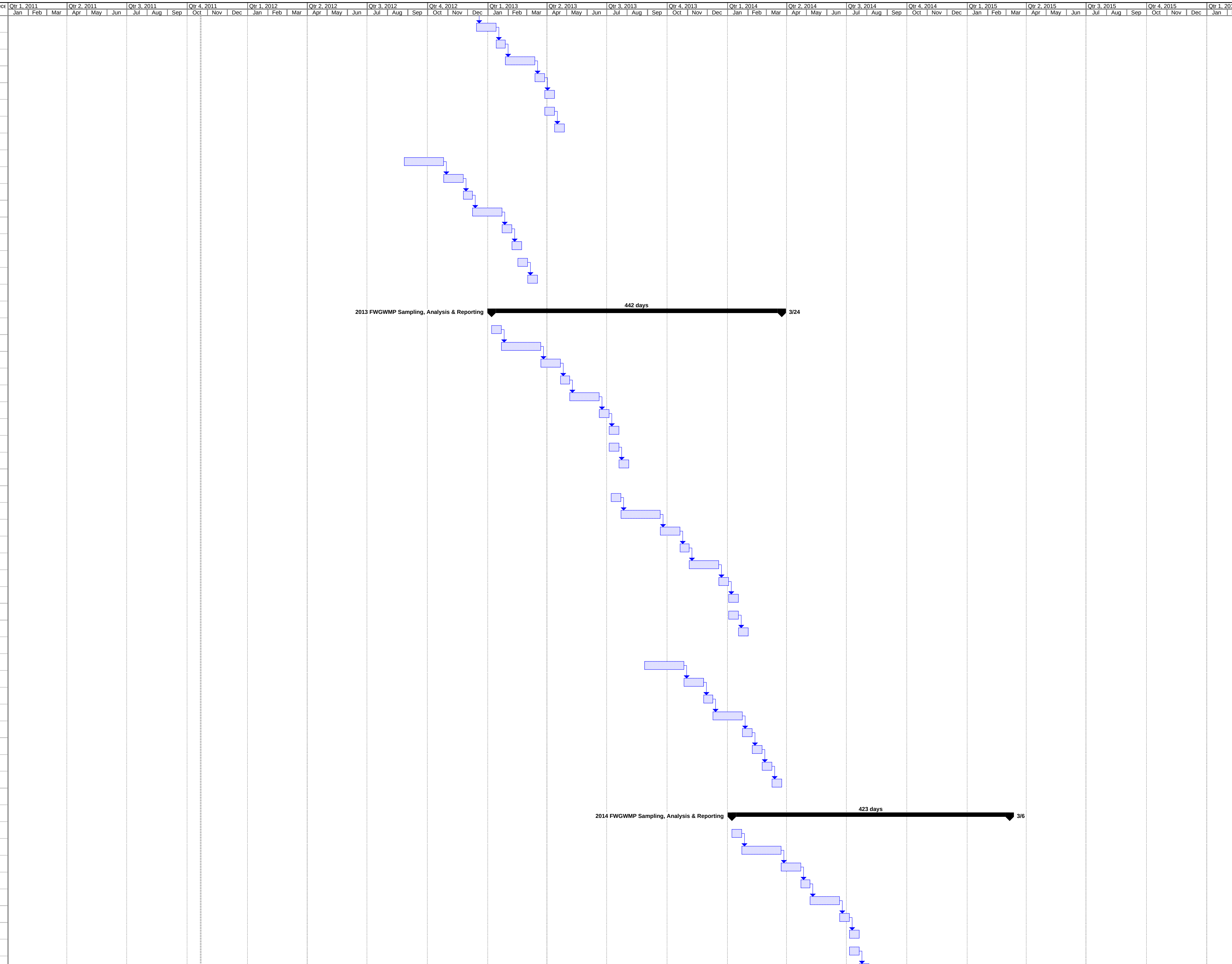


Figure II-1
Facility-Wide Groundwater Schedule - RVAAP

Task | Critical Task | Progress | Milestone | Summary | Rolled Up Task | Rolled Up Critical Task | Rolled Up Milestone | Rolled Up Progress | Split | External Tasks | Project Summary | Group By Summary | Deadline

ID	Milestone	Task Name	Duration	Start	Finish	Predecessors
172						
173	10.1	Completion of July 2014 Sampling Event	15 days	Mon 7/7/14	Mon 7/21/14	
174		Prepare Preliminary Draft of July Groundwater Report	60 days	Tue 7/22/14	Fri 9/19/14	173
175		Army Review of Preliminary Draft	30 days	Sat 9/20/14	Sun 10/19/14	174
176		Response to Comments and Prepare Draft of July Groundwater Report	14 days	Mon 10/20/14	Sun 11/2/14	175
177		Stakeholder Review	45 days	Mon 11/3/14	Wed 12/17/14	176
178		Response to Comments & Submittal of Responses	15 days	Thu 12/18/14	Thu 1/1/15	177
179		Stakeholder Review	15 days	Fri 1/2/15	Fri 1/16/15	178
180		Prepare Final of July Groundwater Report	15 days	Fri 1/2/15	Fri 1/16/15	
181	10.2	Ohio EPA Approval of Final July Report	15 days	Sat 1/17/15	Sat 1/31/15	180
182						
183		Prepare Preliminary Draft of 2014 Annual Groundwater Report	60 days	Mon 8/25/14	Thu 10/23/14	
184		Army Review of Preliminary Draft	30 days	Fri 10/24/14	Sat 11/22/14	183
185		Response to Comments and Prepare Draft of 2012 Annual Groundwater Report	14 days	Sun 11/23/14	Sat 12/6/14	184
186	10.3	Stakeholder Review	45 days	Sun 12/7/14	Tue 1/20/15	185
187		Response to Comments & Submittal of Responses	15 days	Wed 1/21/15	Wed 2/4/15	186
188		Stakeholder Review	15 days	Thu 2/5/15	Thu 2/19/15	187
189		Prepare Final of 2012 Annual Groundwater Report	15 days	Thu 2/5/15	Thu 2/19/15	
190		Ohio EPA Approval of Final 2012 Annual Report	15 days	Fri 2/20/15	Fri 3/6/15	189
191						
192	**12**	**2015 FWGWMP Sampling, Analysis & Reporting**	**389 days**	**Wed 1/7/15**	**Sat 1/30/16**	
193	12.1	Completion of January 2015 Sampling Event	15 days	Wed 1/7/15	Wed 1/21/15	
194		Prepare Preliminary Draft of January Groundwater Report	60 days	Thu 1/22/15	Sun 3/22/15	193
195		Army Review of Preliminary Draft	30 days	Mon 3/23/15	Tue 4/21/15	194
196		Response to Comments and Prepare Draft of January Groundwater Report	14 days	Wed 4/22/15	Tue 5/5/15	195
197		Stakeholder Review	45 days	Wed 5/6/15	Fri 6/19/15	196
198		Response to Comments & Submittal of Responses	15 days	Sat 6/20/15	Sat 7/4/15	197
199		Stakeholder Review	15 days	Sun 7/5/15	Sun 7/19/15	198
200		Prepare Final of January Groundwater Report	14 days	Sun 7/5/15	Sat 7/18/15	
201	12.2	Ohio EPA Approval of Final January Report	15 days	Sun 7/19/15	Sun 8/2/15	200
202						
203	12.1	Completion of July 2015 Sampling Event	15 days	Mon 7/6/15	Mon 7/20/15	
204		Prepare Preliminary Draft of July Groundwater Report	60 days	Tue 7/21/15	Fri 9/18/15	203
205		Army Review of Preliminary Draft	30 days	Sat 9/19/15	Sun 10/18/15	204
206		Response to Comments and Prepare Draft of July Groundwater Report	14 days	Mon 10/19/15	Sun 11/1/15	205
207		Stakeholder Review	45 days	Mon 11/2/15	Wed 12/16/15	206
208		Response to Comments & Submittal of Responses	15 days	Thu 12/17/15	Thu 12/31/15	207
209		Stakeholder Review	15 days	Fri 1/1/16	Fri 1/15/16	208
210		Prepare Final of July Groundwater Report	15 days	Fri 1/1/16	Fri 1/15/16	
211	12.2	Ohio EPA Approval of Final July Report	15 days	Sat 1/16/16	Sat 1/30/16	210

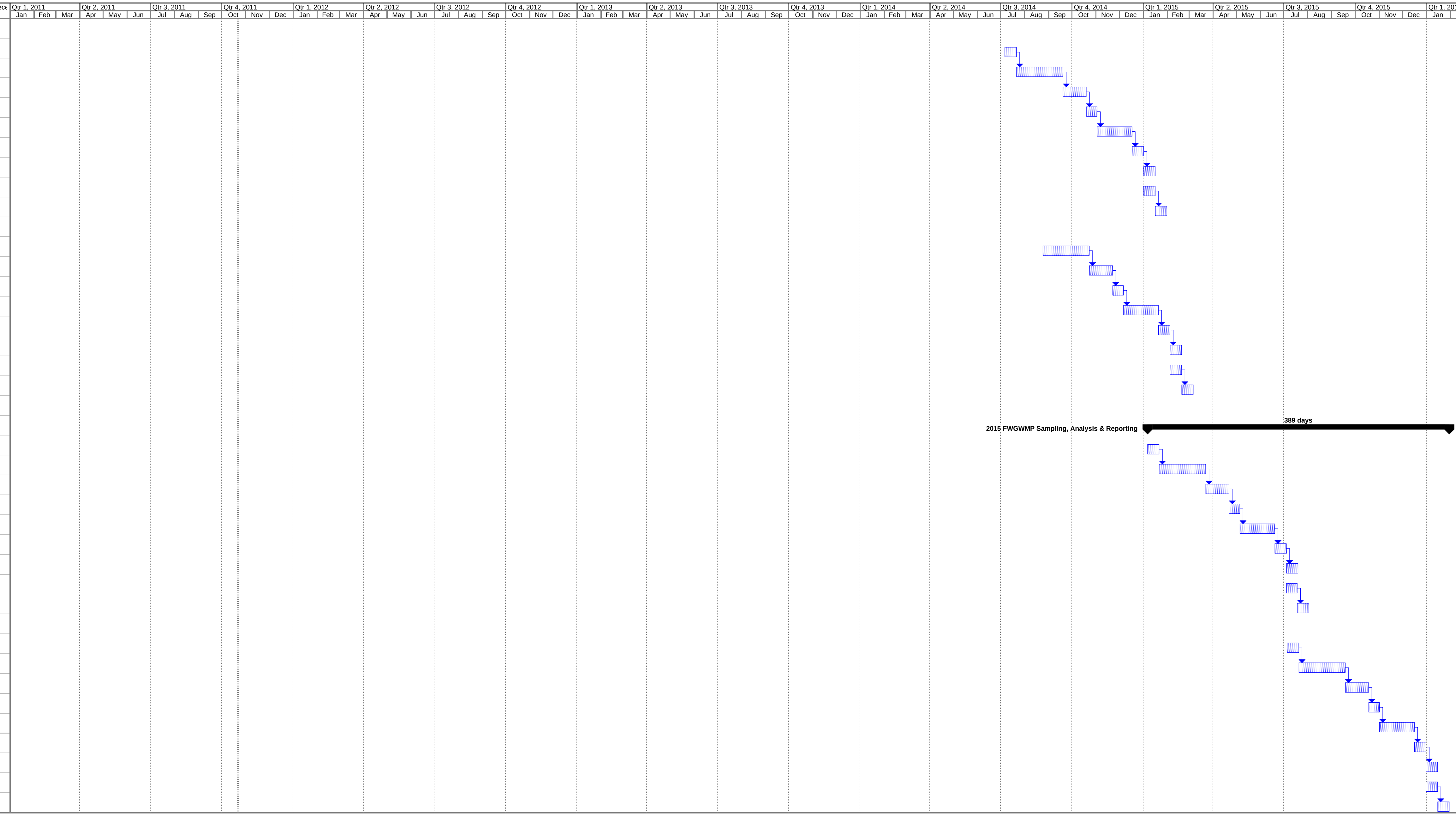
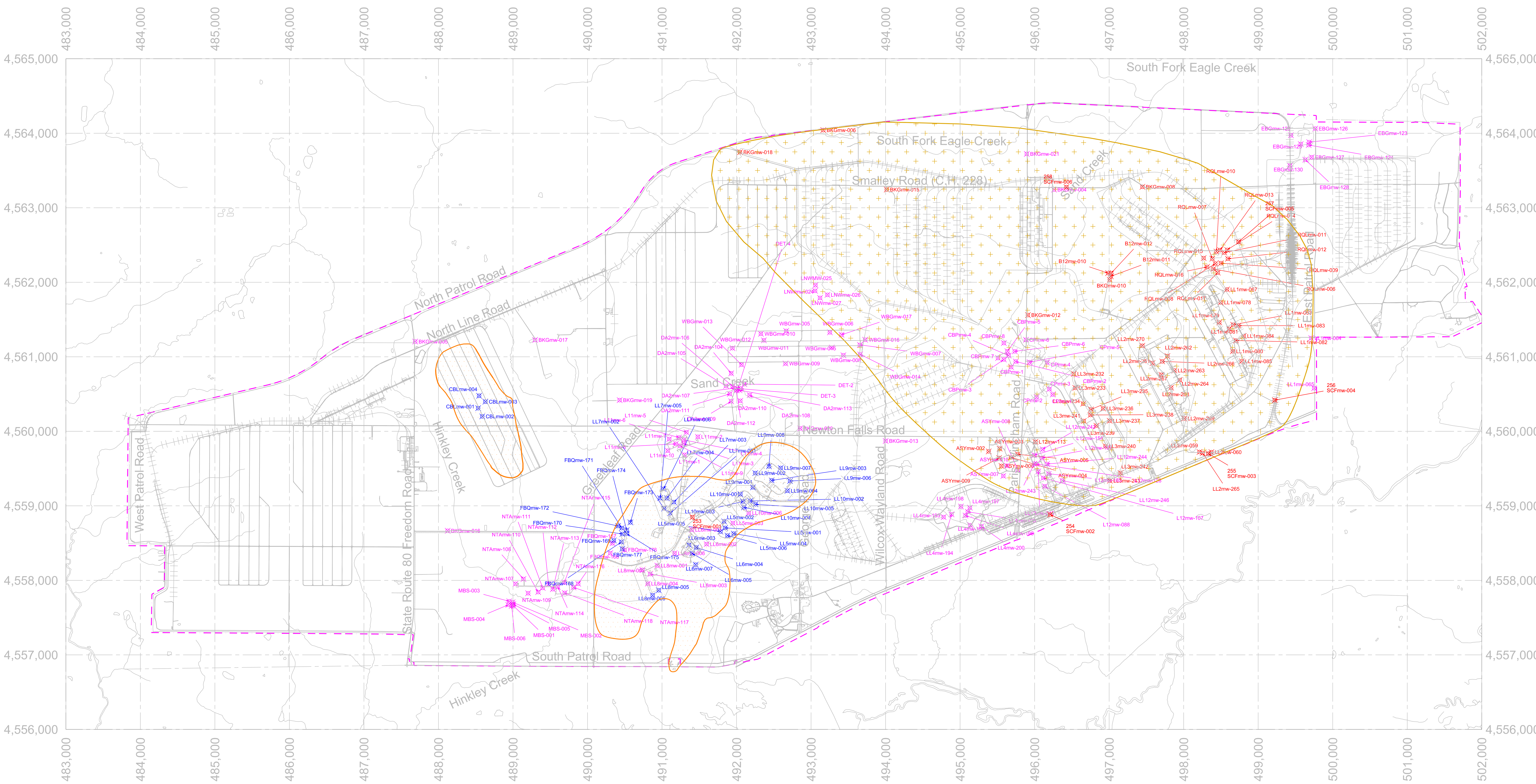


Figure II-1
Facility-Wide Groundwater Schedule - RVAAP

Task		Progress		Summary		Rolled Up Critical Task		Rolled Up Progress		External Tasks		Group By Summary	
Critical Task		Milestone		Rolled Up Task		Rolled Up Milestone		Split		Project Summary		Deadline	



LEGEND

- UNCONSOLIDATED WELL
- HOMEWOOD MEMBER WELL
- SHARON MEMBER WELL
- PROPERTY LINE
- HOMEWOOD MEMBER
- SHARON MEMBER

NOTE: THE UNCONSOLIDATED AQUIFER OVERLAYS THE HOMEWOOD AND SHARON MEMBERS, EXCEPT AS INDICATED ON PLATE 2

0 50 1000

SCALE (METERS)

N

COORDINATE SYSTEM UTM NAD 83 ZONE 17

ENVIRONMENTAL QUALITY
MANAGEMENT, INC.
1800 CARILLON BLVD.
CINCINNATI, OHIO 45240
P (513)825-7500
F (513)825-7495

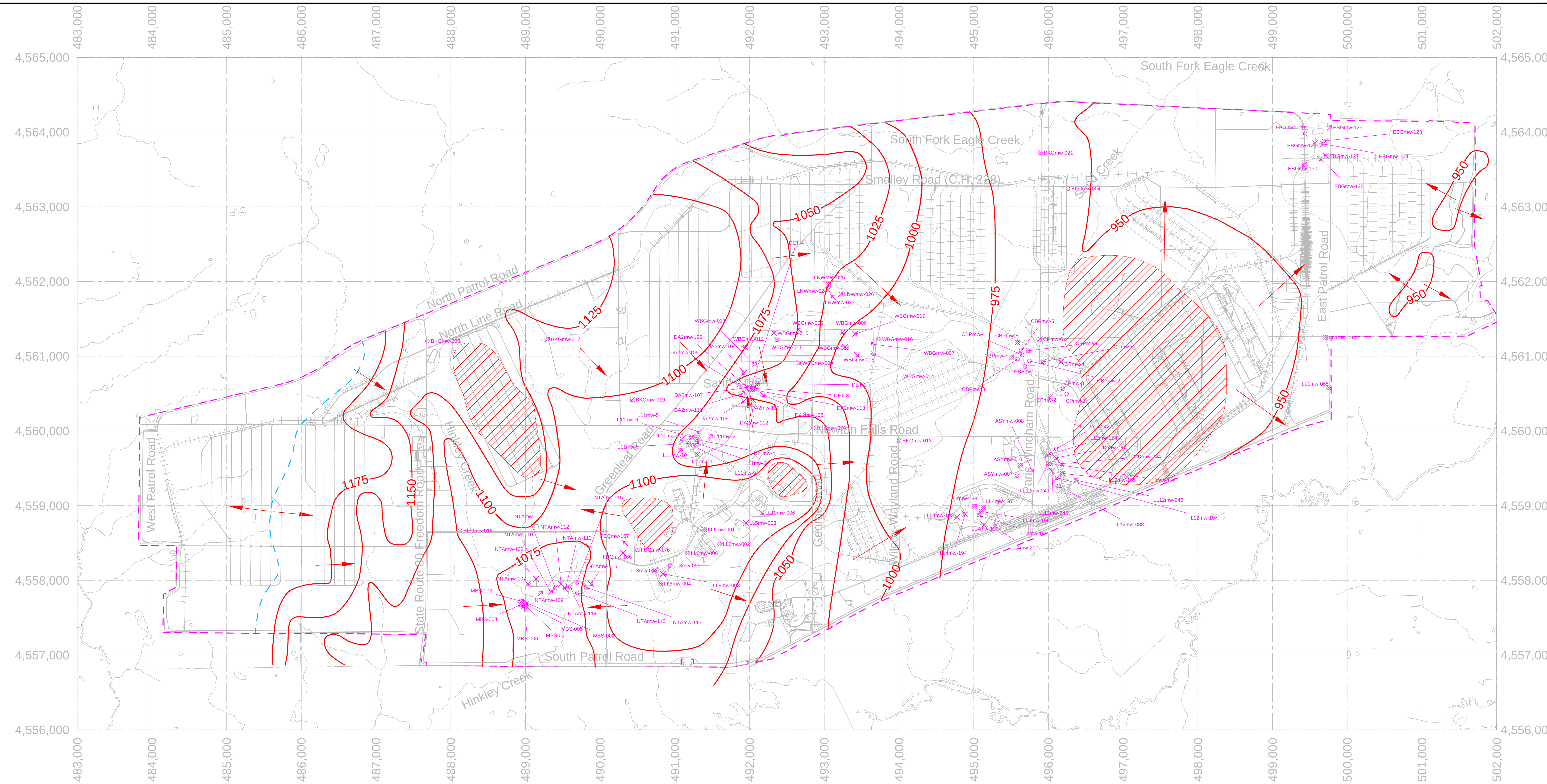
REV	DESCRIPTION	DATE	APPROVED
1	ADDED NOTE	12-04-08	BT
2	ADDED SFCmw-001 THRU 006	9-10-09	JM

REVISIONS

DRAWN	D.TOMO	10/22/07
CHECKED		
APPROVED		
SCALE:	NONE	

MONITORING WELLS AT RVAAP

ORIGINAL SIZE	PROJECT NO.	DWG NO.	REV
E	030240.0006	PLATE 1	2



Well ID	Elevation (ft, amsl)
BKGmw-004	954.31
BKGmw-005	1139.60
BKGmw-013	976.38
BKGmw-016	1094.14
BKGmw-017	1117.18
BKGmw-019	1089.20
BKGmw-020	1057.50
BKGmw-021	959.34
CBPmw-001	962.74
CBPmw-002	960.94
CBPmw-003	962.18
CBPmw-004	960.08
CBPmw-005	959.26
CBPmw-006	959.53
CBPmw-007	960.41
CBPmw-008	956.88
CPmw-001	971.30
CPmw-002	972.19
CPmw-003	972.12
CPmw-004	970.36
CPmw-005	962.21
CPmw-006	955.17

Well ID	Elevation (ft, amsl)
DA2mw-104	1051.80
DA2mw-105	1042.10
DA2mw-106	1038.56
DA2mw-107	1033.14
DA2mw-108	1025.41
DA2mw-109	1055.11
DA2mw-110	1053.23
DA2mw-111	1034.71
DA2mw-112	1029.85
DA2mw-113	1029.32
DETmw-001B	1042.14
DETmw-002	1028.46
DETmw-003	1027.16
DETmw-004	1027.94
EBGmw-123	938.52
EBGmw-124	938.42
EBGmw-125	942.46
EBGmw-126	938.63
EBGmw-127	938.98
EBGmw-128	938.67
EBGmw-129	938.77
EBGmw-130	937.95

Well ID	Elevation (ft, amsl)
FBQmw-166	1103.68
FBQmw-167	1110.29
FBQmw-176	1120.96
L L11mw-002	1073.01
LL10mw-006	1109.51
LL11mw-001	1089.90
LL11mw-003	1085.78
LL11mw-004	1082.67
LL11mw-005	1071.29
LL11mw-006	1082.11
LL11mw-007	1067.87
LL11mw-008	1085.94
LL11mw-009	1088.19
LL11mw-010	1077.84
LL12mw-088	973.80
LL12mw-107	969.89
LL12mw-128	968.02
LL12mw-153	971.42
LL12mw-154	969.93
LL12mw-182	973.22
LL12mw-184	969.86
LL12mw-185	971.91

Well ID	Elevation (ft, amsl)
FBQmw-166	1103.47
LL12mw-187	970.13
LL12mw-188	975.93
LL12mw-242	972.40
LL12mw-243	971.24
LL12mw-244	970.29
LL12mw-245	971.36
LL12mw-246	967.67
LL1mw-064	933.38
LL1mw-065	932.79
LL4mw-193	976.08
LL4mw-194	974.49
LL4mw-195	971.31
LL4mw-196	970.95
LL4mw-197	980.64
LL4mw-198	974.42
LL4mw-199	969.37
LL4mw-200	969.67
LL5mw-003	1106.60
LL6mw-001	1108.95
LL6mw-002	1107.10
LL6mw-006	1108.22

Well ID	Elevation (ft, amsl)
LL8mw-001	1108.08
LL8mw-002	1103.67
LL8mw-003	1103.95
LL8mw-004	1102.23
LNWmw-024	1025.64
LNWmw-025	1024.46
LNWmw-026	1022.71
LNWmw-027	1019.91
MBS-001	1064.20
MBS-002	1064.54
MBS-003	1065.13
MBS-004	1064.52
MBS-005	1064.13
MBS-006	1069.04
NTAmw-107	1067.02
NTAmw-108	1067.26
NTAmw-109	1067.29
NTAmw-110	1067.72
NTAmw-111	1076.30
NTAmw-112	1068.66
NTAmw-113	1068.03
NTAmw-114	1071.69

Well ID	Elevation (ft, amsl)
NTAmw-115	1075.20
NTAmw-116	1088.43
NTAmw-117	1080.02
NTAmw-118	1070.81
WBGmw-005	1048.76
WBGmw-006	1008.06
WBGmw-007	982.86
WBGmw-008	993.64
WBGmw-009	1034.13
WBGmw-010	1061.71
WBGmw-011	1061.61
WBGmw-012	1057.29
WBGmw-013	1059.70
WBGmw-014	980.28
WBGmw-015	1000.37
WBGmw-016	979.43
WBGmw-017	998.23

0 50 1000

SCALE (METERS)

LEGEND

UNCONSOLIDATED WELL

PROPERTY LINE

1100

GROUNDWATER DIRECTION

UNCONSOLIDATED AQUIFER MISSING

INFERRED GROUNDWATER DIVIDE

N

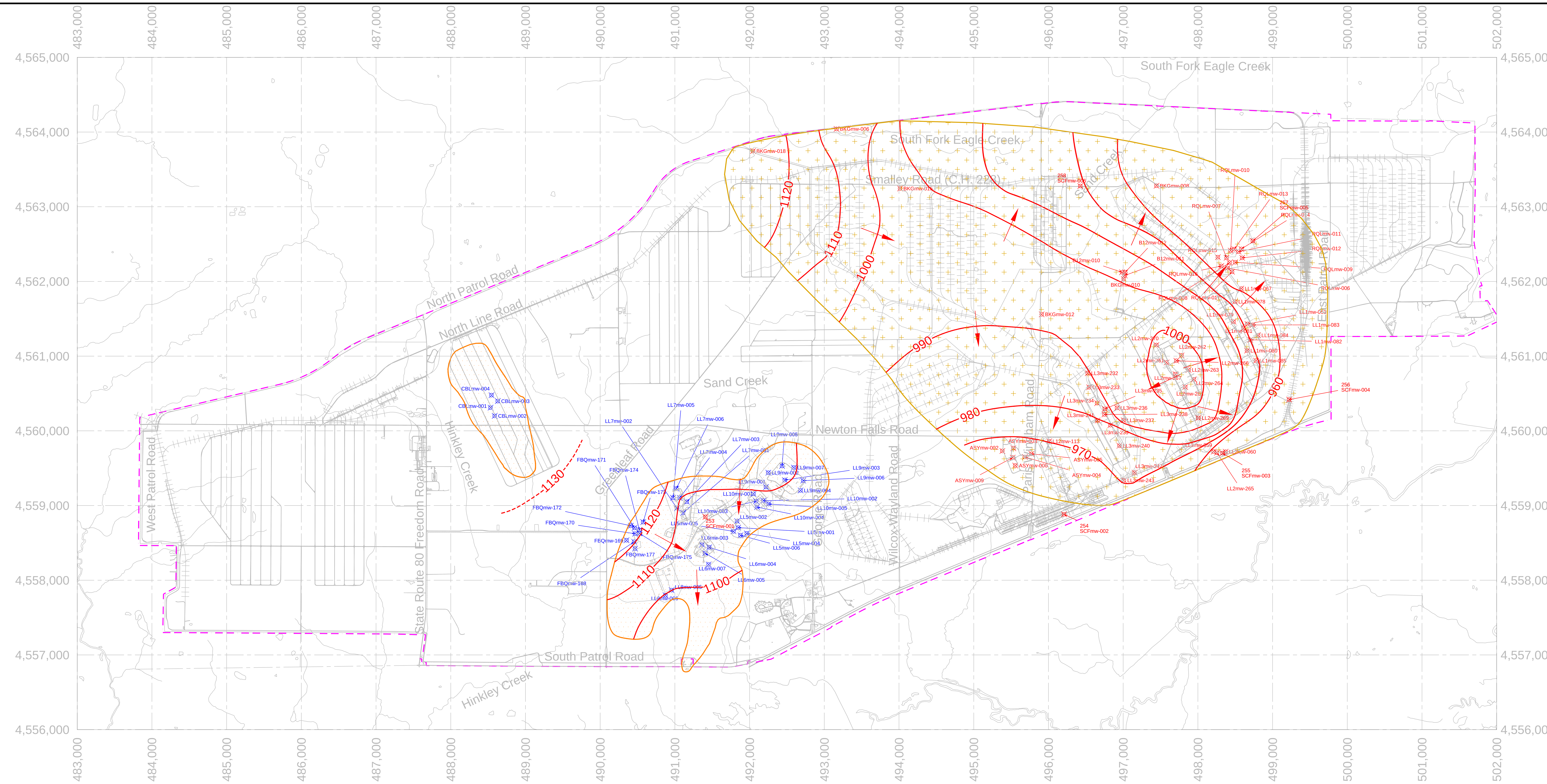
COORDINATE SYSTEM UTM NAD 83 ZONE 17

ENVIRONMENTAL QUALITY MANAGEMENT, INC.
1800 CARILLON BLVD.
CINCINNATI, OHIO 45240
P (513)825-7500
F (513)825-7495

				DRAWN	S.RASOR	11-22-11
				CHECKED	W.THOMPSON	11-22-11
				APPROVED		
REV	DESCRIPTION	DATE	APPROVED	SCALE:	NONE	
REVISIONS						

POTENTIOMETRIC SURFACE OF UNCONSOLIDATED AQUIFER (OCT. 2011)

ORIGINAL SIZE	PROJECT NO.	DWG NO.	REV
E	030240.0006	PLATE 2	1



HOMEWOOD MEMBER WELLS

Well ID	Elevation (ft, amsl)
CBLmw-001	1137.30
CBLmw-002	1136.99
CBLmw-003	1138.32
CBLmw-004	1138.46
FBQmw-168	1120.72
FBQmw-169	1113.24
FBQmw-170	1122.37
FBQmw-171	1123.42
FBQmw-172	1121.39
FBQmw-173	1121.54
FBQmw-174	1121.26
FBQmw-175	1121.29
FBQmw-177	1113.42
LL10mw-001	1106.93
LL10mw-002	1108.29
LL10mw-003	1108.84
LL10mw-004	1107.57
LL10mw-005	1108.58
LL5mw-001	1106.45
LL5mw-002	1106.42
LL5mw-004	1106.42
LL5mw-005	1106.44

Well ID	Elevation (ft, amsl)
LL5mw-006	1106.41
LL6mw-003	1107.76
LL6mw-004	1107.18
LL6mw-005	1107.27
LL6mw-007	1107.12
LL7mw-001	1107.69
LL7mw-002	1111.55
LL7mw-003	1108.04
LL7mw-004	1110.22
LL7mw-005	1112.95
LL7mw-006	1111.35
LL8mw-005	1100.46
LL8mw-006	1095.67
LL9mw-001	1118.03
LL9mw-002	1114.33
LL9mw-003	1123.12
LL9mw-004	1109.70
LL9mw-005	1113.56
LL9mw-006	1109.53
LL9mw-007	1109.56

SHARON MEMBER WELLS

Well ID	Elevation (ft, amsl)
ASYmw-001	968.74
ASYmw-002	969.45
ASYmw-003	968.78
ASYmw-004	969.58
ASYmw-005	971.24
ASYmw-006	968.37
ASYmw-009	969.76
B12mw-010	987.87
B12mw-011	986.90
B12mw-012	986.35
BKGmw-006	1005.50
BKGmw-008	955.59
BKGmw-010	989.72
BKGmw-012	991.05
BKGmw-015	991.51
BKGmw-018	1029.22
LL1mw-063	968.14
LL1mw-067	960.86
LL1mw-078	962.85
LL1mw-079	964.87
LL1mw-080	986.47
LL1mw-081	969.32

Well ID	Elevation (ft, amsl)
LL1mw-082	978.07
LL1mw-083	961.30
LL1mw-084	970.63
LL1mw-085	960.94
LL2mw-059	952.43
LL2mw-060	950.71
LL2mw-261	1004.41
LL2mw-262	1005.30
LL2mw-263	1004.02
LL2mw-264	1006.33
LL2mw-265	950.62
LL2mw-266	1005.26
LL2mw-267	1005.49
LL2mw-268	1002.80
LL2mw-269	994.97
LL2mw-270	1002.17
LL3mw-232	980.69
LL3mw-233	977.58
LL3mw-234	996.54
LL3mw-235	992.31
LL3mw-236	995.39
LL3mw-237	990.42

Well ID	Elevation (ft, amsl)
LL3mw-238	991.82
LL3mw-239	979.29
LL3mw-240	978.79
LL3mw-241	985.12
LL3mw-242	982.54
LL3mw-243	976.82
RQLmw-006	959.99
RQLmw-007	959.60
RQLmw-008	959.44
RQLmw-009	959.63
RQLmw-010	956.75
RQLmw-011	954.51
RQLmw-012	955.44
RQLmw-013	955.30
RQLmw-014	953.28
RQLmw-015	959.20
RQLmw-016	960.36
RQLmw-017	960.73

SHARON SHALE WELLS

Well ID	Elevation (ft, amsl)
LL12mw-113	974.96
LL12mw-183	969.48
LL12mw-186	972.46
LL12mw-189	973.80

*WELLS NOT USED TO PRODUCE POTENTIOMETRIC MAP

0 50 1000

SCALE (METERS)

LEGEND

HOMEWOOD MEMBER WELL

SHARON MEMBER WELL

PROPERTY LINE

1100 / 1030 LINE OF EQUAL GROUNDWATER ELEVATION (ft,amsl) (INTERMEDIATE DASHED)

GROUNDWATER DIRECTION

HOMEWOOD MEMBER

SHARON MEMBER

N

COORDINATE SYSTEM UTM NAD 83 ZONE 17

ENVIRONMENTAL QUALITY MANAGEMENT, INC.
1800 CARILLON BLVD.
CINCINNATI, OHIO 45240
P (513)825-7500
F (513)825-7495

REV	DESCRIPTION	DATE	APPROVED
1	ADDED SFCmw-001 THRU 006	9-10-09	JM

REVISIONS

DRAWN	S.RASOR	11-22-11
CHECKED	W.THOMPSON	11-22-11
APPROVED		
SCALE:	NONE	

POTENTIOMETRIC SURFACE OF BEDROCK -HOMEWOOD AND SHARON (OCT. 2011)

ORIGINAL SIZE	PROJECT NO.	DWG NO.	REV
E	030240.0006	PLATE 3	1