Draft

Facility-Wide Sampling and Analysis Plan for Environmental Investigations

Revision 0

Ravenna Army Ammunition Plant
Ravenna, Ohio

Contract No. W912QR-08-D-0008
Delivery Order No. 0016

Prepared for:

United States Army Corps of Engineers
Louisville District

Prepared by:

Science Applications International Corporation
8866 Commons Boulevard
Twinsburg, Ohio 44087

November 11, 2010

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14. ABSTRACT

This document details the expected sampling methods, equipment, and procedures; sample custody/documentation requirements; sample packaging, shipping, and handling requirements; generic management of investigation-derived wastes; chemical QC requirements; field documentation; data reporting; corrective actions and the minimum requirements that must be followed during sampling and analysis for all investigations at RVAAP.

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Twinsburg, Ohio 44087

November 11, 2010

CONTRACTOR STATEMENT OF INDEPENDENT TECHNICAL REVIEW

Science Applications International Corporation (SAIC) has completed the Draft Facility-Wide Sampling and Analysis Plan for Environmental Investigations Revision 0 at the Ravenna Army Ammunition Plant, Ravenna, Ohio. Notice is hereby given that an independent technical review has been conducted that is appropriate to the level of risk and complexity inherent in the project. During the independent technical review, compliance with established policy principles and procedures, utilizing justified and valid assumptions, was verified. This included review of data quality objectives; technical assumptions; methods, procedures, and materials to be used; the appropriateness of data used and level of data obtained; and reasonableness of the results, including whether the product meets the customer's needs consistent with law and existing USACE policy.

Sally Absher
Sally Absher
Study/Design Team Leader

11-10-10
Date

Rob Porges
Independent Technical Review Team Leader

11-10-10
Date

Significant concerns and the explanation of the resolution are as follows:

Internal SAIC Independent Technical Review comments are recorded on a Document Review Record per SAIC quality assurance procedure QAAP 3.1. This Document Review Record is maintained in the project file. Changes to the report addressing the comments have been verified by the Study/Design Team Leader. As noted above, all concerns resulting from independent technical review of the project have been considered.

W. Kevin Jago
Kevin Jago, P.G.
Principal w/ A-E firm

11-11-10
Date

DOCUMENT DISTRIBUTION

for the
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Facility-Wide Sampling and Analysis Plan for Environmental Investigations
Revision 0

Ravenna Army Ammunition Plant
Ravenna, Ohio

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NGB = National Guard Bureau
OHARNG = Ohio Army National Guard
RVAAP = Ravenna Army Ammunition Plant
USACE = United States Army Corps of Engineers
USAEC = United States Army Environmental Command
REIMS = Ravenna Environmental Information Management System
SAIC = Science Applications International Corporation

EXECUTIVE SUMMARY

Science Applications International Corporation (SAIC) prepared this Facility-wide Sampling and Analysis Plan (FWSAP) for Environmental Investigations at the Ravenna Army Ammunition Plant (RVAAP), Ravenna, Ohio, under contract number GS-10F-0076J, delivery order number W912QR-05-F-0033 with the United States Army Corps of Engineers (USACE), Louisville District. This FWSAP is developed in accordance with USACE and Ohio Environmental Protection Agency (Ohio EPA) guidance documents to meet the requirements for the investigation of known or suspected contaminated sites regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA); the Resource Conservation and Recovery Act (RCRA); and other federal or state regulations that govern environmental restoration activities at RVAAP. The FWSAP is comprised of two facility-wide plans: the Field Sampling Plan (FSP) and the Quality Assurance Program Plan (QAPP). A third facility-wide plan, the Safety and Health Plan (SHP) is prepared as a separate, stand-alone document per USACE requirements. The objectives of this FWSAP are as follows:

- Establish standards (and procedures, to the extent practical) for the performance of all environmental field sampling and data handling efforts that take place at RVAAP.

- Be available to regulators, managers, and contractors in an easily accessible electronic format.

- Serve as the master standard operating procedure (SOP) with the realization that new information and new technologies may result in changes to these procedures.

- Incorporate improvements and modifications to the original facility-wide plans.

Standards of performance are necessary to ensure consistency and defensibility of the large amounts of environmental data expected to be gathered at RVAAP, regardless of area of concern (AOC), funding source, U.S. Army Project Manager, or contracted firm performing the work. All environmental data will be archived in the RVAAP Environmental Information Management System (REIMS) and must be consistent across all programs. The requirements for consistency among investigation programs include detailed procedures for sample collection and handling and documentation, data validation, and quality assurance (QA)/quality control (QC). These protocols, along with the project organization presented here, have proven successful in the foregoing United States Department of Defense (DoD) Installation Restoration Program (IRP) work administered by the U.S. Army at RVAAP.

The original *Facility-wide Sampling and Analysis Plan* (USACE 1996b) 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 (Figure ES-1). 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. On June

10, 2004, Ohio EPA issued the *Director's Final Findings and Orders* (Ohio EPA 2004) for RVAAP, which require conformance with CERLCA and the National Oil and Hazardous Substances Pollution Contingency Plan for completion of environmental restoration activities. All RVAAP environmental activities are conducted in accordance with the requirements of the DFFO under work plans reviewed and approved by Ohio EPA. The U.S. Army recognizes that not all environmental investigation activities are IRP-driven and that the requirements under CERCLA may be more rigorous than required for some AOCs. However, the CERCLA model is used in this updated FWSAP for all environmental data collection and analysis for all currently identified 26 individual IRP AOCs, 2 facility-wide AOCs, 13 compliance restoration sites, and 14 munitions response sites (Table ES-1 and Figure ES-2). Throughout this FWSAP, the term "AOC" applies to these areas and sites. This model provides consistency with all previous IRP data collected at RVAAP and provides high-quality data on which to base cleanup decisions. The foundations set forth in this FWSAP apply to several possible types of IRP and non-IRP environmental investigations and studies, including the following:

- Phase I and Phase II remedial investigations (RIs; CERCLA);
- Feasibility studies (FSs; CERCLA);
- Groundwater investigations (CERCLA);
- Confirmatory sampling of removal or remedial actions (CERCLA);
- Confirmatory sampling of RCRA closures (RCRA);
- Long-term monitoring (CERCLA or compliance monitoring);
- Unexploded ordnance/ordnance explosive waste (UXO/OE) removal;
- Engineering evaluation/cost analyses; and
- Sampling of non-AOC areas before placement of clean fill.

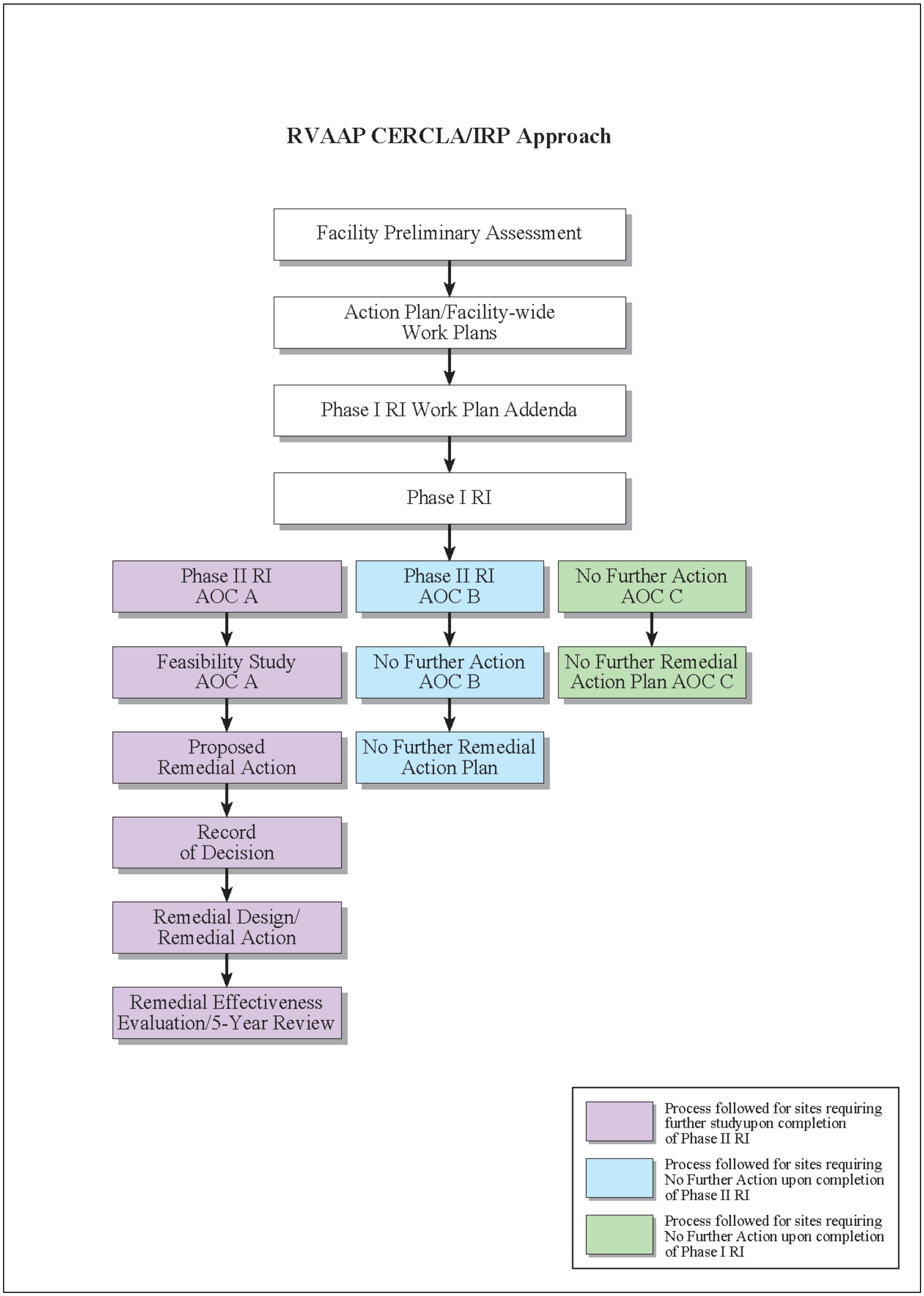


Figure ES-1. CERCLA Approach at RVAAP

Characterization of AOCs at RVAAP will be accomplished using the facility-wide plans (FSP, SHP, QAPP, and Environmental Information Management Plan) that can be customized with addenda for only those elements of the work that are project-specific. This approach reduces costs associated with creating redundant work plan information and accelerates the review of work plans for individual projects. The facility-wide plans address work elements expected to be integral to all AOC investigations. The elements of the facility-wide plans are listed below.

- FSP: This document details the expected sampling methods, equipment, and procedures; sample custody/documentation requirements; sample packaging, shipping, and handling requirements; generic management of investigation-derived waste (IDW); chemical QC requirements; field documentation; data reporting; and corrective actions.

- SHP: This document identifies the potential hazards and presents a risk analysis for each expected chemical, physical, and biological hazard expected at RVAAP during the performance of the common field tasks. The SHP defines provisions for personal protective equipment (PPE), hazard and emergency communication, training, and general safe work practices to be observed by field personnel at RVAAP during environmental investigations.

- QAPP: The QAPP addresses analytical data quality objectives (DQOs) and specific QA/QC procedures to be used when collecting and analyzing samples. The document identifies the roles and responsibilities of each element of the QA/QC team for a project. The QAPP addresses sampling QC procedures (e.g., preservation, handling, and custody); analytical holding times; calibration; preventive maintenance; laboratory QC; data quality assessment, data precision, accuracy completeness, sensitivity, representativeness, and compatibility requirements; and data reporting. Because USACE will continue to fulfill the role of QA Administrator for RVAAP, specific USACE guidance will be adopted for environmental investigations at RVAAP.

- The Environmental Information Management Plan addresses work elements that follow the field components of IRP and other environmental investigations.

The facility-wide plans cannot be implemented without the accompaniment of investigation-specific addenda to the Facility-wide Field Sampling Plan (FWFSP), Facility-wide Quality Assurance Project Plan (FWQAPP), and Facility-wide Safety and Health Plan (FWSHP), at a minimum. The addenda will contain specific project scope and objectives, sampling rationale and locations, analytical DQOs, analytical laboratory specifications, and the project schedule, as well as specific health and safety precautions and protocols. Sampling procedures not addressed in this FWSAP will also be included as appropriate. The addenda will be tiered under the facility-wide plans and used in conjunction with them to the extent practical. Nothing in these facility-wide plans prevents a user (such as a contracted consulting firm) from modifying specific procedures and standards, according to the goals of the specific investigation, in an RVAAP- and Ohio EPA-reviewed addendum to the FWFSP, FWQAPP, or FWSHP.

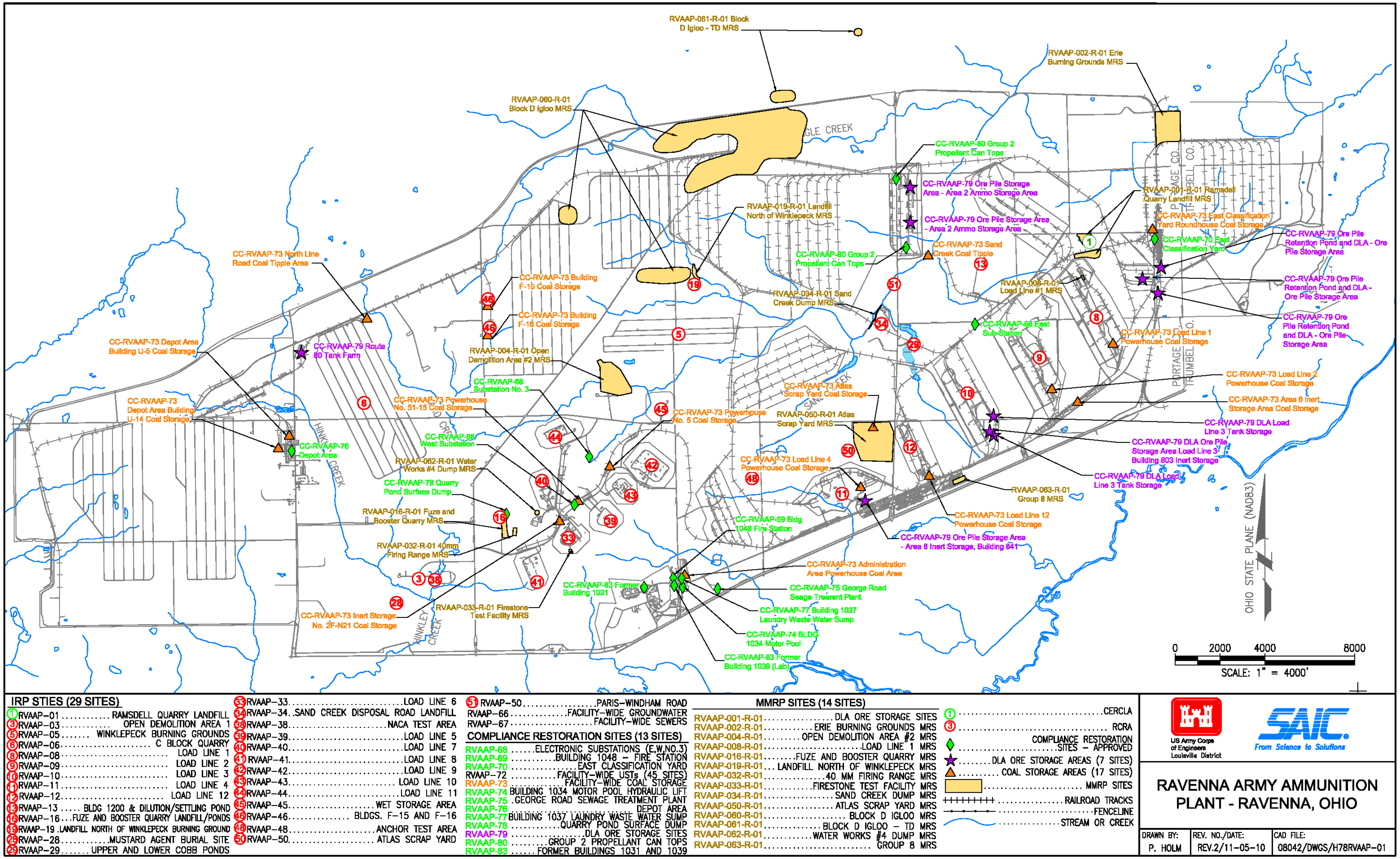
Table ES-1. AOCs at RVAAP

IRP/Compliance Restoration/Munitions Response Site		Regulations
RVAAP-01	Ramsdell Quarry Landfill	Other
RVAAP-03	Open Demolition Area #1	CERCLA
RVAAP-05	Winklepeck Burning Grounds	CERCLA
RVAAP-06	C Block Quarry	CERCLA
RVAAP-08	Load Line 1	CERCLA
RVAAP-09	Load Line 2	CERCLA
RVAAP-10	Load Line 3	CERCLA
RVAAP-11	Load Line 4	CERCLA
RVAAP-12	Load Line 12	CERCLA
RVAAP-13	Building 1200 and Dilution/Settling Pond	CERCLA
RVAAP-16	Fuze and Booster Quarry Landfill/Ponds	CERCLA
RVAAP-19	Landfill North of Winklepeck Burning Grounds	CERCLA
RVAAP-28	Mustard Agent Burial Site	CERCLA
RVAAP-29	Upper and Lower Cobbs Ponds	CERCLA
RVAAP-33	Load Line 6	CERCLA
RVAAP-34	Sand Creek Disposal Road Landfill	CERCLA
RVAAP-38	NACA Test Area	CERCLA
RVAAP-39	Load Line 5	CERCLA
RVAAP-40	Load Line 7	CERCLA
RVAAP-41	Load Line 8	CERCLA
RVAAP-42	Load Line 9	CERCLA
RVAAP-43	Load Line 10	CERCLA
RVAAP-44	Load Line 11	CERCLA
RVAAP-45	Wet Storage Area	CERCLA
RVAAP-46	Buildings F-15 and F-16	CERCLA
RVAAP-48	Anchor Test Area	CERCLA
RVAAP-50	Atlas Scrap Yard	CERCLA
RVAAP-51	Dump along Paris-Windham Road	CERCLA
RVAAP-66	Facility-Wide Groundwater	CERCLA
RVAAP-67	Facility-Wide Sewers	CERCLA
CC-RVAAP-68	Electric Substations (East, West, No. 3)	CERCLA
CC-RVAAP -69	Building 1048 - Fire Station	CERCLA
CC-RVAAP -70	East Classification Yard	CERCLA
CC-RVAAP -72	Facility-Wide Underground Storage Tanks (45 sites)	CERCLA
CC-RVAAP -73	Facility-Wide Coal Storage	CERCLA
CC-RVAAP -74	Building 1034 Motor Pool Hydraulic Lift	CERCLA
CC-RVAAP -75	George Road Sewage Treatment Plant	CERCLA
CC-RVAAP -76	Depot Area	CERCLA
CC-RVAAP -77	Building 1037 Laundry Waste Water Sump	CERCLA
CC-RVAAP -78	Quarry Pond Surface Dump	--
CC-RVAAP -79	DLA Ore Storage Sites	--

Table ES-1. AOCs at RVAAP (continued)

IRP/Compliance Restoration/Munitions Response Site		Regulations
CC-RVAAP -80	Group 2 Propellant Can Tops	--
CC-RVAAP -83	Former Buildings 1031 and 1039	--
RVAAP-001-R-01	Ramsdell Quarry Landfill MRS	CERCLA
RVAAP-002-R-01	Erie Burning Grounds MRS	CERCLA
RVAAP-004-R-01	Open Demolition Area #2 MRS	CERCLA
RVAAP-008-R-01	Load Line 1 MRS	CERCLA
RVAAP-016-R-01	Fuze and Booster Quarry MRS	CERCLA
RVAAP-019-R-01	Landfill North of Winklepeck MRS	CERCLA
RVAAP-032-R-01	40-mm Firing Range MRS	CERCLA
RVAAP-033-R-01	Firestone Test Facility MRS	CERCLA
RVAAP-034-R-01	Sand Creek Dump MRS	CERCLA
RVAAP-050-R-01	Atlas Scrap Yard MRS	CERCLA
RVAAP-060-R-01	Block D Igloo MRS	CERCLA
RVAAP-061-R-01	Block D Igloo-TD MRS	CERCLA
RVAAP-062-R-01	Water Works #4 Dump MRS	CERCLA
RVAAP-063-R-01	Group 8 MRS	CERCLA

AOC = Area of concern
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act
MRS = Munitions Response Site
PCB = Polychlorinated biphenyl
RCRA = Resource Conservation and Recovery Act
RVAAP = Ravenna Army Ammunition Plant



IRP STIES (29 SITES)

①RVAAP–01 .... RAMSDELL QUARRY LANDFILL
③RVAAP–03 .... OPEN DEMOLITION AREA 1
⑤RVAAP–05 .... WINKLEPECK BURNING GROUNDS
⑥RVAAP–06 .... C BLOCK QUARRY
⑧RVAAP–08 .... LOAD LINE 1
⑨RVAAP–09 .... LOAD LINE 2
⑩RVAAP–10 .... LOAD LINE 3
⑪RVAAP–11 .... LOAD LINE 4
⑫RVAAP–12 .... LOAD LINE 12
⑬RVAAP–13 ..... BLDG 1200 & DILUTION/SETTLING POND
⑯RVAAP–16 ...FUZE AND BOOSTER QUARRY LANDFILL/PONDS
⑲RVAAP–19 .LANDFILL NORTH OF WINKLEPECK BURNING GROUND
㉘RVAAP–28 ....MUSTARD AGENT BURIAL SITE
㉙RVAAP–29 ....UPPER AND LOWER COBB PONDS
㉝RVAAP–33 ....LOAD LINE 6
㉞RVAAP–34 ..SAND CREEK DISPOSAL ROAD LANDFILL
㊳RVAAP–38 ....NACA TEST AREA
㊴RVAAP–39 ....LOAD LINE 5
㊵RVAAP–40 ....LOAD LINE 7
㊶RVAAP–41 ....LOAD LINE 8
㊷RVAAP–42 ....LOAD LINE 9
㊸RVAAP–43 .... LOAD LINE 10
㊹RVAAP–44 ....LOAD LINE 11
㊺RVAAP–45 ....WET STORAGE AREA
㊻RVAAP–46 .... BLDGS. F–15 AND F–16
㊽RVAAP–48 ....ANCHOR TEST AREA
㊿RVAAP–50 .... ATLAS SCRAP YARD
(51) RVAAP–50 ....PARIS–WINDHAM ROAD
RVAAP–66 ....FACILITY–WIDE GROUNDWATER
RVAAP–67 ....FACILITY–WIDE SEWERS

COMPLIANCE RESTORATION SITES (13 SITES)

RVAAP-68 ......ELECTRONIC SUBSTATIONS (E,W,NO.3)
RVAAP-69 ....BUILDING 1048 – FIRE STATION
RVAAP-70 ....EAST CLASSIFICATION YARD
RVAAP–72 ....FACILITY–WIDE USTs (45 SITES)
RVAAP-73 ....FACILITY–WIDE COAL STORAGE
RVAAP-74 BUILDING 1034 MOTOR POOL HYDRAULIC LIFT
RVAAP-75 .GEORGE ROAD SEWAGE TREATMENT PLANT
RVAAP-76 ....DEPOT AREA
RVAAP-77 BUILDING 1037 LAUNDRY WASTE WATER SUMP
RVAAP-78 ....QUARRY POND SURFACE DUMP
RVAAP-79 ....DLA ORE STORAGE SITES
RVAAP-80 ....GROUP 2 PROPELLANT CAN TOPS
RVAAP-83 ......FORMER BUILDINGS 1031 AND 1039

MMRP SITES (14 SITES)

RVAAP-001-R-01 ....DLA ORE STORAGE SITES
RVAAP-002-R-01 ....ERIE BURNING GROUNDS MRS
RVAAP-004-R-01 ....OPEN DEMOLITION AREA #2 MRS
RVAAP-008-R-01 ....LOAD LINE 1 MRS
RVAAP-016-R-01 ....FUZE AND BOOSTER QUARRY MRS
RVAAP-019-R-01 ... LANDFILL NORTH OF WINKLEPECK MRS
RVAAP-032-R-01 ....40 MM FIRING RANGE MRS
RVAAP-033-R-01 ....FIRESTONE TEST FACILITY MRS
RVAAP-034-R-01 ....SAND CREEK DUMP MRS
RVAAP-050-R-01 ....ATLAS SCRAP YARD MRS
RVAAP-060-R-01 .... BLOCK D IGLOO MRS
RVAAP-061-R-01 ....BLOCK D IGLOO – TD MRS
RVAAP-062-R-01 ....WATER WORKS #4 DUMP MRS
RVAAP-063-R-01 .... GROUP 8 MRS

① ....CERCLA
③ .... RCRA
◆ ....COMPLIANCE RESTORATION SITES – APPROVED
★ ....DLA ORE STORAGE AREAS (7 SITES)
▲ .... COAL STORAGE AREAS (17 SITES)
▭ .... MMRP SITES
┼┼┼┼┼┼┼┼┼ ....RAILROAD TRACKS
–·–·–·– ....FENCELINE
〜 ....STREAM OR CREEK

RAVENNA ARMY AMMUNITION PLANT - RAVENNA, OHIO

DRAWN BY:	REV. NO./DATE:	CAD FILE:
P. HOLM	REV.2/11–05–10	08042/DWGS/H78RVAAP–01

Figure ES-2. RVAAP Installation Map With AOCs, Munitions Response Sites and Compliance Restoration Site Locations

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ACRONYMS AND ABBREVIATIONS

AOC	Area of Concern
ASTM	American Society of Testing and Materials
bgs	Below Ground Surface
BKG	Background
Camp Ravenna	Camp Ravenna Joint Military Training Center
CCQC	Contractor Chemical Quality Control
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	*Code of Federal Regulations*
COC	Chain of Custody
COPC	Chemical of Potential Concern
CQC	Contractor Quality Control
CSM	Conceptual Site Model
CUG	Cleanup Goal
DCQCR	Daily Chemical Quality Control Report
DO	Dissolved Oxygen
DoD	United States Department of Defense
DOT	United States Department of Transportation
DNT	Dinitrotoluene
DQO	Data Quality Objective
ELAP	Environmental Laboratory Accreditation program
ESS	Explosives Safety Submission
FCR	Field Change Request
FS	Feasibility Study
FSA	Field Staging Area
FWCUG	Facility-wide Cleanup Goal
FWFSP	Facility-wide Field Sampling Plan
FWQAPP	Facility-wide Quality Assurance Project Plan
FWSAP	Facility-wide Sampling and Analysis Plan
FWSHP	Facility-wide Safety and Health Plan
gpm	Gallons per Minute
HMX	octahydro-1,3,5,7-tetranitroi-1,3,5,7-tetrazocane
IATA	International Air Transport Association
IDW	Investigation-derived Waste
IRP	Installation Restoration Program
ISM	Incremental Sampling Method
LIMS	Laboratory Information Management System
MCL	Maximum Contaminant Limit
MEC	Munitions and Explosives of Concern
MRS	Munitions Response Site
MS	Matrix Spike
MSD	Matrix Spike Duplicate

ACRONYMS AND ABBREVIATIONS (CONTINUED)

NCR	Nonconformance Report
NFA	No Further Action
NGT	National Guard Trainee
NTU	Nephelometric Turbidity Unit
O&M	Operation and Maintenance
OHARNG	Ohio Army National Guard
Ohio EPA	Ohio Environmental Protection Agency
ORP	Oxidation-Reduction Potential
OSP	Ohio State Plane
PCB	Polychlorinated Biphenyl
PID	Photoionization Detector
PPE	Personal Protective Equipment
ppm	Parts Per Million
PVC	Polyvinyl Chloride
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
RCRA	Resource Conservation and Recovery Act
RDX	Cyclotrimethylenetrinitramine
REIMS	Restoration Environmental Information Management System
RMIS	Restoration Management Information System
RI	Remedial Investigation
RVAAP	Ravenna Army Ammunition Plant
SAIC	Science Applications International Corporation
SHP	Safety and Health Plan
SHSO	Site Health and Safety Officer
SOP	Standard Operating Procedure
SVOC	Semi-volatile Organic Compound
SWMU	Solid Waste Management Unit
TAL	Target Analyte List
TCLP	Toxicity Characteristic Leaching Procedure
TNT	Trinitrotoluene
TSCA	Toxic Substances Control Act
USACE	United States Army Corps of Engineers
USATHAMA	United States Army Toxic and Hazardous Materials Agency
USEPA	United States Environmental Protection Agency
UXO	Unexploded Ordnance
VOC	Volatile Organic Compound
XRF	X-ray Fluorescence

1.0 INTRODUCTION

This Facility-Wide Field Sampling Plan (FWFSP) is developed in accordance with the United States Army Corps of Engineers (USACE) and Ohio Environmental Protection Agency (Ohio EPA) guidance documents to meet the requirements for the investigation of known or suspected contaminated sites regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA); the Resource Conservation and Recovery Act (RCRA); and other federal or state regulations that govern environmental restoration activities at the Ravenna Army Ammunition Plant (RVAAP). The FWFSP establishes the methods and procedures to characterize areas of concern (AOCs), compliance restoration sites, and munitions response sites (MRSs) characterization RVAAP. As this document refers to "AOCs" throughout, this term is to be inclusive of compliance restoration sites and MRSs.

This FWFSP details the expected sampling methods, equipment, and procedures; sample custody/documentation requirements; sample packaging, shipping, and handling requirements; generic management of investigation-derived waste (IDW); chemical quality control (QC) requirements; field documentation; data reporting; and corrective actions.

This document will be customized with addenda for elements of the work that are investigation-specific. This approach reduces costs associated with creating redundant work plan information and accelerates the review of work plans for individual projects. The addenda to the FWFSP will contain specific project scope and objectives, sampling rationale and locations, and the project schedule. Sampling procedures not addressed in this FWFSP will also be included as appropriate. The addenda will be tiered under the facility-wide plan and used in conjunction with it to the extent practical. Nothing in the facility-wide plan prevents a user (such as a contracted consulting firm) from modifying specific procedures and standards, according to the goals of the specific investigation.

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2.0 PROJECT DESCRIPTION

2.1 FACILITY DESCRIPTION AND HISTORY

When the RVAAP Installation Restoration Program (IRP) began in 1989, RVAAP was identified as a 21,419-acre facility. The property boundary was resurveyed by Ohio Army National Guard (OHARNG) over a 2-year period (2002 and 2003) and the 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 has been transferred to the National Guard Bureau and subsequently licensed to OHARNG for use as a military training site.

The current RVAAP consists of 1,280 acres scattered throughout the OHARNG Camp Ravenna Joint Military Training Center, herein referred to as Camp Ravenna (Figure 2-1). Camp Ravenna is in northeastern Ohio within Portage and Trumbull Counties, approximately 3 miles (4.8 km) east-northeast of the city of Ravenna and approximately 1 mile (1.6 km) northwest of the city of Newton Falls (Figure 2-1). The RVAAP portions of the property are solely located within Portage County. RVAAP/Camp Ravenna is a parcel of property approximately 11 miles (17.7 km) long and 3.5 miles (5.6 km) 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 (Figure 2-1). Camp Ravenna is surrounded by several communities: Windham on the north; Garrettsville 6 miles (9.6 km) to the northwest; Newton Falls 1 mile (1.6 km) to the southeast; Charlestown to the southwest; and Wayland 3 miles (4.8 km) to the south (Figure 2-1).

When RVAAP was operational, Camp Ravenna did not exist and the entire 21,683-acre parcel was a government-owned, contractor-operated industrial facility. The RVAAP IRP encompasses investigation and cleanup of past activities over the entire 21,683 acres of the former RVAAP. References to RVAAP in this document are considered to be inclusive of the historical extent of RVAAP, which is inclusive of the combined acreages of the current Camp Ravenna and RVAAP, unless otherwise specifically stated. Industrial operations at the former RVAAP consisted of 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 [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. Following cleaning, the waste water, containing 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.

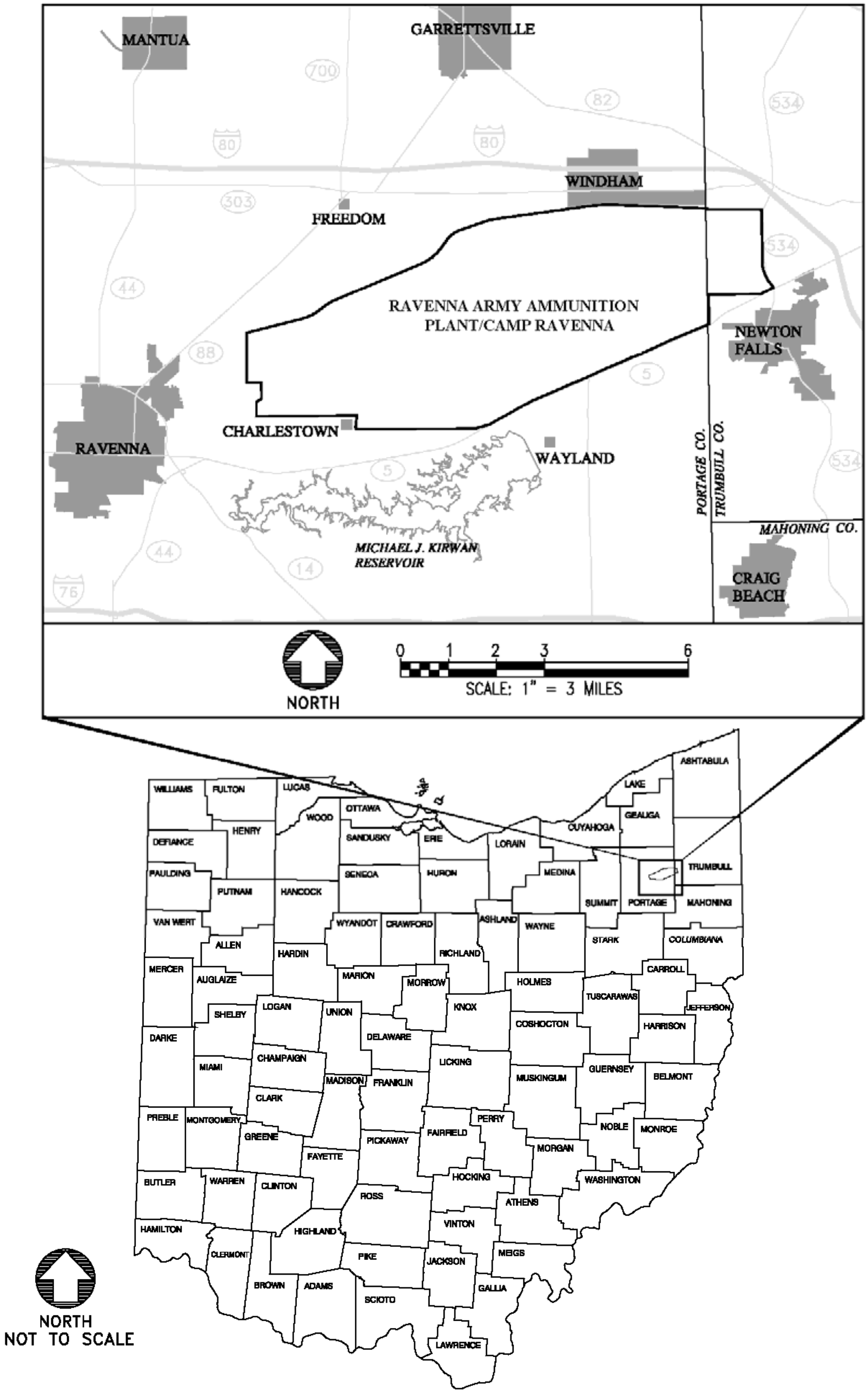


Figure 2-1. General Location and Orientation of RVAAP/Camp Ravenna

In 1950, the facility was placed in standby status and operations were limited to renovation, demilitarization, and normal maintenance of equipment, along with storage of munitions. Production activities were resumed from July 1954 to October 1957 and again from May 1968 to August 1972. In addition to production missions, various demilitarization activities were conducted at facilities constructed at Load Lines 1, 2, 3, and 12. Demilitarization activities included disassembly of munitions and explosives melt-out and recovery operations using hot water and steam processes. Periodic demilitarization of various munitions continued through 1992.

In addition to production and demilitarization activities at the load lines, other facilities at RVAAP include AOCs that were used for the burning, demolition, and testing of munitions. These burning and demolition grounds consist of large parcels of open space or abandoned quarries. Potential contaminants at these AOCs include explosives, propellants, metals, and waste oils. Other types of AOCs present at RVAAP include landfills, an aircraft fuel tank testing facility, and various general industrial support and maintenance facilities.

2.2 ENVIRONMENTAL SETTING

2.2.1 Climatic Conditions

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 93.25 cm (37.3 inches), with the highest monthly average occurring in July (10.2 cm [4.07 inches]) and the lowest monthly average occurring in February (5.0 cm [2.03 inches]). Average annual total snowfall is approximately 140.5 cm (56.2 inches), with the highest monthly average occurring in January (32.2 cm [12.9 inches]). Due to the influence of lake-effect snowfall events associated with Lake Erie (located approximately 56.3 km [35 miles] to the northwest of RVAAP), snowfall totals vary widely throughout northeastern Ohio.

The average annual daily temperature in the RVAAP area is 48.3ºF, with an average daily high temperature of 57.7ºF and an average daily low temperature of 38.7ºF. The record high temperature of 100ºF occurred in July 1988, and the record low temperature of -22ºF occurred in January 1994. The prevailing wind direction at RVAAP is from the southwest, with the highest average wind speed occurring in January (18.7 km [11.6 miles] per hour) and the lowest average wind speed occurring in August (11.9 km [7.4 miles] per hour).

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 facility property occurred as the result of a tornado in 1985.

2.2.2 Physiographic Setting

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 its 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 (e.g., 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 burial glacial valley filled with sand and gravel potentially exists in the central portion of the facility, oriented in a southwest-northeast direction. The presumed depth of the valley ranges from 30.5 to 60.7 m (100 to 200 ft).

2.2.3 Geologic Setting

The regional geology at RVAAP consists of horizontal to gently dipping sedimentary bedrock strata of Mississippian and Pennsylvanian age overlain by varying thicknesses of 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).

2.2.3.1 Unconsolidated Deposits

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 to gently undulating. Where the bedrock surface has more relief, the till cover produces a masked erosional topography. There is some evidence that varied clays, indicative of lake deposits, exist in some of the deeper bedrock valleys (USACE 1970, 2005a). The Hiram Till is the most extensive till in northeast Ohio and covers approximately the eastern two-thirds of RVAAP. It is the 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 ft 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 till that contains approximately 28% sand and 30% 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 ft in the western portion of the facility; although, its median thickness is only 4 ft. 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 the 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.

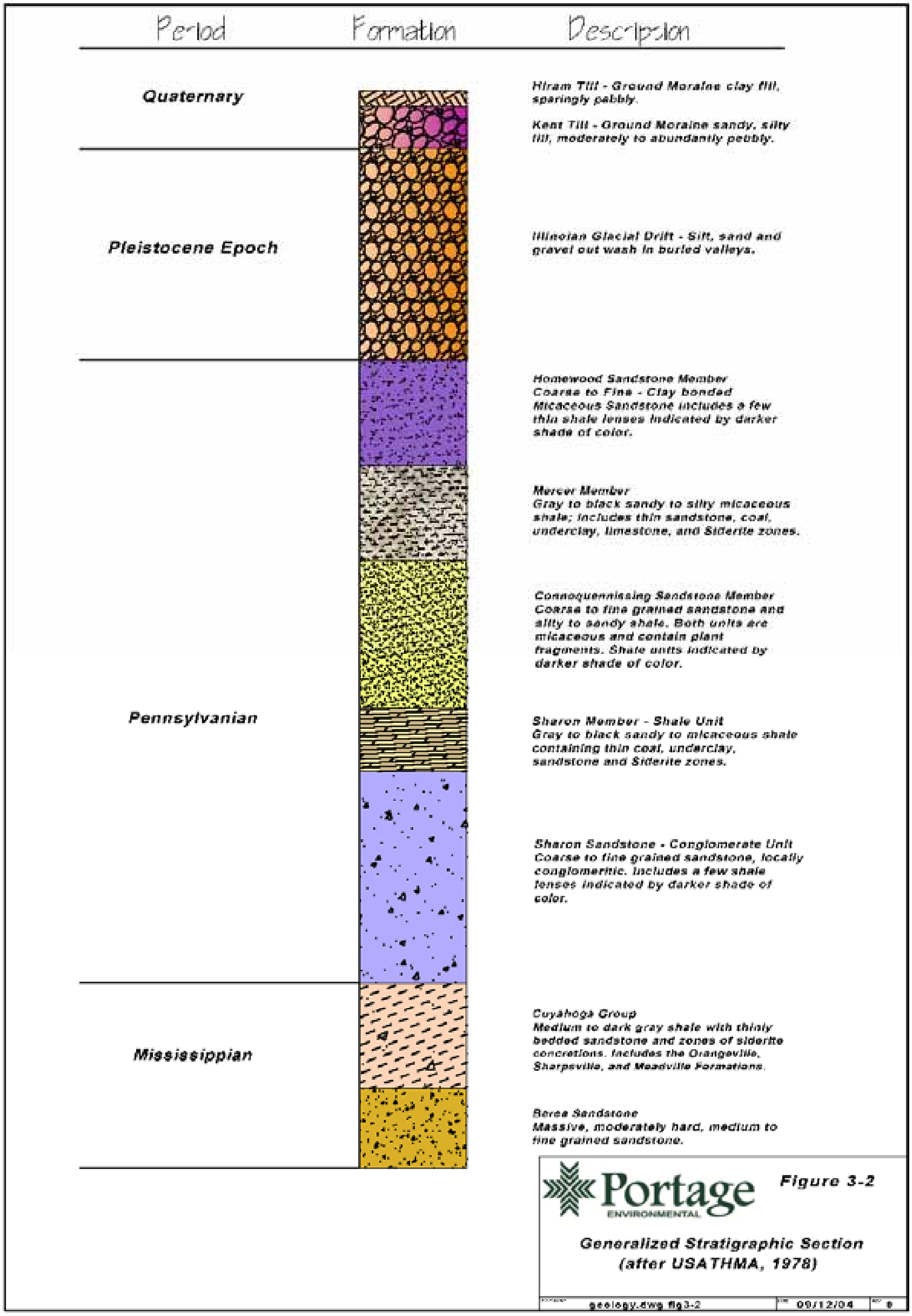
In addition to the glacial deposits, other unconsolidated deposits include alluvium associated with the surface drainages that may or may not be continuous with the surrounding glacial tills.

2.2.3.2 Bedrock

The bedrock underlying the glacial deposits consists of sedimentary deposits, predominantly Pennsylvanian in age, with minor deposits of Mississippian-age rocks. The *Preliminary Assessment for the Ravenna Army Ammunition Plant* (USACE 1996a) reports that the bedrock units at RVAAP display a gentle southward dip of 5 to 10 ft/mile. In the subsurface 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. A generalized stratigraphic section is presented in Figure 2-2, and a geologic bedrock map of RVAAP, along with a stratigraphic description of the units, is presented in Figure 2-3. The youngest bedrock unit found on RVAAP is the Homewood Sandstone Member of the Pottsville Formation. The Homewood Sandstone consists of coarse to fine-grained clay-bonded micaceous sandstone with thin shale lenses. The Mercer Member of the Pottsville Formation directly underlies the Homewood Sandstone and is comprised of gray to black silty micaceous shale, thin sandstones, and coal. The Connoquennessing Sandstone Member, underlying the Mercer Member, consists of a coarse to fine-grained sandstone and silty to sandy shale. The Sharon Member Shale unit consisting of gray to black sand and micaceous shale with thin coal separates the Connoquennessing Sandstone Member from the underlying Sharon Sandstone/Conglomerate. Comprised of tan coarse to fine-grained orthoquartzite sandstone, the Sharon Sandstone/Conglomerate is loosely cemented and is the most important aquifer found at RVAAP. The Mississippian bedrock units found in the eastern portion of RVAAP consist of the Meadville Shale, a blue-gray shale, and the Berea Sandstone, a massive moderately hard medium to fine-grain sandstone.

2.2.4 Hydrologic Setting

Groundwater at RVAAP is present in both the overlying unconsolidated glacial deposits and alluvium and in selected bedrock units. Groundwater from both unconsolidated and bedrock aquifers predominantly flows in an eastward direction.



Hiram Till - Ground Moraine clay fill, sparingly pebbly.

Kent Till - Ground Moraine sandy, silty fill, moderately to abundantly pebbly.

Illinoian Glacial Drift - Silt, sand and gravel out wash in buried valleys.

Homewood Sandstone Member
Coarse to Fine - Clay bonded Micaceous Sandstone includes a few thin shale lenses indicated by darker shade of color.

Mercer Member
Gray to black sandy to silty micaceous shale; includes thin sandstone, coal, underclay, limestone, and Siderite zones.

Connoquenessing Sandstone Member
Coarse to fine grained sandstone and silty to sandy shale. Both units are micaceous and contain plant fragments. Shale units indicated by darker shade of color.

Sharon Member - Shale Unit
Gray to black sandy to micaceous shale containing thin coal, underclay, sandstone and Siderite zones.

Sharon Sandstone - Conglomerate Unit
Coarse to fine grained sandstone, locally conglomeritic. Includes a few shale lenses indicated by darker shade of color.

Cuyahoga Group
Medium to dark gray shale with thinly bedded sandstone and zones of siderite concretions. Includes the Orangeville, Sharpsville, and Meadville Formations.

Berea Sandstone
Massive, moderately hard, medium to fine grained sandstone.

Figure 2-2. Generalized Stratigraphic Section of Deposits at RVAAP (USATHAMA 1978)

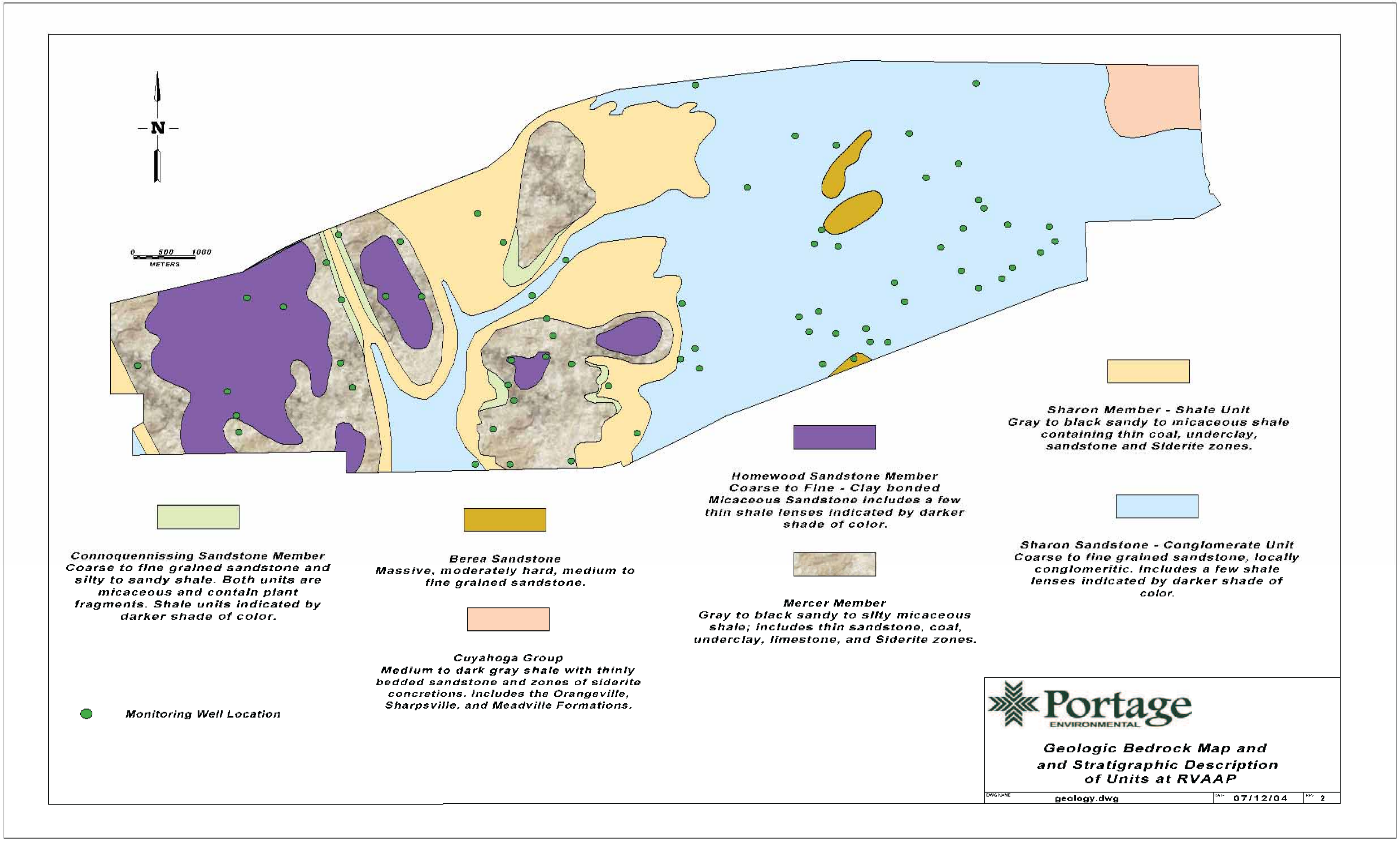


Figure 2-3. Geologic Bedrock Map and Stratigraphic Description of Units at RVAAP

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2.2.4.1 Groundwater In Unconsolidated Sediment

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 on RVAAP is a tributary, finer-grained sediment compared to the main buried valley aquifer would be expected, suggesting that lower water yields would be expected. Water production wells previously drilled in the area (Barnes 1950) also support the insignificance of a buried valley aquifer at RVAAP. Figure 2-4 shows the potentiometric surface of unconsolidated sediment within the facility from January 2009. 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.

2.2.4.2 Groundwater in Bedrock Sediment

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

Figure 2-5 shows the potentiometric surface of bedrock within the facility from January 2009. The bedrock potentiometric map shows a more uniform and regional eastward flow direction that is not as affected by local surface topography. Due to the lack of well data in the western portion of RVAAP, the discussion below focuses on groundwater occurrence in the eastern portion of RVAAP. 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.

Kammer (1982) also presents data from several hydraulic tests conducted in the Sharon Sandstone/Conglomerate, the Homewood Sandstone, and wells that combine both the Sharon Sandstone/Conglomerate and the Connoquennessing Sandstone. For wells solely completed in the Sharon Sandstone/Conglomerate, hydraulic conductivity values range from 8 to 14 ft/day (3×10-3 to 5×10-3 cm/sec) – approximately half of the values reported by Barnes (1950). For the sole Homewood Sandstone well test, the hydraulic conductivity was reported to be 8 ft/day (3×10-3 cm/sec) – at the lower range for wells in the Sharon Sandstone/Conglomerate. For wells completed in both the Sharon and Connoquennessing Sandstone, the range of hydraulic conductivity values was 3 to 11 ft/day (1×10-3 to 4×10-3 cm/sec). Results from these wells suggest either the Connoquennessing Sandstone does not supply significant quantities of water or the shale member of the Sharon is of substantial thickness within the screened interval to limit water to the wells.

The *Preliminary Assessment for the Ravenna Army Ammunition Plant* (USACE 1996a) states that the Sharon Sandstone/Conglomerate is the primary source of groundwater for RVAAP and produces the most significant well yields of the Pottsville Formation members with hydraulic conductivity values of 1 to 270 ft/day (4×10-4 to 9×10-2 cm/sec). The Connoquennessing and Homewood Sandstones are the remaining aquifers of the Pottsville Formation and exhibit hydraulic conductivities of 1 to 40 ft/day (4×10-4 to 1×10-2 cm/sec) and 1 to 27 ft/day (4×10-4 to 9×10-3 cm/sec), respectively. Slug tests conducted on bedrock wells in the Load Line 2 area yielded a range of 0.01 to 7 ft/day (4×10-6 to 2×10-3 cm/sec) (USACE 2004).

Using available hydraulic information, an assumed effective porosity, and Darcy's Law, it is possible to estimate the rate of contaminant transport in the unconsolidated and bedrock aquifers. For groundwater flow estimates in the unconsolidated aquifer, a wide range of hydraulic conductivity values is reported in the available literature. Using the hydraulic conductivity range presented in the *Phase III Remedial Investigation Report for Winklepeck Burning Grounds* (USACE 2005) of 1.31×10+2 ft/day (4×10-2 cm/sec) in sandy materials to as low as 2.83×10-4 ft/day (1×10-7 cm/sec) for clays, an effective porosity of 20%, and an average hydraulic gradient of 0.004, groundwater flow velocities (also referred to as the average linear velocity) in the unconsolidated deposits range from 0.002 to 950 ft/yr (0.0006 to 290 m/yr). This wide range in groundwater flow values is reflective of the heterogeneous nature of the unconsolidated deposits. Flow in the clayey glacial tills is basically insignificant while groundwater flow rates in the sandy lenses can be important. The lateral extent of these sandy unconsolidated deposits and the implications for significant transport pathways are not well understood. Because of the extreme variability of the localized sand deposits, including types of materials, horizontal and vertical extents, depths from surface, full understanding of these sand layers is virtually impossible. The likelihood that sandy deposits are continuous over large areas is not likely, however, and transport of contamination in the unconsolidated aquifer is not considered to be significant on a facility-wide basis.

Using a range of hydraulic conductivity values reported by Barnes (1950) and Kammer (1982) of 8-34 ft/day (3×10-3 to 1×10-2 cm/sec), an effective porosity of 20%, and an average hydraulic gradient of 0.005, groundwater flow velocities in the bedrock aquifer (Sharon Sandstone/Conglomerate) are estimated to be 70 to 300 ft/yr (21 to 91 m/yr). This range is expected to be more consistent over RVAAP and indicates that the Sharon Sandstone/Conglomerate is capable of being a regional groundwater transport pathway.

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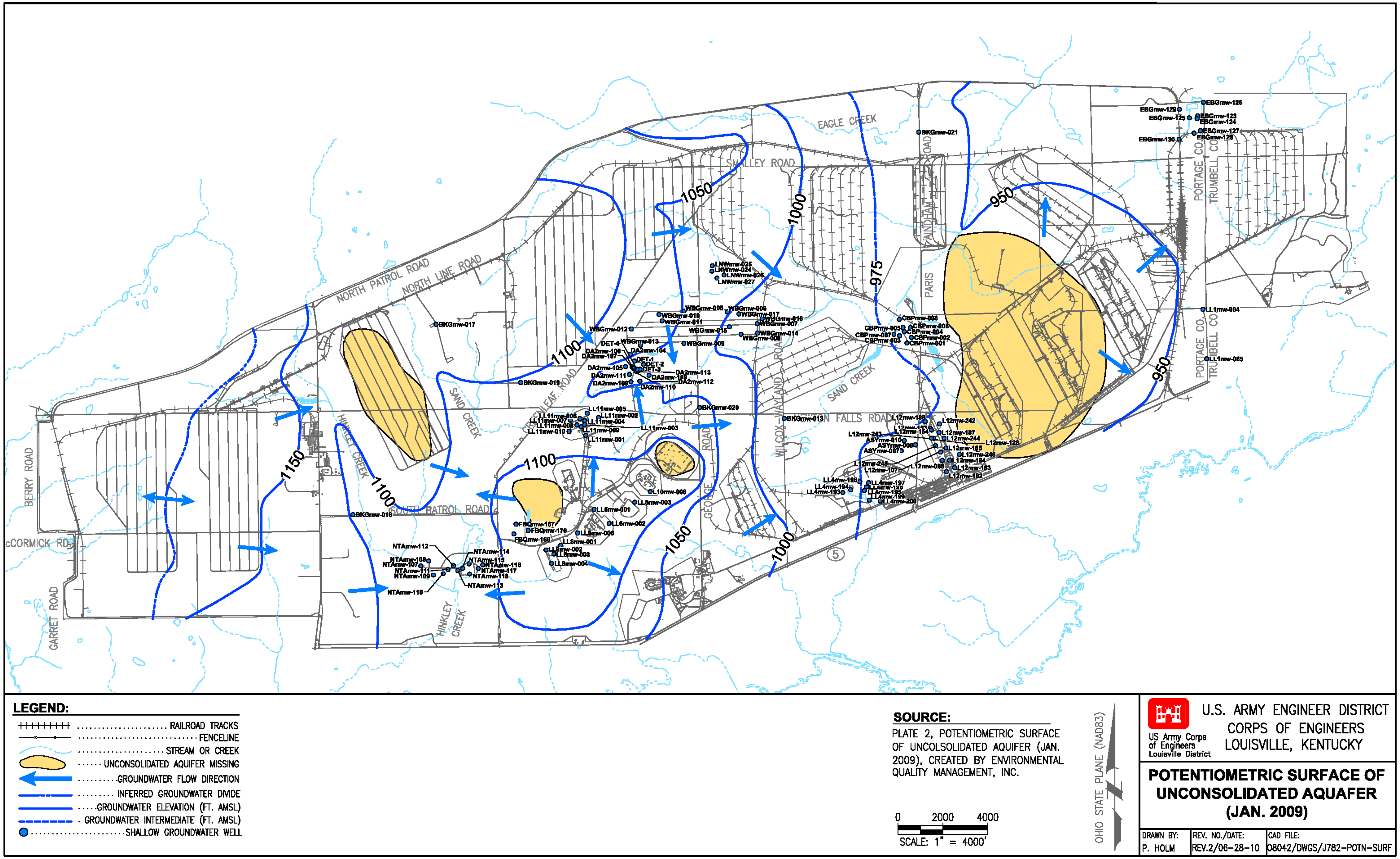

Figure 2-4. Potentiometric Surface of Unconsolidated Sediment at RVAAP (January 2009)

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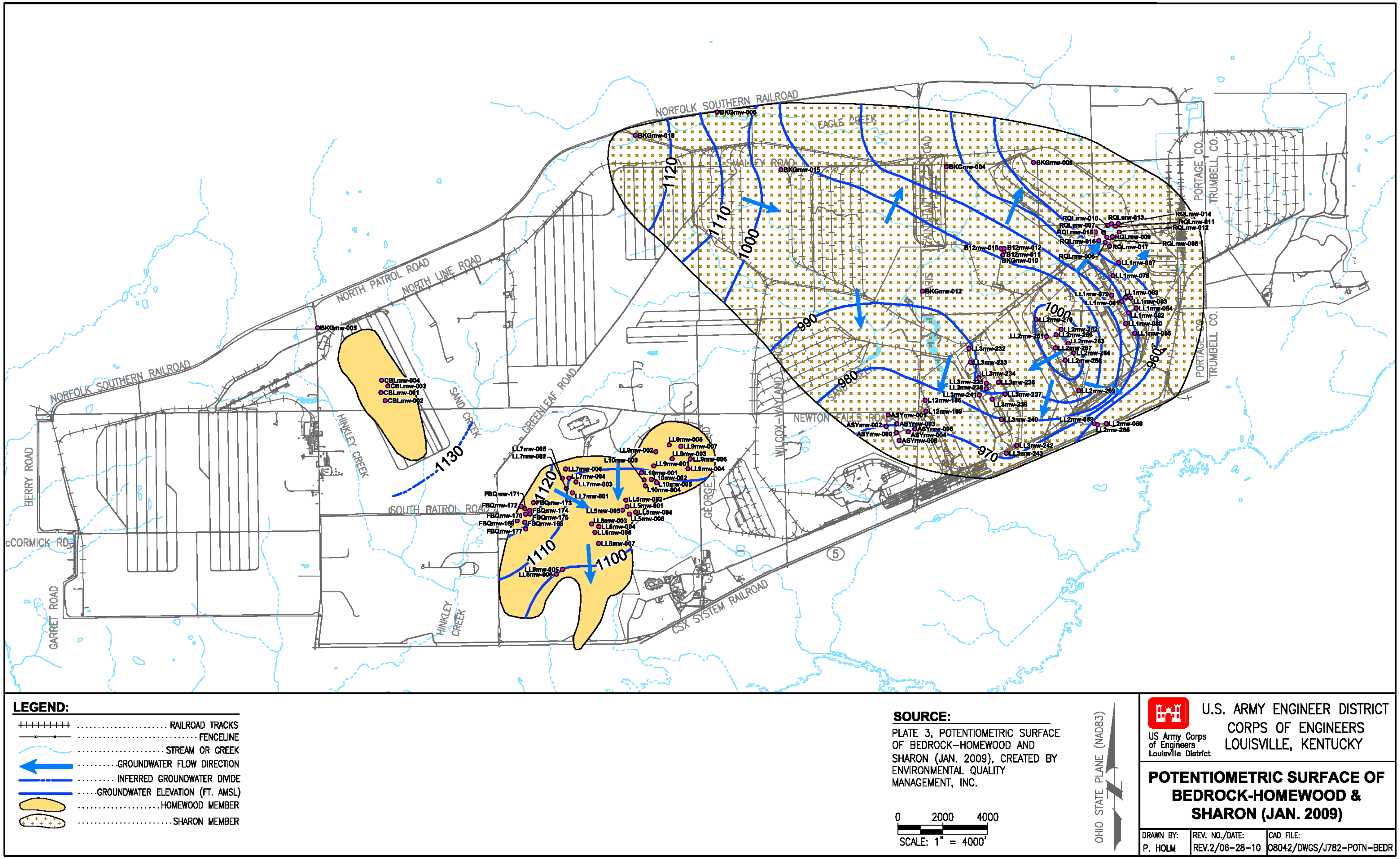

Figure 2-5. Potentiometric Surface in Bedrock Formations at RVAAP (January 2009)

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2.2.4.3 Surface Water

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, generally in a north to south direction, before flowing into the M.J. Kirwan Reservoir, which is located to the south of State Route 5. The West Branch flows out of the reservoir along the southern facility boundary before joining the Mahoning River east of 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 (Figure 2). All of these water courses have many associated tributaries.

Sand Creek, with a drainage area of 36 km^2 (13.9 $miles^2$), flows generally in a northeast direction to its confluence with the South Fork of Eagle Creek. In turn, the South Fork of Eagle Creek then continues in a northerly direction for 4.3 km (2.7 miles) to its confluence with Eagle Creek. The drainage area of the South Fork of Eagle Creek is 67.8 km^2 (26.2 $miles^2$), including the area drained by Sand Creek. Hinkley Creek originates just southeast of the intersection between State Routes 88 and 303 to the north of the facility. Hinkley Creek, with a drainage area of 28.5 km^2 (11.0 $miles^2$), flows in a southerly direction through the facility to its confluence with the West Branch of the Mahoning River south of the facility.

Approximately 50 ponds are scattered throughout the facility. Many were built within natural drainage ways to function as settling ponds or basins for process effluent and runoff. Others are natural in origin and result from glacial action or beaver activity. All water bodies at RVAAP support an abundance of aquatic vegetation and are well stocked with fish. None of the ponds within the facility are currently used as potable water supply sources.

Storm water runoff is controlled primarily by natural drainage except in facility operations areas where an extensive storm sewer network helps to direct runoff to drainage ditches and settling ponds. In addition, the storm sewer system was one of the primary drainage mechanisms for process effluent during the period that production facilities were in operation.

2.2.4.4 Groundwater Utilization

All groundwater utilized at RVAAP during past operations was obtained from on-site production wells, with the majority of wells screened in the Sharon Conglomerate. Production wells scattered throughout the facility provided necessary sanitary and process water for RVAAP operations. All remaining process production wells were permanently abandoned in 1992. Currently, only two groundwater production wells remain in operation. These wells, located in the central portion of the facility, provide sanitary water to the remaining personnel.

Residential groundwater use in the surrounding area is similar to that for RVAAP, with the Sharon Sandstone acting as the major producing aquifer in the area. The Connoquennessing 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 Groundwater 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 are (1) glacial till overlying bedded sedimentary rock, (2) glacial till overlying sandstone, (3) and 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 of from 140 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.

2.2.4.5 Surface Water Utilization

Past and present surface water utilization at RVAAP generally was limited to use by wildlife and recreational users. Although some surface water may have been used intermittently for various facility operations, 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. It is likely that some agricultural use of surface water was conducted in this area before facility construction due to the presence of homesteads and farms at that time. On-site recreational surface water use was limited to manage fishing programs conducted in the past. Camp Ravenna has an established fishing program administered through the Ohio Army National Guard (OHARNG). Based on conversations with facility personnel, it is likely that some recreational trespasser use of surface water does occur on a limited basis.

The major surface water drainages at RVAAP all exit facility property and eventually flow into the Mahoning River to the east. Surface water from Sand Creek, which flows to the northeast across the facility, joins the South Fork of Eagle Creek, which flows to the east inside the northern property boundary. The South Fork of Eagle Creek continues to the east until it eventually discharges to the Mahoning River. It is likely that limited agricultural and recreational use of the South Fork of Eagle Creek does occur off of facility property; although, no data are available to allow a more detailed study. Hinkley Creek, which enters facility property from the north and flows to the south across the western portion of RVAAP, eventually discharges to the West Branch of the Mahoning River (and the West Branch Reservoir) south of State Route 5. It is doubtful that Hinkley Creek is used for any agricultural purposes; although, limited recreational use may occur.

2.2.5 Air Quality For Surrounding Area

RVAAP is located in a rural area and has air quality that generally can be described as good. Based on a southwesterly prevailing wind direction, the city of Akron (located 37 km [23 miles] to the south-southwest) is the nearest significant upwind urban area. Currently, there are no significant airborne emissions from RVAAP. In addition, there is no operating air monitoring program in place at the facility at this time. There are no significant documented air pollution sources in close proximity to facility property that would affect air quality at RVAAP.

2.2.6 Ecological Setting

Available estimates indicate approximately one-third of RVAAP property meets the regulatory definition of a wetland, with the majority of the wetland areas located in the eastern portion of the facility. Wetland areas at RVAAP include seasonal wetlands, wet fields, and forested wetlands. Many of the wetland areas are the result of natural drainage or beaver activity; however, some wetland areas are associated with anthropogenic settling ponds and drainage areas. The potential for impacts on wetland areas at RVAAP is real due to the amount of process effluent discharged to settling ponds and the natural drainage of the area in the past.

The flora and fauna present at RVAAP are varied and widespread. Table 2-1 provides a list of rare species confirmed to be on Camp Ravenna by biological inventories and confirmed sightings.

A current list of rare species is kept on file at the Camp Ravenna Environmental Office. Future IRP activities will require consideration of these species to ensure detrimental effects on threatened or endangered RVAAP flora and fauna do not occur. There are no federal, state, or local parks or protected areas on RVAAP property.

Table 2-1. RVAAP Rare Species List

CAMP RAVENNA JOINT MILITARY TRAINING CENTER (CRJMTC) RARE SPECIES LIST
27 April 2010

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

A. State Endangered

1. American bittern, *Botaurus lentiginosus* (migrant)
2. Northern harrier, *Circus cyaneus*
3. Yellow-bellied Sapsucker, *Sphyrapicus varius*
4. Golden-winged warbler, *Vennivora chrysoptera*
5. Osprey, *Pandion haliaetus* (migrant)
6. Trumpeter swan, *Cygnus buccinators* (migrant)
7. Mountain Brook Lamprey, *Ichthyomyzon greeleyi*
8. Graceful Underwing, *Catocala gracilis*
9. Tufted Moisture-loving Moss, *Philonotis Fontana var. caespitosa*
10. Bobcat, *Felis rufus*
11. Narrow-necked Pohl's Moss, *Pohlia elongata var. elongate*
12. Sandhill Crane, *Grus Canadensis* (probable nester)
13. Bald Eagle, *Haliaetus leucocephalus* (nesting pair)

B. State Threatened

1. Barn owl, *Tyto alba*
2. Dark-eyed junco, *Junco hyemalis* (migrant)
3. Hermit thrush, *Catharus guttatus* (migrant)
4. Least bittern, *Ixobrychus exilis*
5. Least flycatcher, *Empidonax minimus*
6. *Psilotreta indecisa* (caddis fly)
7. Simple willow-herb, *Epilobium strictum*
8. Woodland Horsetail, *Equisetum sylvaticum*
9. Lurking leskea, *Plagiothecium latebricola*
10. Pale sedge, *Carex pallescens*

C. State Potentially Threatened Plants

1. Gray Birch, *Betula populifolia*
2. Butternut, *Juglans cinerea*
3. Northern rose azalea, *Rhododendron nudiflorum var. roseum*
4. Hobblebush, *Viburnum alnifolium*
5. Long Beech Fern, *Phegopteris connectilis (Thelypteris phegopteris)*
6. Straw sedge, *Carex straminea*
7. Water avens, *Geum rivale*
8. Tall St. John's wort, *Hypercium majus*
9. Swamp oats, *Sphenopholis pensylvanica*
10. Shinning ladies'-tresses, *Spiranthe slucida*
11. Arbor Vitae, *Thuja occidentalis*
12. American Chestnut, *Castanea dentate*

Table 2-1. RVAAP Rare Species List (continued)

D. State Species of Concern

1. Pygmy shrew, *Sorex hovi*
2. Star-nosed mole, *Condylura cristata*
3. Woodland jumping mouse, *Napaeozapus insignis*
4. Sharp-shinned hawk, *Accipiter striatus*
5. Marsh wren, *Cistothorus palustris*
6. Henslow's sparrow, *Ammodramus henslowii*
7. Cerulean warbler, *Dendroica cerulea*
8. Prothonotary warbler, *Protonotaria citrea*
9. Bobolink, *Dolichonyx oryzivorus*
10. Northern bobwhite, *Colinus virginianus*
11. Common moorhen, *Gallinula chloropus*
12. Great egret, *Ardea alba* (migrant)
13. Sora, *Porzana carolina*
14. Virginia Rail, *Rallus limicola*
15. Creek heelsplitter, *Lasmigona compressa*
16. Eastern box turtle, *Terrapene carolina*
17. Four-toed Salamander, *Hemidacrylium scuta/um*
18. *Stenonema ithica* (mayfly)
19. *Apamea mixta* (moth)
20. *Brachylomia algens* (moth)
21. Sedge wren, *Cistothorus platensis*

E. State Special Interest

1. Canada warbler, *Wilsonia canadensis*
2. Little blue heron, *Egretta caerula*
3. Magnolia warbler, *Dendroica magnolia*
4. Northern waterthrush, *Seiurus noveboracensis*
5. Winter wren, *Troglodytes troglodytes*
6. Back-throated blue warbler, *Dendroica caerulescens*
7. Brown creeper, *Certhia americana*
8. Mourning warbler, *Oporornis philadelphia*
9. Pine siskin, *Carduelis pinus*
10. Purple finch, *Carpodacus purpureus*
11. Red-breasted nuthatch, *Sitta canadensis*
12. Golden-crowned kinglet, *Regulus satrapa*
13. Blackburnian warbler, *Dendroica fusca*
14. Blue grosbeak, *Guiraca caerulea*
15. Common snipe, *Gallinago gallinago*
16. American wigeon, *Anas americana*
17. Gadwall, *Anas strepera*
18. Green-winged teal, *Anas crecca*
19. Northern shoveler, *Anas clypeata*
20. Redhead duck, *Aythya americana*
21. Ruddy duck, *Oxyura jamaicensis*

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.

2.3 SUMMARY OF EXISTING SITE DATA

Over 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 contamination to groundwater had occurred (USATHAMA 1982). In 1988, the United States Army Environmental Hygiene Agency conducted a groundwater contamination survey and an evaluation of solid waste management units (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. The following year, the Jacobs 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 Restoration Management Information System (RMIS).

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 RIs of 11 AOCs. These AOCs were Load Lines 1 through 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.

The annual Installation Action Plan contains a full description of the status of all investigations and other activities at the facility. The current Installation Action Plan and a complete listing of RVAAP investigations can be found at RVAAP Access (www.rvaap.org).

RVAAP Access is a public website created as part of the RVAAP Environmental Information Management System (REIMS) produced to inform the public about cleanup activities at RVAAP and provide access to documents for review. The website contains information on the history of RVAAP and general information about the cleanup process. This website provides information in a simple, easy-to-use format that allows the reader to work from general information to specific areas of investigation and then to actual scientific reports and summaries. The website represents an important component of the public outreach for the RVAAP cleanup program.

3.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

This FWFSP presents the project organization and responsibility from a generic perspective because of the global nature of the plan with respect to the anticipated multiple investigations that are expected to be performed under this FWFSP at RVAAP. The project organization and responsibilities identified here are based on the generic functional roles necessary to implement the field activities described in the FWFSP and do not include specific names of organizations or individuals. Project-specific organization and responsibilities will be included in each investigation-specific Sampling and Analysis Plan (SAP) addendum to identify individual responsibilities and any new roles that may be appropriate for a specific investigation. USACE, Louisville District is expected to continue to fulfill the role of laboratory data quality assurance (QA) Administrator for all environmental projects.

The organization chart shown in Figure 3-1 outlines the generic management structure to be used when implementing field investigations at RVAAP. The functional responsibilities of key personnel are described below. Specific assignment of personnel to each of these positions will be made before each specific investigation and will be based on a combination of (1) experience in the type of work to be performed, (2) experience working with government personnel and procedures, (3) a demonstrated commitment to high quality, and (4) staff availability.

3.1 CONTRACTOR PROGRAM MANAGER

The Contractor Program Manager ensures the overall management and quality of all projects performed at RVAAP under the general contract. This individual ensures that all project goals and objectives are met in a high-quality and timely manner. QA and nonconformance issues will be addressed by this individual, in coordination with the Contractor Project Manager, for corrective action.

3.2 CONTRACTOR PROJECT MANAGER

The Contractor Project Manager has direct responsibility for implementing a specific project, including all phases of work plan development, field activities, data management, and report preparation. This individual provides overall project management and serves as the technical lead and principal point of contact with USACE, Louisville District; RVAAP; or other U.S. Army Project Managers. These activities involve coordinating all personnel working on the project, interfacing with U.S. Army project personnel, and tracking project budgets and schedules. The Contractor Project Manager develops, monitors, and fills project staffing needs; delegates specific responsibilities to project team members; and coordinates with administrative staff to maintain a coordinated and timely flow of all project activities. The Project Manager reports directly to the Program Manager.

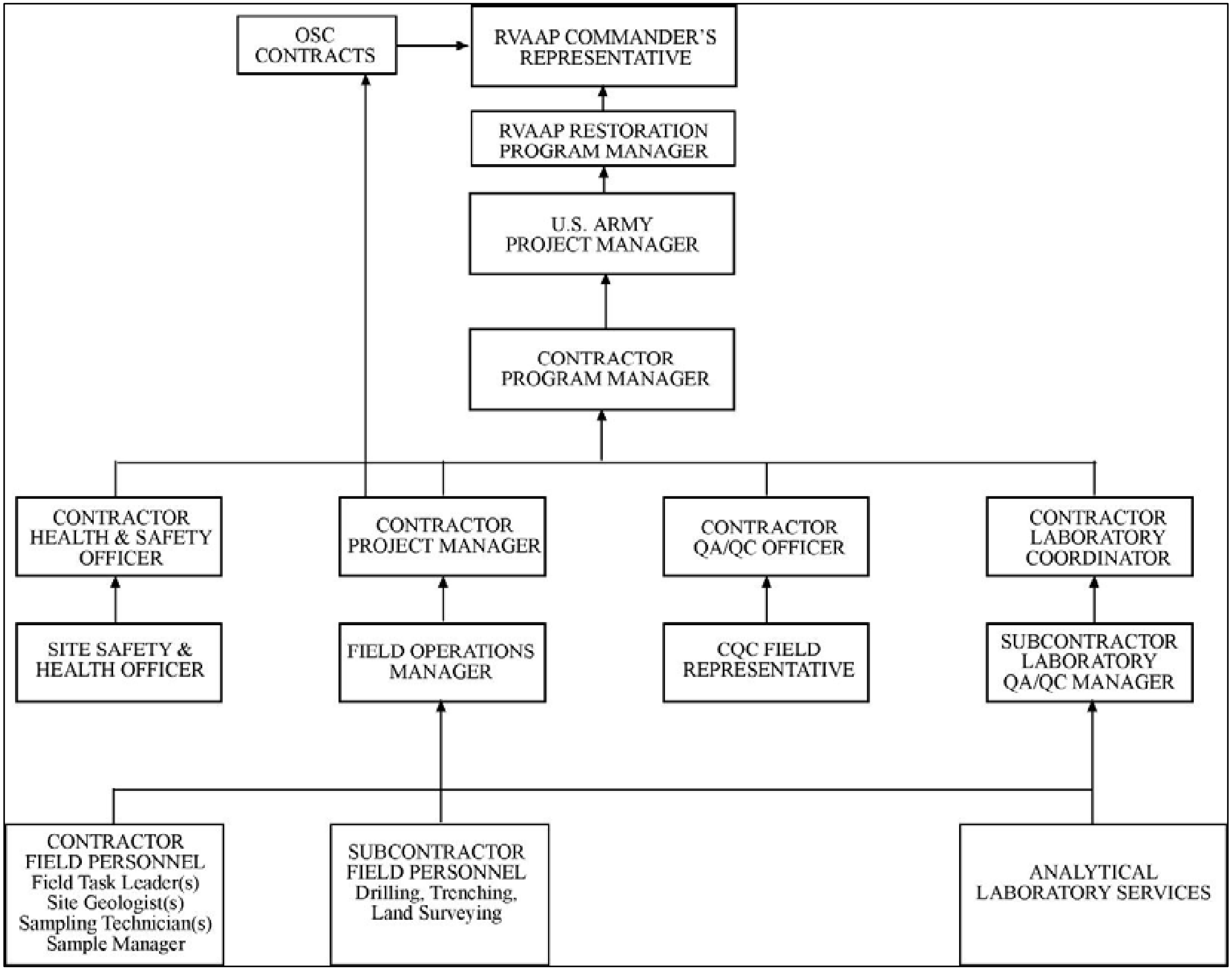

Figure 3-1. Generic Project Organization Chart for RVAAP AOC-Specific Investigations

3.3 CONTRACTOR QUALITY ASSURANCE/QUALITY CONTROL OFFICER

The Contractor QA/QC Officer is responsible for the project QA/QC in accordance with the requirements of the Facility-Wide Quality Assurance Project Plan (FWQAPP), the investigation-specific Quality Assurance Project Plan (QAPP) addendum, and appropriate management guidance. This individual, in coordination with the Contractor Field Contractor Quality Control (CQC) Officer, participates in the project field activity readiness review; approves variances before work proceeds; approves, evaluates, and documents the disposition of Nonconformance Reports (NCRs); oversees and approves any required project training; and designs audit and surveillance plans followed by supervision of these activities. This individual and the Field CQC Officer report directly to the Contractor Program Manager but also inform the Contractor Project Manager of all information and decisions reported.

3.4 CONTRACTOR HEALTH AND SAFETY OFFICER

The Contractor Health and Safety Officer ensures that health and safety procedures designed to protect personnel are maintained throughout all field activities conducted at RVAAP. This is accomplished by strict adherence to the Facility-Wide Safety and Health Plan (FWSHP), which has been prepared as a companion document to this FWSAP, and the investigation-specific SSHP, which will be prepared as an addendum to the FWSHP for each investigation. This individual, in coordination with the Site Health and Safety Officer (SHSO), has the authority to halt fieldwork if health and/or safety issues arise that are not immediately resolvable in accordance with the FWSHP and the investigation-specific SSHP addenda. This individual and the SHSO report directly to the Contractor Program Manager but also inform the Contractor Project Manager of all information and decisions reported.

3.5 SUBCONTRACTOR LABORATORY QUALITY ASSURANCE/QUALITY CONTROL MANAGER

Analytical laboratories will be subcontracted for each investigation to perform off-site chemical analysis for all media sampled. The subcontract laboratory will be accredited in accordance with the DoD Environmental Laboratory Accreditation Program (ELAP). The subcontracted laboratory's QA/QC Manager is responsible for the laboratory QA/QC in accordance with the requirements of the FWQAPP and the investigation-specific addenda. In coordination with the Contractor Laboratory Coordinator, this individual handles and documents samples received by the laboratory, ensures that all samples are analyzed in accordance with required and approved methodologies, ensures that instrument calibration is performed properly and documented, ensures that field and internal laboratory QC samples are analyzed and documented, and ensures that all analytical results for both field and QC samples are reported in the format required in the FWQAPP and the investigation-specific addenda. The subcontracted laboratory QA/QC Manager also ensures laboratory NCRs are processed in a timely manner and makes decisions regarding cost and schedule related to processing NCRs and implementing Corrective Action Report recommendations and/or requirements. This individual reports directly to the Contractor Laboratory Coordinator but also informs the Contractor Project Manager of all information and decisions reported.

3.6 CONTRACTOR LABORATORY COORDINATOR

The Contractor Laboratory Coordinator coordinates sample collection and subsequent laboratory analysis in accordance with the requirements of the FWFSP and FWQAPP and their investigation-specific addenda. This individual obtains required sample containers from the laboratory for use during field sample collection, resolves questions the laboratory may have regarding QAPP requirements and deliverables, and prepares a quality assessment report for sample data package deliverables received from the laboratory. This individual reports directly to the Contactor Program Manager but also informs the Contractor Project Manager of all information and decisions reported.

3.7 CONTRACTOR FIELD OPERATIONS MANAGER

The Contractor Field Operations Manager implements all field activities for a specific investigation in accordance with the FWFSP and FWQAPP and their investigation-specific addenda. This individual ensures technical performance of all field sampling activities; adheres to required sample custody and other related QA/QC field procedures; coordinates field subcontractor personnel activities; manages project IDW; performs QA checks of all field documentation; and prepares Field Change Orders, if required. This individual reports directly to the Contractor Project Manager, except with regard to QA/QC matters that are reported directly to the Contractor QA/QC Officer.

3.8 CONTRACTOR FIELD PERSONNEL

In addition to the Field Operations Manager, other contractor field personnel implementing field activities will be the field team leader(s), site geologist(s), sampling technician(s), and the sample manager. These individuals, in coordination with field subcontractor personnel, perform all field sampling activities in accordance with the FWFSP and FWSHP and their investigation-specific addenda. These individuals report directly to the Field Operations Manager.

3.9 SUBCONTRACTOR FIELD PERSONNEL

Contractors often subcontract various companies to provide field support services while implementing specific investigations at RVAAP. The anticipated primary support services are drilling (soil borings and monitoring wells), trenching, and land surveying. Subcontractor field personnel, in coordination with contractor field personnel, perform their specific scope of services as identified in the investigation-specific SAP addenda. Field personnel assigned by the subcontractors to each project are qualified and experienced to perform the scope of their work; these personnel are required to review and comply with both the FWFSP and FWSHP and their investigation-specific addenda. The scope of work performed by each subcontractor is documented in the subcontract agreements with each organization, along with equipment and material requirements and experience and qualifications of the assigned personnel. All subcontractor field personnel report directly to the Field Operations Manager, who ensures that all subcontractor activities comply with project requirements.

4.0 SCOPE AND OBJECTIVES

4.1 FACILITY-WIDE SCOPE AND OBJECTIVES

This FWFSP defines, to the extent practical, generic methods and procedures for field sampling activities expected to be used during the investigation of all AOCs at RVAAP. Based on the similarity of the former waste-generating operations, the chemicals of potential concern (COPCs), and the media of concern expected at each AOC to be investigated, several field sampling methodologies are expected to be utilized repeatedly during the investigation of all AOCs. Consequently, these sampling activities are addressed in this FWFSP and will be applied, as appropriate and with the use of investigation-specific FSP addenda, during the investigation of all AOCs.

Based on the current understanding of AOCs at RVAAP, the primary media of concern are soil (surface and subsurface) and sediment, groundwater, and surface water. This FWFSP presents sampling methods and procedures for monitoring well installation and groundwater sampling (Section 5.4), subsurface soil sampling (Section 5.5), surface soil and sediment sampling (Section 5.6), and surface water sampling (Section 5.7). This FWFSP also defines generic protocols for sample chain of custody (COC)/documentation (Section 6.0), sample packaging and shipping (Section 7.0), IDW (Section 8.0), contractor chemical quality control (CCQC; Section 9.0), daily chemical quality control reports (DCQCRs; Section 10.0), corrective actions (Section 11.0), and project schedule (Section 12.0) that can be applied to all investigations at RVAAP. Electronic data deliverable file specifications can be found in the 2001 Environmental Information Management Plan for RVAAP (USACE 2001).

This FWFSP is developed in accordance with requirements established in the *Requirements for the Preparation of Sampling and Analysis Plans* (USACE 2001b) and *Monitoring Well Design, Installation, and Documentation at Hazardous and/or Toxic Waste Sites* (USACE 1994) and the *Technical Guidance Manual for Hydrogeologic Investigations and Groundwater Monitoring* (Ohio EPA 2009). Requirements for environmental sampling of various media are contained in Appendices C, E, and F of the *Requirements for the Preparation of Sampling and Analysis Plans* (USACE 2001b) and were used as general guidelines for developing sampling methods and procedures (environmental and field QC), sample handling (preparation and shipping), field and sample documentation, and equipment decontamination procedures. Requirements for monitoring well installation (e.g., drilling, construction, development, purging/sampling, documentation, and abandonment) are contained in *Monitoring Well Design, Installation, and Documentation at Hazardous and/or Toxic Waste Sites* (USACE 1994) and were used as general guidelines for developing these procedures.

This FWFSP provides overall guidance for performing the types of sampling activities identified herein; however, because of the generic nature of this document, its use relative to a project-specific investigation must be accompanied by an investigation-specific field sampling plan (FSP) addendum to ensure the successful implementation of each investigation-specific work plan. The FSP addenda will be tiered under this FWSAP and will address investigation-specific scope and objectives, sampling approach and rationale, data uses, project-specific sampling methods and procedures or deviations not covered in this FWFSP, specific IDW requirements, and any project-specific details not included in this FWFSP. Each investigation-specific FSP addendum will be developed following the *Requirements for the Preparation of Sampling and Analysis Plans* (USACE 2001b) and will be approved by Ohio EPA and the U.S. Army before implementation. Ohio EPA has review and comment authority on all documents submitted under the Defense State Memorandum of Agreement.

The scope and objectives of each AOC-specific investigation will be developed based on guidance for data quality objectives (DQOs) specified in the *Data Quality Objectives Process for Superfund* (USEPA 1993b). The SAP addenda will define project-specific scope and objectives, sampling rationale and approach, and data quality needs to support decisions to be made using the data collected during each investigation. Project DQOs will be developed to tier under the facility-wide DQOs presented below.

4.2 FACILITY-WIDE DATA QUALITY OBJECTIVES

As part of the facility-wide approach to environmental investigation activities at RVAAP, facility-wide DQOs have been developed consistent with the USEPA DQO process. The DQO process is a tool to guide investigations at CERCLA sites. Although not all AOCs at RVAAP are CERCLA sites, this model still has relevance for decision-makers. The DQOs serve two major purposes: (1) to present the facility-wide approach to sampling at the facility, and (2) to present the process that will be used to develop investigation-specific SAPs. The stages of the DQO development process are as follows:

- Develop the conceptual site model (CSM);
- State the problem;
- Identify decisions to be made;
- Define the study boundaries;
- Develop the decision rule (if/then);
- Identify inputs to the decision (data uses and data needs);
- Specify limits on uncertainty; and
- Optimize the sample design.

Project-specific DQOs will be developed using available guidelines from USEPA, the *Technical Project Planning Process* (USACE 1998), or the Final Uniform Federal Policy QAPP Checklist of 2008 as applicable U.S. Department of Defense (DoD) guidelines for planning RVAAP environmental projects.

4.2.1 Conceptual Site Model

A CSM is the cornerstone for planning a field sampling effort. It reflects an understanding of the known or expected site conditions and serves as the basis for making decisions about sample locations, frequencies, and required analytes. A good CSM is inclusive of all available information, incorporating the hydrogeologic features and other characteristics of the AOC that combine to define the problem to be addressed (e.g., location of buried waste, primary contaminants and their properties, contaminant transport pathways, and potential human exposure scenarios).

A preliminary CSM for RVAAP has been developed using available information. Portions of the CSM are described in detail in other sections of this plan. Aspects of the CSM important for sampling design are noted below. Perhaps of more importance than what is known are the uncertainties that must be addressed by the field sampling efforts. Available information indicates the following:

- Surface geology across RVAAP is highly variable. Glacial overburden ranges in depth from approximately 1.5 m (5 ft) (Hiram Till in the eastern portion of the facility) to 12.2 m (40 ft) (Lavery Till in the western portion). Bedrock outcroppings have been noted in the southeastern portion of RVAAP. The till is reported to be somewhat impermeable with hydraulic conductivities thought to be greater than 10-6 cm/sec. Additional hydraulic conductivity testing is needed to evaluate the highly variable conditions of the surficial material.

- A burial glacial valley filled with sand and gravel potentially exists in the central portion of the facility, oriented in a southwest-northeast direction. The presumed depth of the valley ranges from 30.5 to 60.7 m (100 to 200 ft).

- The variable nature of the till combined with the topography of RVAAP results in a complex surface water system on the facility.

    - The South Fork of Eagle Creek and Sand Creek drain much of the facility. The creeks converge and exit the facility in the northeast. AOCs in the central portion of RVAAP (e.g., Open Demolition Area #2 and Upper and Lower Cobbs Ponds) likely feed this drainage system. This system flows east to the West Branch of the Mahoning River, which eventually flows south to the Michael J. Kirwan Reservoir.

    - Hinkley Creek in the western portion of RVAAP drains due south. A notable AOC along Hinkley Creek is Open Demolition Area #1.

    - Drainage from the main load lines appears to flow east and southeast. The southeastern portion of RVAAP is swampy, even in the summer months. Drainages to the south flow into the Michael J. Kirwan Reservoir.

    - Approximately 50 ponds are scattered throughout the facility. Many of these ponds have acted as settling basins over the years. The ponds appear to support an abundance of wildlife and fish.

- Because of the somewhat impermeable nature of the till, a large percentage of rainfall is expected to exit the facility via the surface drainages.

- Groundwater is present both in shallow unconsolidated sediment and the deeper bedrock zone. Groundwater from both unconsolidated and bedrock aquifers predominantly flows in an eastward direction; however, the unconsolidated zone shows numerous local flow variations that are influenced by topography and drainage patterns. Groundwater as shallow as 0.61 m (2 ft) below ground surface (bgs) has been detected in portions of RVAAP. It is not known whether shallow groundwater is perched or continuous.

- The sand and gravel aquifers associated with the buried valleys are a major source of potable water in the local area and can yield up to 6,080 L (1,600 gal) per minute. The 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 also act as groundwater discharge locations. In addition, topographic ridges between surface water drainage features act as groundwater divides for groundwater found in the unconsolidated deposits (Section 2.2.3.1; Figure 2-4).

- Bedrock formations in the area are also a source of potable water, with the Sharon Conglomerate member of the Pottsville Formation representing the largest bedrock aquifer. Depending on the existence and depth of overburden, the Sharon Conglomerate ranges from an unconfined to a leaky artesian aquifer. Water yields from area wells completed in the Sharon Sandstone/Conglomerate range from 30 to 400 gpm (USATHAMA 1978). Well yields of 5 to 200 gpm were reported for bedrock wells completed in the Sharon Sandstone/Conglomerate (Kammer 1982). Other local bedrock units capable of producing water include the Homewood Sandstone, which is generally thinner and only capable with well yields less than 10 gpm, and the Connoquenessing Sandstone. The Connoquenessing is a good aquifer where it occurs but is less productive than the Sharon Sandstone/Conglomerate (Kammer 1982; Section 2.2.3.2; Figure 2-5).

- Major COPCs include explosive-related chemicals (e.g., TNT, dinitrotoluene [DNT], and cyclonite), propellants (e.g., nitroglycerine, nitroguanidine, and nitrocellulose), and metals (e.g., arsenic, aluminum, barium, cadmium, chromium, lead, mercury, silver, selenium, and zinc). Additional chemicals, including polychlorinated biphenyls (PCBs) and manganese, have been identified at some AOCs. Most of the COPCs are relatively insoluble, tend to adsorb to soil particles rather than dissolve into water, and are relatively long-lived.

- Currently, the facility is not accessible to the public. OHARNG uses approximately 20,403 acres of the former 21,683-acre RVAAP as a training site. The most likely pathway of exposure to off-site receptors is via chemical migration through the surface water and groundwater systems.

4.2.2 Define the Problem

The problem to be addressed at RVAAP is that hazardous contaminants from past waste disposal activities may be posing a current or future risk on-site via direct contact with environmental media, off-site receptors via contaminant migration, and ecological receptors.

4.2.3 Remedial Action Objectives

A major goal of implementing the DQO process is to ensure that all data critical for decision making are collected as part of the field investigations. This should include data necessary for selecting and implementing a cost-effective remedial action if such an action is required. For example, if an impermeable cap is a probable remedial technology, then data should be collected to characterize the potential for subsurface lateral groundwater flow. During the planning for investigation at each AOC, potential remedies will be identified. This ensures that all data necessary for a Feasibility Study (FS), should one be necessary, are available.

4.2.4 Identify Decisions

Table 4-1 presents key decisions that need to be made with regard to investigation data collection at RVAAP. Primary decisions are upper-tier decisions that drive subsequent field investigations. Secondary decisions are more specific to RVAAP. In planning for each AOC, specific decisions for that AOC will be identified.

Table 4-1. Key Decisions for RVAAP Investigations

Decision Number	Primary Decisions	Secondary Decisions
D1	Determine the Need for Additional Action at RVAAP	
	Do waste sources at RVAAP pose an unacceptable human health or ecological risk (e.g., 10-6 to 10-4) to: 1. Current on- or off-site receptors? 2. Future on- or off-site receptors?	D1-1 What are the residual concentrations of contaminants at the sources? D1-2 Are wastes leaving the AOC via surface water/sediment? D1-3 Are wastes leaving the AOC via groundwater? D1-4 Are wastes posing a threat to ecological receptors? D1-5 Is there a risk to humans from consumption of ecological receptors (e.g., fish and deer)? D1-6 What is the current and future land use?

Table 4-1. Key Decisions for RVAAP Investigations (continued)

Decision Number	Primary Decisions	Secondary Decisions
D2	Determine the Best Response Actions from a Facility-wide Perspective	
	What are effective ways of reducing risk to achieve threshold criteria as set by stakeholders?	D2-1 What are the priority AOCs for addressing off-site releases via surface water and/or groundwater? D2-2 What AOCs may need remediation to mitigate current and potential future on-site exposures? D2-3 What technologies are effective at reducing off-site risk, given the facility-wide understanding of surface water/groundwater hydrologic conditions and potential future on-site exposures?

RVAAP = Ravenna Army Ammunition Plant.

4.2.5 Define Study Boundaries

The spatial boundary for initial fieldwork at an AOC is the fence line or other boundary (e.g., railroad tracks, drainage divides, or other defined features) for each individual AOC. The potential for off-site migration will be addressed by sampling at the boundary (e.g., in drainages at the fence line) and, as necessary and appropriate, at selected locations beyond the boundary.

The spatial boundary for any follow-up field investigation work will be determined based on the results of initial field efforts. If warranted, the spatial boundary for follow-up work may extend beyond the facility boundary to include off-post sampling.

4.2.6 Identify Decision Rules

Decision rules guide the sampling effort, which in turn, defines the level of characterization necessary for decision making. For example, by specifying risk goals (e.g., 10-6) in the decision rule, planners can identify the analytical levels needed for the sampling effort.

For this FWFSP, the primary decision rule governing work at RVAAP is the determination of the nature and extent of contamination by comparing existing analytical data to chemical-specific screening criteria. The screening criteria used are the facility-wide cleanup goals (FWCUGs) developed in the *Facility-wide Human Health Cleanup Goals Report* (USACE 2010), herein referred to as the FWCUG Report. Additional data comparisons for risk management decisions and evaluations may need to be conducted for specific projects depending on DQOs.

The chemical-specific FWCUGs at the 10-6 cancer risk level and non-carcinogenic risk hazard quotient using the 0.1 risk value are the specific screening criteria included in this FWFSP. FWCUGs are used to determine which analytes and which areas must be further evaluated to assess the nature and extent of contamination. FWCUGs at these risk levels were developed in the FWCUG Report for multiple receptors. To ensure the nature and extent of contamination is defined to the most restrictive future receptor/land use, the guideline screening criterion for each chemical in each medium is set as the FWCUG with the least value for any of the receptors at these risk levels. The assumption is the presence of contaminants at or less than their background concentration indicates the absence of contamination. If the screening criterion for an inorganic chemical is less than the background concentration, then the background concentration will be used as the screening criterion for determining exceedances that need to be further investigated. The guideline screening criteria values and their descriptions are presented in Table 4-2.

4.2.7 Identify Inputs to the Decision

"Inputs to the decision" consist of results of the field investigation and data analysis, modeling, and risk estimates. The data needed to provide decision inputs vary from AOC to AOC depending on the waste type, site setting, and other AOC-specific factors; the data needs will be defined on an AOC-specific basis.

4.2.8 Specify Limits on Decision Error

Remedial action decisions may eventually need to be made for RVAAP AOCs based on the results of the data assessment and baseline risk assessment. Controlling the potential for making a wrong decision begins in the DQO process by identifying what types of errors may be introduced during sample collection and data assessment and attempting to limit those errors. Although DQO guidance provides some methods for attempting to limit error by designing statistically based sampling plans (USEPA 1993b), most practitioners have found the methods generally account for only single factors (e.g., how a single contaminant is distributed in a single medium) when, in fact, response action decisions are based on understanding multiple factors (multi-media distribution and partitioning, multiple chemicals of varying degrees of toxicity, and risk modeling output and the various parameter required for that effort).

USEPA specifies two types of decision errors that should be addressed during DQOs: sampling errors and measurement errors (USEPA 1993b). A third type of error, modeling error, is an important consideration when interpreting risk assessment results. Provided below is a summary of errors that may contribute to decision error and ways to minimize the potential for errors during sample collection and reporting.

Table 4-2. FWCUGs Used as Screening Criteria to Determine Exceedances

Chemical[a] (mg/kg or mg/L)	Surface Soil	Type	Subsurface Soil	Type	Groundwater Unconsolidated[b]	Type	Groundwater Bedrock[b]	Type	Surface Water[c]	Type	Wet Sediment[d]	Type
Nitrate	12,000	RFC	12,000	RFC	1.7	RFC	1.7	RFC	25	RFC	None[e]	N/A
Aluminum	17,700	BKG	19,500	BKG	1	RFC	1	RFC	15	RFC	13,900	BKG
Antimony	2.8	RFC	2.8	RFC	0.00039	RFC	0.00039	RFC	0.0049	RFC	2.8	RFC
Arsenic	15.4	BKG	19.8	BKG	0.0117	BKG	0.000056	RFA	0.0032	BKG	19.5	BKG
Barium	350	NGT	350	NGT	0.2	RFC	0.256	BKG	2.9	RFC	350	NGT
Cadmium	6.4	RFC	6.4	RFC	0.00046	RFC	0.00046	RFC	0.0041	NGT	6.4	RFC
Chromium	17.4	BKG	27.2	BKG	0.0073	BKG	0.0027	RFC	0.025	NGT	18.1	BKG
Chromium, hexavalent	1.6	NGT	1.6	NGT	None	N/A	None	N/A	0.025	NGT	1.6	NGT
Cobalt	10.4	BKG	23.2	BKG	0.021	RFC	0.021	RFC	None	N/A	9.1	BKG
Copper	310	RFC	310	RFC	None	N/A	None	N/A	0.61	RFC	310	RFC
Lead	400	TB	400	TB	0.015	MCL	0.015	MCL	0.015	TB	400	TB
Manganese	1,450	BKG	3,030	BKG	1.02	BKG	1.34	BKG	0.63	RFC	1,950	BKG
Mercury	2.3	RFC	2.3	RFC	None	N/A	None	N/A	0.0044	RFC	2.3	RFC
Nickel	160	RFC	160	RFC	0.021	RFC	0.0834	BKG	0.31	RFC	160	RFC
Silver	39	RFC	39	RFC	None	N/A	None	N/A	0.077	RFC	39	RFC
Thallium	0.61	RFC	0.91	BKG	0.000083	RFC	0.000083	RFC	0.0012	RFC	0.89	BKG
Vanadium	45	RFC	45	RFC	0.0064	RFC	0.0064	RFC	0.057	NGT	45	RFC
Zinc	2,300	RFC	2,300	RFC	0.31	RFC	0.31	RFC	4.6	RFC	2,300	RFC
1,3,5-Trinitrobenzene	230	RFC	230	RFC	None	N/A	None	N/A	None	N/A	None	N/A
1,3-Dinitrobenzene	0.77	RFC	0.77	RFC	0.0001	RFC	0.0001	RFC	None	N/A	None	N/A
2,4,6-Trinitrotoluene	3.7	RFC	3.7	RFC	0.00052	RFC	0.00052	RFC	0.0078	RFC	3.7	RFC
2,4-Dinitrotoluene	0.75	RFA	0.75	RFA	0.00012	RFA	0.00012	RFA	0.002	RFA	0.75	RFA
2,6-Dinitrotoluene	0.77	RFA	0.77	RFA	0.00012	RFA	0.00012	RFA	0.0021	RFA	None	N/A
2-Amino-4,6-Dinitrotoluene	1.5	RFC	1.5	RFC	0.00021	RFC	0.00021	RFC	0.0031	RFC	1.5	RFC
2-Nitrotoluene	3.9	RFC	3.9	RFC	0.00037	RFA	0.00037	RFA	0.0074	RFA	None	N/A
4-Amino-2,6-Dinitrotoluene	1.5	RFC	1.5	RFC	0.00021	RFC	0.00021	RFC	0.0031	RFC	1.5	RFC
4-Nitrotoluene	53	RFC	53	RFC	0.005	RFA	0.005	RFA	0.1	RFA	None	N/A
HMX	360	RFC	360	RFC	None	N/A	None	N/A	0.78	RFC	360	RFC

Table 4-2. FWCUGs Used as Screening Criteria to Determine Exceedances (continued)

Chemical[a] (mg/kg or mg/L)	Surface Soil	Type	Subsurface Soil	Type	Groundwater Unconsolidated[b]	Type	Groundwater Bedrock[b]	Type	Surface Water[c]	Type	Wet Sediment[d]	Type
Nitrobenzene	None	N/A	None	N/A	0.00052	RFC	0.00052	RFC	None	N/A	None	N/A
Nitroglycerin	53	RFC	53	RFC	0.005	RFA	0.005	RFA	None	N/A	53	RFC
RDX	8	RFC	8	RFC	0.00077	RFA	0.00077	RFA	0.015	RFA	8	RFC
4,4'-DDD	None	N/A	None	N/A	0.000059	RFA	0.000059	RFA	None	N/A	None	N/A
4,4'-DDE	2.6	RFC	2.6	RFC	0.000047	RFA	0.000047	RFA	None	N/A	None	N/A
4,4'-DDT	None	N/A	None	N/A	0.000027	RFA	0.000027	RFA	0.0001	RFA	None	N/A
Aldrin	0.053	RFC	0.053	RFC	0.0000047	RFA	0.0000047	RFA	0.000073	RFA	None	N/A
Dieldrin	0.056	RFC	0.056	RFC	0.0000036	RFA	0.0000036	RFA	None	N/A	0.056	RFC
Endrin	1.1	RFC	1.1	RFC	None	N/A	None	N/A	None	N/A	None	N/A
Endrin Aldehyde	None	N/A	None	N/A	None	N/A	None	N/A	None	N/A	None	N/A
Heptachlor	0.2	RFC	0.2	RFC	0.000014	RFA	0.000014	RFA	None	N/A	None	N/A
Heptachlor Epoxide	0.098	RFC	0.098	RFC	0.0000094	RFA	0.0000094	RFA	0.00019	RFA	None	N/A
Lindane	None	N/A	None	N/A	0.000051	RFA	0.000051	RFA	None	N/A	None	N/A
PCB-1016	0.2	RFA	0.2	RFA	None	N/A	None	N/A	None	N/A	0.2	RFA
PCB-1242	None	N/A	None	N/A	0.00021	RFA	0.00021	RFA	None	N/A	None	N/A
PCB-1248	0.2	RFA	0.2	RFA	None	N/A	None	N/A	None	N/A	None	N/A
PCB-1254	0.12	RFC	0.12	RFC	0.000021	RFC	0.000021	RFC	0.00031	RFC	0.12	RFC
PCB-1260	0.2	RFA	0.2	RFA	0.00021	RFA	0.00021	RFA	None	N/A	0.2	RFA
Toxaphene	None	N/A	None	N/A	0.000048	RFA	0.000048	RFA	None	N/A	None	N/A
alpha-BHC	None	N/A	None	N/A	0.000014	RFA	0.000014	RFA	None	N/A	None	N/A
alpha-Chlordane	None	N/A	None	N/A	None	N/A	None	N/A	None	N/A	None	N/A
beta-BHC	0.5	RFC	0.5	RFC	0.000047	RFA	0.000047	RFA	0.00095	RFA	None	N/A
gamma-Chlordane	None	N/A	None	N/A	None	N/A	None	N/A	None	N/A	None	N/A
1,4-Dichlorobenzene	None	N/A	None	N/A	None	N/A	None	N/A	0.019	RFA	None	N/A
2,4-Dimethylphenol	None	N/A	None	N/A	None	N/A	None	N/A	0.25	RFC	None	N/A
2-Methylnaphthalene	31	RFC	31	RFC	None	N/A	None	N/A	None	N/A	None	N/A
4-Chloro-3-methylphenol	None	N/A	None	N/A	None	N/A	None	N/A	None	N/A	None	N/A
4-Methylphenol	None	N/A	None	N/A	None	N/A	None	N/A	0.068	RFC	None	N/A
4-Nitrobenzenamine	None	N/A	None	N/A	0.0031	RFC	0.0031	RFC	None	N/A	None	N/A

Table 4-2. FWCUGs Used as Screening Criteria to Determine Exceedances (continued)

Chemical[a] (mg/kg or mg/L)	Surface Soil	Type	Subsurface Soil	Type	Groundwater Unconsolidated[b]	Type	Groundwater Bedrock[b]	Type	Surface Water[c]	Type	Wet Sediment[d]	Type
4-Nitrophenol	61	RFC	61	RFC	None	N/A	None	N/A	None	N/A	None	N/A
Benz(*a*)anthracene	0.22	RFA	0.22	RFA	0.0000039	RFA	0.0000039	RFA	0.000014	RFA	0.22	RFA
Benzo(*a*)pyrene	0.022	RFA	0.022	RFA	0.00000023	RFA	0.00000023	RFA	0.0000008	RFA	0.022	RFA
Benzo(*b*)fluoranthene	0.22	RFA	0.22	RFA	0.0000023	RFA	0.0000023	RFA	0.0000079	RFA	0.22	RFA
Benzo(*k*)fluoranthene	2.2	RFA	2.2	RFA	None	N/A	None	N/A	0.023	RFA	2.2	RFA
Bis(2-chloroethoxy)methane	23	RFC	23	RFC	None	N/A	None	N/A	None	N/A	None	N/A
Bis(2-ethylhexyl)phthalate	None	N/A	None	N/A	0.0009	RFA	0.0009	RFA	0.0035	RFA	None	N/A
Carbazole	45	RFC	45	RFC	None	N/A	None	N/A	None	N/A	None	N/A
Chrysene	22	RFA	22	RFA	None	N/A	None	N/A	0.0014	RFA	None	N/A
Dibenz(*a,h*)anthracene	0.022	RFA	0.022	RFA	0.00000015	RFA	0.00000015	RFA	0.00000052	RFA	0.022	RFA
Dibenzofuran	15	RFC	15	RFC	None	N/A	None	N/A	None	N/A	None	N/A
Fluoranthene	160	RFC	160	RFC	None	N/A	None	N/A	None	N/A	None	N/A
Fluorene	240	RFC	240	RFC	None	N/A	None	N/A	None	N/A	None	N/A
Indeno(1,2,3-*cd*)pyrene	0.22	RFA	0.22	RFA	0.0000023	RFA	0.0000023	RFA	0.0000078	RFA	0.22	RFA
N-Nitroso-di-n-propylamine	0.12	RFC	0.12	RFC	None	N/A	None	N/A	None	N/A	None	N/A
Naphthalene	120	RFC	120	RFC	None	N/A	None	N/A	None	N/A	None	N/A
Nitrobenzene	None	N/A	None	N/A	0.00052	RFC	0.00052	RFC	None	N/A	None	N/A
Pentachlorophenol	2.1	RFA	2.1	RFA	0.000074	RFA	0.000074	RFA	0.00028	RFA	None	N/A
Pyrene	120	RFC	120	RFC	None	N/A	None	N/A	0.47	RFC	None	N/A
bis(2-Chloroethoxy)methane	23	RFC	23	RFC	None	N/A	None	N/A	None	N/A	None	N/A
1,1,2,2-Tetrachloroethane	None	N/A	None	N/A	0.000069	RFA	0.000069	RFA	0.00039	NGT	None	N/A
1,2-Dichloroethane	None	N/A	None	N/A	0.00016	RFA	0.00016	RFA	None	N/A	None	N/A
1,2-Dichloroethene	None	N/A	None	N/A	None	N/A	None	N/A	0.12	RFC	None	N/A
1,4-Dichlorobenzene	None	N/A	None	N/A	None	N/A	None	N/A	0.019	RFA	None	N/A
Benzene	None	N/A	None	N/A	0.00043	RFA	0.00043	RFA	None	N/A	None	N/A
Carbon Tetrachloride	None	N/A	None	N/A	0.0002	RFA	0.0002	RFA	None	N/A	None	N/A
Chloroform	None	N/A	None	N/A	0.00021	RFA	0.00021	RFA	0.001	NGT	None	N/A
Methylene Chloride	None	N/A	None	N/A	0.0053	RFA	0.0053	RFA	0.046	NGT	None	N/A
Tetrachloroethene	None	N/A	None	N/A	0.000098	RFA	0.000098	RFA	0.00083	RFA	None	N/A

Table 4-2. FWCUGs Used as Screening Criteria to Determine Exceedances (continued)

Chemical[a] (mg/kg or mg/L)	Surface Soil	Type	Subsurface Soil	Type	Groundwater Unconsolidated[b]	Type	Groundwater Bedrock[b]	Type	Surface Water[c]	Type	Wet Sediment[d]	Type
Trichloroethene	None	N/A	None	N/A	0.000031	RFA	0.000031	RFA	0.00016	NGT	None	N/A
cis-1,2-Dichloroethene	None	N/A	None	N/A	None	N/A	None	N/A	0.16	RFC	None	N/A

- This table lists all chemicals for which CUGs were developed in the Facility-wide CUG Report (USACE 2010). Screening criteria are based on the CUGs of hazard index (HI) = 0.1 and target risk = 10^{-6}. Values were rounded to two significant digits. When background values were higher than the screening criteria based on the CUG (HI = 0.1/target risk=10^{-6}), the background value became the screening criterion. Background values were not rounded to two significant digits and were obtained from the April 2001 Phase II Winklepeck Remedial Investigation Report (USACE 2001a). Additional comparisons were performed against the CUGs for HI = 1.0 and target risk=10^{-5}. A comparatively small list of facility-wide chemicals of potential concern (COPCs) exceeded these CUGs. Generally, the CUG (HI = 1.0 or target risk = 10^{-5}) can be calculated by multiplying the screening criteria by 10 (one exception to this rule is for metal background values that are not based on risk and, therefore, are the same for both the screening criteria and the CUG).

[a] Although a CUG was developed for iron), iron is generally not screened against a CUG because this chemical has historically been considered an essential nutrient at the Ravenna Army Ammunition Plant (RVAAP). The RVAAP Risk Manual (USACE 2005b) identifies iron as one of the essential elements that should not be evaluated as a COPC as long as it is present at low concentrations (i.e., below 100,000 to 180,000 mg/kg). The maximum detection of iron from previous sampling at subject areas of concern (AOCs) is 76,000 mg/kg.

[b] Groundwater screening criteria and background values provided are representative of filtered groundwater samples. Unfiltered groundwater samples were not evaluated.

[c] Surface water screening criteria and background values are representative of unfiltered water. Filtered surface sample results were not evaluated.

[d] Wet sediment screening criteria are equal to surface soil screening criteria with the exception of when background values were greater than the CUG-based screening criteria.

[e] "None" indicates no CUG was developed in the Facility-wide CUG Report. In the event a chemical without a screening value is determined to be a COPC, a CUG will be developed.

CUG = Cleanup goal
BKG = Background
FWCUG = Facility-wide cleanup goal
HMX = Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine
MCL = Maximum contaminant level
N/A = Not applicable
NGT = National Guard Trainee
PCB = Polychlorinated biphenyl
RDX = Cyclonite
RFA = Resident subsistence farmer adult
RFC = Resident subsistence farmer child
TB = Technology-based screening level

4.2.8.1 Sampling Errors

Most sampling plans attempt to avoid the potential of a false-positive error (i.e., avoid concluding that wastes do not pose a risk when they actually do). During the planning for each AOC, sample locations and frequencies are identified using the knowledge of the AOC (CSM) and the requirements of the risk assessment. For example, if the CSM suggests surface water is the major contaminant migration pathway for the AOC, more sampling resources are directed toward characterizing this potential for the pathway to pose a current or future risk. Screening tools (e.g., geophysical surveys, Geoprobe® sampling) also may be used to determine optimum sampling locations where analytical data can be collected using definitive sampling methods to define the nature and extent of contamination. Screening tools cannot be used to define the nature and extent of contamination but their use can be effective in reducing the number of confirmatory samples collected to characterize an AOC.

4.2.8.2 Measurement Errors

Measurement errors in laboratory data can be minimized through proper planning, implementing applicable laboratory QC, and programmatic data verification and validation procedures. Proposed processes and procedures are provided in the FWQAPP. A primary focus of the review, verification, and validation process will be to avoid the potential for false-positive errors (i.e., avoiding the potential of finding no risk when a risk actually exists). Analytical project-reporting levels established to meet the needs of risk assessment are presented in Tables 4-3 through 4-9 of the FWQAPP. Associated risk level concentrations for the major COPCs are presented in Table 4-3 of this FWFSP.

Analytical data will be generated using USEPA SW-846 methods, USEPA water and wastewater methods, and American Society of Testing and Materials (ASTM) methods. Alternate or supplemental methods may be added as the need arises through specification in an approved addendum to this FWFSP. Analytical data will receive its initial review by the laboratory generating the information prior to the results being reported as definitive data, as identified in the FWQAPP.

Verification of the analytical data is performed independently of the analytical laboratory by the Contractor. This verification ensures that precision, accuracy, sensitivity, and completeness of the analytical data are adequate for their intended use. Because the greatest uncertainty in a measurement is often a result of the sampling process, the inherent variability of the matrix, or the environmental population, verification will focus at a level necessary to minimize the potential of using false-positive or false-negative concentrations in the decision-making process (i.e., first priority will be to assure accurate identification of detected versus non-detected analytes). Additionally, 10% of the project data will undergo comprehensive data validation through an organization independent of both the laboratory and the Contractor. This validation is accomplished by comparing the contents of the data packages and the QA/QC results to the requirements contained in the requested analytical methods as outlined in the QAPP. This review, combined with the U.S. Army QA split sample analyses and documentation, forms the basis for an overall data quality assessment by the U.S. Army.

Verification and validation are accomplished by comparing the contents of the data packages and QA/QC results to requirements contained in the requested analytical methods. In general, verification and validation support staff conduct a systematic review of data for compliance with the established QC criteria based on the following categories:

- Holding times;
- Blanks;
- Laboratory control samples;
- Calibration;
- Surrogate recovery (organic methods);
- Internal standards (primarily organic methods);
- Matrix spike/matrix spike duplicate (MS/MSD) and duplicate results;
- Sample re-analysis;
- Secondary dilutions;
- Laboratory case narrative;
- Serial dilutions, and
- Post digestion spikes

The protocol for analyte data verification and validation is presented in the following manuals or guidelines:

- *DoD Quality Systems Manual for Environmental Laboratories* (Version 4.1 or most recent) (DOD 2009);

- *Louisville DoD Quality Systems Manual Supplement (LS)* (USACE 2007);

- *USEPA Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review* (USEPA 2008);

- *USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review* (USEPA 1994a); and

- *USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review* (USEPA 1994b).

Consistent with the data quality requirements as defined in the DQOs, all project data and associated QC will be evaluated and qualified as per the outcome of the review.

4.2.9 Optimize Sample Design

4.2.9.1 Purposes Of Sampling

Sampling and analysis for the RVAAP field investigations will focus on the following:

- Determining the presence of contamination;
- Determining the nature and extent of contamination;
- Identifying the connections between contaminant sources and pathway media; and
- Thoroughly characterizing an AOC using a comprehensive sampling methodology.

4.2.9.2 Selection of Sample Locations

Biased sampling will be used to accomplish the purposes described above. That is, process history, topography, geology, and other information specific to an individual AOC will be used to identify locations where residual contamination would most probably remain.

For instance, field screening for explosives in composited soil samples may be utilized where 100% of samples with detected concentrations and 15% of samples without detected concentrations are sent to an analytical laboratory for analysis. In addition, 15% of all the samples will be subjected to the RVAAP full-suite of analyses (this standard also applies to all incremental sampling method [ISM] samples).

Given the non-uniform horizontal distributions of contaminated areas on ammunition plants such as RVAAP (e.g., former burning pads separated by apparently unused, uncontaminated land), the investigation of a given AOC may require characterization of the spaces between contaminated areas as well. For this purpose, biased or non-biased ISM sampling will be used to acquire representative information. Sections 5.5 and 5.6 contain procedures for the various preferred soil sampling methods.

Table 4-3. Required Detection Limits for Performing the Baseline Risk Assessment for Primary COPCs at RVAAP

Chemical	Detection Limit Requirements[a]			
	Soil (mg/kg)		Water (mg/L)	
Primary COPCs				
2,4-Dinitrotoluene	0.9	(1)	0.0001	(3)
2,6-Dinitrotoluene	0.9	(1)	0.0001	(3)
2,4,6-Trinitrotoluene	21	(1)	0.003	(3)
RDX	5.8	(1)	0.0008	(3)
Composition B (RDX+TNT)	See limits for individual constituents			
HMX	3,900	(2)	2	(4)
Nitrocellulose	Best available[d]		Best available	
Nitroglycerine	Best available		Best available	
Nitroguanidine	7,800	(2)	4	(4)
Aluminum	Best available		Best available	

Table 4-3. Required Detection Limits for Performing the Baseline Risk Assessment for Primary COPCs at RVAAP (continued)

Chemical	Detection Limit Requirements[a]			
	Soil (mg/kg)		Water (mg/L)	
Arsenic	0.4	(1)	0.0001	(3)
Barium	5,500	(2)	2	(5)
Cadmium	78	(2)	0.005	(5)
Chromium	230	(2)	0.1	(4)
Lead	400	[b]	0.015	[c]
Mercury	23	(2)	0.002	(5)
Selenium	390	(2)	0.05	(5)
Silver	390	(2)	0.2	(4)
Zinc	24,000	(2)	11	(4)
Other COPCs				
1,3,5-Trinitrobenzene	2,300	(2)	1	(4)
1,3-Dinitrobenzene	7.8	(2)	0.004	(4)
Nitrobenzene	39	(2)	0.02	(4)
o-Nitrotoluene	780	(2)	0.4	(4)
n-Nitrotoluene	780	(2)	0.4	(4)
p-Nitrotoluene	780	(2)	0.4	(4)
Manganese	3,600	(2)	2	(5)
VOCs				
SVOCs				
PCBs	0.3	(1)	0.00004	(3)

[a] Basis for requirement: achieve a concentration at least equivalent to (1) 10-6 risk goal assuming soil ingestion by children and adults, (2) hazard quotient (HQ) = 1 assuming child soil ingestion, (3) 10-6 risk goal assuming adult drinking water ingestion, (4) HQ = 1 assuming adult drinking water ingestion, (5) federal maximum contaminant level for drinking water.

[b] Proposed soil action level for lead (USEPA 1994c).

[c] Proposed technology action level for lead in drinking water (USEPA 1993a).

[d] Compounds considered not to be toxic at environmental levels.

COPC = Chemical of potential concern
HMX = Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine
PCB = Polychlorinated biphenyl
RDX = Cyclonite
RVAAP = Ravenna Army Ammunition Plant
SVOC = Semivolatile organic compound
TNT = Trinitrotoluene
VOC = Volatile organic compound

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5.0 FIELD ACTIVITIES

This section provides the general sampling methodologies and guidance required for environmental investigative activities at RVAAP.

5.1 GEOPHYSICS

Geophysical analysis is not anticipated to be routinely necessary for the AOC-specific investigations. In the event that geophysical analysis is required, the rationale and procedures for this activity will be presented in the investigation-specific addenda to this FWFSP.

5.2 SOIL GAS SURVEY

Soil gas surveys are not anticipated to be routinely necessary for AOC-specific investigations. In the event that a soil gas survey is required, the rationale and procedures for this activity will be presented in the investigation-specific addenda to this FWFSP.

5.3 UTILITY CLEARANCE

Prior to all subsurface activities, contractors must notify and coordinate a utility clearance with the RVAAP Operation and Maintenance (O&M) Contractor and the RVAAP Environmental Manager. While most active utilities are outside of CERCLA AOCs, utility clearances are required to ensure that subsurface activities will not damage or otherwise affect operational facility utilities or personnel safety. A request for utility clearance will be submitted in writing to the RVAAP O&M Contractor, OHARNG Environmental Coordinator, and the RVAAP Environmental Manager 10 business days prior to subsurface activities on-site. The request must describe and illustrate sample locations and activities to be performed so utilities can be adequately marked or cleared. RVAAP's O&M Contractor will provide the utility clearance as the Ohio Utility Protection Service one-call system is not currently active on-site. Clearance or avoidance measures, including utility maps, will be issued in writing by RVAAP to the Contractor prior to subsurface activities on-site. If a utility (known or unknown) is discovered (damaged or undamaged) during field activities, work will be stopped immediately and the RVAAP O&M Contractor and OHARNG Environmental Coordinator will be notified. The RVAAP O&M Contractor is responsible for coordinating further clearance of the discovered utility. Work will not recommence until the status of the utility (live, abandoned) has been determined.

5.4 GROUNDWATER

5.4.1 Rationales

As defined in Section 4.0, investigation-specific addenda to the FWFSP will be developed for the purpose of identifying unique elements of each investigation not addressed in this FWFSP.

Therefore, the rationales related to monitoring well locations and installation, sample collection, field and laboratory analyses, determination of background values, and QA/QC sample collection and frequency will be addressed within each of the investigation-specific addenda as appropriate.

5.4.2 Monitoring Well Installation

5.4.2.1 Drilling Methods and Equipment

5.4.2.1.1 Equipment Condition and Cleaning

All drilling and support equipment used for monitoring well installation during each AOC-specific investigation will be in first-class working order, clean, and free of leaks. All switches (including a minimum of two functioning safety switches); gauges; and other electrical, mechanical, pneumatic, and hydraulic systems will be in a safe and operable condition before arrival and during operation. The Drill Rig Operational Checklist (Figure 5-1) will be completed prior to commencement of drilling and at a minimum frequency of once per week after drilling commences. All safety switches or "kill switches" will be tested and documented every working day prior to activities on-site. All safety switches must be operational prior to drilling activities.

All drilling equipment will be cleaned with steam or pressurized hot water and free of any contamination (organic or inorganic) before arriving for each AOC-specific investigation. After arrival, but before commencement of drilling activities, all drilling equipment (including the rig, support vehicles, water tanks [interior and exterior], augers, drill casings, rods, samplers, and tools) will be cleaned with steam or pressurized hot water using approved water at an approved, centralized decontamination pad. Approval for location of the centralized decontamination pad is provided by the RVAAP Environmental Manager. Sampling devices will also be decontaminated in accordance with Section 5.5.2.8.

Similar decontamination of drilling and sampling equipment will be conducted upon completion of each monitoring well borehole. However, only the equipment used or soiled during the drilling and sampling activities at each borehole location will be decontaminated. All drilling and sampling equipment used during the course of each AOC-specific investigation will be decontaminated.

The temporary decontamination pad to be used for equipment cleaning will be located, to the greatest extent possible, in an area surficially cross- or downgradient from the monitoring well borehole locations. The pad will be constructed in such a manner to allow for containment and collection of decontamination solid and liquid wastes and to minimize loss of overspray water during decontamination activities. Solid and liquid wastes generated from the decontamination process (IDW) will be managed in accordance with the procedures defined in Section 8.0.

Figure 5-1. Drill Rig Operational Checklist for RVAAP AOC-Specific Investigations (pg 1of 4)

DRILL RIG OPERATIONAL CHECKLIST

Site Name:____________________________

Rig
Model: _______________________________ Manufacturer:_______________________________________

Serial Number: _________________________ Rig Owner: _

All of the below items have been inspected and are in proper working condition prior to beginning work. Any deficiencies noted have been corrected prior to beginning work.

Contractor Rig Inspector/Field Manager:

____
(Print Name) (Signature) (Date)

Drilling Subcontractor Supervisor:

____
(Print Name) (Signature) (Date)

Place an X in each appropriate ( )

1.0 GENERAL

1.1 Check all safety devices which are part of drill rig and which can be verified (see note).
Is (are all) device(s) intact and operating as designed?

Emergency Interrupt System

A. Kill Switch 1 Yes ( ) No ( ) NA ( )
B. Kill Switch 2 Yes ( ) No ( ) NA ( )
C. Kill Switch 3 Yes ( ) No ( ) NA ( )
D. Kill Switch 4 Yes ( ) No ( ) NA ( )
E. Kill Switch 5 Yes ( ) No ( ) NA ( )
F. Other __________________________________ Yes ( ) No ( ) NA ( )

G. Other __________________________________ Yes ( ) No ( ) NA ( )

H. Other __________________________________ Yes ( ) No ( ) NA ( )

Note: All safety devices (not otherwise listed in this checklist) should be identified for each drill rig at the beginning of each project and subsequently checked at each inspection. Testing of all safety devices must be observed by health and safety personnel. List only safety devices which can be checked without disassembly or without rendering the device ineffective. This checklist does not cover United States Department of Transportation requirements.

Figure 5-1. Drill Rig Operational Checklist for RVAAP AOC-Specific Investigations (pg 2 of 4)

1.2 Is the proper type and capacity of fire extinguisher(s) present, properly charged, and inspected? Yes ( ) No ( ) NA ( )

1.3 Are all drilling rods and downhole equipment free of burs and in good condition? Yes ( ) No ( ) NA ( )

1.4 Are rig and mast a safe distance from electrical lines? Yes ( ) No ( ) NA ( )

1.5 Can mast be raised without encountering overhead obstructions? Yes ( ) No ( ) NA ( )

1.6 Have spill prevention materials been placed under rig (e.g., plastic sheeting)? Yes ( ) No ( ) NA ( )

1.7 Is a spill kit present? Yes ( ) No ( ) NA ( )

1.8 Is the safe operating zone/exclusion zone posted (minimum radius at least equal to height of raised drill mast)? Yes ( ) No ( ) NA ( )

1.9 Do all modifications made to the drill rig permit it to operate in a safe manner and allow the drill to operate within the manufacturer's specifications? Yes ( ) No ( ) NA ( )

1.10 Are moving parts (excluding cathead and other moving parts normally used during operations) properly guarded? Yes ( ) No ( ) NA ( )

1.11 Are all exhaust pipes, which would come in contact with personnel during normal operation properly guarded? Yes ( ) No ( ) NA ( )

1.12 Are tank(s) and lines free of leakage? Yes ( ) No ( ) NA ( )

1.13 Are all normal or manufacturer-recommended maintenance activities or schedules performed at the required frequency? Yes ( ) No ( ) NA ( )

1.14 Are walking and standing surfaces, steps, and rungs, free of excess grease, oil, or mud which could create a hazard? Yes ( ) No ( ) NA ( )

1.15 Is the derrick raise/lower alarm working properly? Yes ( ) No ( ) NA ( )

1.16 Is all downhole equipment clean and free of oil and dirt? Yes ( ) No ( ) NA ( )

2.0 CONTROL MECHANISMS

Are all control mechanisms and gauges on the drill rig functional and free of oil, grease, and ice (checked while running)? Yes ( ) No ( ) NA ( )

Figure 5-1. Drill Rig Operational Checklist for RVAAP AOC-Specific Investigations **(pg 2 of 4)**

3.0 HYDRAULICS AND PNEUMATICS

Note: The mast should be lowered during the completion of this section to allow inspection of portions of the lifting mechanisms normally out of reach during operation.

3.1 Do all hydraulic reservoirs exhibit proper fluid levels? Yes ( ) No ( ) NA ( )

3.2 Are hydraulic and/or pneumatic systems in good condition free of leaks frays or other damage and functioning correctly (checked while running)? Yes ( ) No ( ) NA ( )

4.0 LIFTING MECHANISMS

Note: The mast should be lowered during the completion of this section to allow inspection of portions of the lifting mechanisms normally out of reach during operation.

4.1 Are all wires, ropes, cables, and lines in good condition and working properly? (Not kinked, worn, corroded, cracked, bent, crushed, frayed, stretched, birdcaged, or otherwise damaged) Yes ( ) No ( ) NA ( )

4.2 Have all wires, ropes, cables, and lines been wrapped around winch drums without excessive pinching or binding? Yes ( ) No ( ) NA ( )

4.3 Are all pulleys undamaged and functional? Yes ( ) No ( ) NA ( )

4.4 Are all clips, clamps, clevises, hooks, and other hardware used to rig wires, ropes, cables, or lines undamaged and attached properly? Yes ( ) No ( ) NA ( )

4.5 Do all eyes formed in wires, ropes, cables, or lines attached to the rig use a thimble to retain the shape of the eye? Yes ( ) No ( ) NA ( )

4.6 Do all hooks having functioning safety gates/latches? Yes ( ) No ( ) NA ( )

Figure 5-1. Drill Rig Operational Checklist for RVAAP AOC-Specific Investigations (pg 2 of 4)

5.0 NONCONFORMING ITEMS

5.1 When did the last operation checklist inspection take place for this drill rig at this AOC?

Date: ____________________________

5.2 Have any nonconforming items been carried over from the last inspection? List any such items and dates or original nonconformance.

A. ____

Date: ____________________________

B. ____

Date: ____________________________

C. ____

Date: ____________________________

D. ____

Date: ____________________________

Any nonconforming items must be documented in the following remarks section and reported to the field operations manager for the project prior to operating the drill ring. Reference all remarks to the item numbers noted above.

Remarks:

____

____

____

____

5.4.2.1.2 Drilling Methods

Two types of drilling methods are anticipated to be used for groundwater monitoring well installation during the AOC-specific investigations, assuming the monitoring wells are installed for subsurface contaminant characterization. The two methods are hollow-stem auger drilling and air rotary drilling. These methods, when used during investigations, will be implemented as dry drilling methods.

Either the hollow-stem auger or air rotary method will be used to drill soil portions of monitoring well boreholes provided that soil sample collection for physical and/or chemical analyses is not required. The hollow-stem auger method is used to drill overburden material to best obtain lithologic samples for archival purposes. In the event that physical and/or chemical samples are required to be collected, only the hollow-stem auger method will be utilized to continuously collect samples from the surface to the unconsolidated overburden surficial material-bedrock interface or borehole termination. Regardless of the drilling method, lithologic samples of soil and rock will be collected, described, and archived from the surface to total depth in each borehole per procedures described in Section 5.4.2.3.2. The methods and equipment to be used for subsurface soil sample collection from boreholes drilled using the hollow-stem auger method are presented in Sections 5.5.2.4 and 5.5.2.5. The air rotary method will be used to drill competent bedrock portions of monitoring well boreholes. In the event that bedrock cores are required to be collected as part of the borehole drilling, the methods and equipment are presented in Section 5.4.2.3.2.

Soil drilling using the hollow-stem auger method will be accomplished using a truck-mounted auger rig of sufficient size and power to advance augers to the required drilling depth. Soil and bedrock drilling using the air rotary method will be accomplished using a truck-mounted air rotary rig, which will advance a tricone roller bit to the required drilling depth. All rock coring will be conducted with a minimum core size of 2.0 inches (50.0 mm) in diameter (“N” series). The total depth of each monitoring well borehole will be dictated by the depth of local groundwater and will be contingent upon the constraints of the maximum drilling depth for boreholes defined by the U.S. Army for each AOC-specific investigation. A discussion of these constraints and the decision criteria associated with installing monitoring wells in boreholes will be presented in the investigation-specific addenda to this FWFSP.

With regard to the air rotary method, soil and bedrock cuttings will be removed from the borehole during drilling using high-pressure air, and they will be directed to the surface through the borehole annulus or through a borehole casing (if installed) in bedrock sections. Drill cuttings traveling to the ground surface will be directed into a diverter sealed to the top of the borehole or the borehole casing. The drill cuttings will then exit from the diverter through a discharge vent and will be directed into a container located next to the borehole.

The air compressor used for the air rotary method may be equipped with an air-line oil filter. If no oil is used in compressor operation, then no further action is required. If oil is used as part of compressor operations, then the oil filter will be changed in accordance with manufacturer’s recommendations; however, if oil is visibly detected in the filtered air, then the filter will be changed more frequently. The air filter will be examined daily for breakthrough. Sufficient samples of the air compressor initial reservoir oil will be collected and retained until completion of the AOC investigation. These samples will be evaluated in the event that oil from the compressor unit is suspected to have contributed to contamination detected at the AOC. Logs completed for each borehole will be used to record the following information regarding air usage:

- Equipment description;
- Manufacturer and model;
- Air pressure used;
- Frequency of oil filter change;
- Evaluation of system performance; and
- Record of any oil loss from the unit.

Procedures used to mitigate adverse subsurface effects resulting from the implementation of hollow-stem auger or air rotary drilling methods and procedures used to manage IDW generated at borehole locations during hollow-stem auger or air rotary drilling will be presented in the investigation-specific addenda to this FWFSP.

Various drilling scenarios may be used to complete monitoring well boreholes during the course of the AOC investigations due to specific site conditions. Therefore, the type of drilling method required (e.g., hollow-stem auger or air rotary) and size(s) of augers or tricone roller bits will be dictated by the scenario that is applicable for a particular AOC investigation. Details regarding the drilling method, approach, and rationale for each investigation will be presented in the investigation-specific addenda to this FWFSP.

5.4.2.1.3 Drilling Scenarios

Based on the assumption that monitoring wells for the initial AOC-specific investigations are installed for the purpose of subsurface contaminant characterization, a majority of these wells will be installed using 5.0-cm (2.0-inch)-diameter well screen and casing. Furthermore, it is assumed that some monitoring wells for the investigations will be drilled to relatively shallow depths and completed in overlying soil material, while other monitoring wells will be drilled to greater depths and completed in the underlying bedrock. Based on these assumptions, five different drilling scenarios may be used for borehole completion.

In circumstances where wells are to be completed in bedrock, coring may be necessary to determine lithologies and the degree and nature of weathering and fracturing in bedrock. N-series coring shall be performed in the bedrock interval prior to 15.2-cm (6.0-inch)-diameter air-rotary overdrilling to install the monitoring well. Methods and procedures for drilling should follow ASTM D 5784 (ASTM 2006a), ASTM D 5782 (ASTM 2006b), ASTM D 6001 (ASTM 2005a), and ASTM D 6282 (ASTM 2005b).

The first drilling scenario would be implemented for monitoring well boreholes required to be drilled through overlying soil material known to be contaminated and into the underlying non-contaminated bedrock. For this scenario, the well borehole would initially be drilled down to the soil-bedrock interface using either the direct-push (Section 5.5.2.1.5) or hollow-stem auger method if soil sampling is required or the air rotary method if soil sampling is not required. The borehole will then be additionally advanced into the top of the bedrock approximately 0.9 to 1.5 m (3 to 5 ft). A hole-opening device may be utilized to increase the diameter of the borehole soil section to the required size if the standard-sized auger lead or tricone roller bits are not adequate. Next, steel surface casing extending from the ground surface to the bottom of the borehole would be installed and the annulus between the casing and borehole grouted. After the grout cures for at least 12 hr, drilling of the bedrock portion of the borehole would be completed using the air rotary method. The surface casing used for this scenario would not be removed during subsequent installation of the monitoring well.

The second drilling scenario would be implemented for monitoring well boreholes required to be drilled through overlying soil material and into the underlying bedrock which is known to be contaminated. For this scenario, initial drilling of the well borehole would be conducted in the same manner as described for the first drilling scenario. The borehole will then be additionally advanced through the contaminated bedrock material into a non-contaminated stratigraphic interval approximately 0.9 to 1.5 m (3 to 5 ft). A hole-opening device may be utilized to increase the diameter of the borehole overburden interval to the required size if the standard-sized auger lead or tricone roller bits were not of sufficient diameter. Next, steel surface casing extending from the ground surface to the bottom of the borehole in the non-contaminated bedrock interval would be installed and the annulus between the casing and borehole grouted. After allowing grout to cure for at least 12 hr, drilling of the non-contaminated bedrock portion of the borehole would be completed using the air rotary method. If the overlying soil is not stable enough to allow contaminated bedrock coring, a steel casing may be installed from the overburden to bedrock interface followed by a secondary casing through the contaminated bedrock. The utilization of secondary casings will be addressed in project specific addenda. The surface casing used for this scenario would not be removed during subsequent installation of the monitoring well.

The third drilling scenario would be implemented for monitoring well boreholes required to be drilled through overlying soil material not requiring isolation but known to be unstable (i.e., prone to caving) and into the underlying bedrock. For this scenario, initial drilling of the well borehole would be conducted in the same manner as described for the first drilling scenario. Immediately after installing the surface casing, the bedrock portion of the borehole would be drilled using the air rotary method. Monitoring wells installed within boreholes drilled using this scenario would be constructed inside the surface casing that would be removed during grouting of the well.

The fourth drilling scenario would be implemented for monitoring well boreholes required to be drilled into overlying soil material not requiring isolation and known to be stable or required to be drilled through this material and into the underlying bedrock. For this scenario, drilling of the soil portion of the borehole would be conducted in the same manner as described for the initial drilling in the first drilling scenario. If required, drilling of the bedrock portion of the borehole would be completed using the air rotary method. No surface casing would be used during implementation of this drilling scenario.

The fifth drilling scenario would be implemented for monitoring well boreholes required to be drilled into overlying soil material not requiring isolation and known to be unstable. For this scenario, borehole drilling using the hollow-stem auger method would be accomplished by advancing the augers to the required depth. Monitoring wells installed within boreholes drilled using this method would be constructed inside the augers that would be removed during grouting of the well. Borehole drilling using the air rotary method would be accomplished by advancing the tricone roller bit to the required depth. A hole-opening device would be utilized to increase the diameter of the borehole soil section to the required size if the standard-sized tricone roller bits are not adequate. Following completion of the borehole, temporary surface casing would be installed. Monitoring wells installed within boreholes drilled using this method would be constructed inside the surface casing that would be removed during grouting of the well.

In each of these drilling scenarios, it may be necessary to isolate overlying soil material if heaving sands are encountered. In these instances, steel surface casing would be installed from the surface to within the confining interval immediately above the heaving sand. The annulus between the casing and borehole would be grouted. After the grout cures for at least 12 hr, a closed-end (temporarily plugged) auger would be used to drill the heaving sand interval. The temporary plug would then be knocked out and the drilling would continue or the well completed, as outlined in the above drilling scenarios.

Table 5-1 summarizes the five drilling scenarios described above and the types of standard hollow-stem augers, tricone roller bits, and surface casings that may be used during implementation of these scenarios.

5.4.2.2 Materials

The following discussion regarding materials to be used for construction of monitoring wells during the AOC-specific investigations is based upon the assumption that the wells will be installed for the purpose of subsurface contaminant characterization and thus will be 5.0 cm (2.0 inches) in diameter. Furthermore, it is anticipated that two different types of monitoring wells may be constructed during the investigations, above-grade installations and flush-mounted installations.

Details regarding monitoring well installation are presented in Section 5.4.2.3 of this FWFSP. All materials used for monitoring well construction and the type of well to be constructed (e.g., above-grade or flush-mounted) will be presented in the investigation-specific addenda to this FWFSP.

5.4.2.2.1 Casing/Screen

The casing, screen, and fitting materials to be used for monitoring well construction during the AOC-specific investigations will be composed of new, pre-cleaned, 5.0-cm (2.0-inch) rigid Schedule 40 or Schedule 80 polyvinyl chloride (PVC). Screen sections will be commercially fabricated and slotted with openings equal to 0.025 cm (0.010 inches). Screen and casing sections will be flush threaded, and thermal or solvent welded couplings will not be used. Gaskets, pop rivets, and screws will not be used during monitoring well construction. Pre-packed screens will be used for intervals that cannot be filter-packed conventionally.

All materials used for monitoring well construction will be as chemically inert as technically practical with respect to the environment. All PVC screens, casings, and fittings will conform to National Sanitation Foundation/American National Standards Institute Standard 14 (NSF 2009) for potable water usage or the *Annual Book of ASTM Standards* (ASTM 1995) and will bear the appropriate rating logo. Additional specifications are provided in the *Handbook of Suggested Practices for the Design and Installation of Ground-Water Monitoring Well* (USEPA 1991).

The well caps and centralizers used for monitoring well construction will be composed of new, pre-cleaned PVC. The tops of all new monitoring well casings associated with well installations will be covered with water-tight expandable-flange locking well caps. The caps will be fitted to the casings and will be designed to preclude binding to the casing resulting from tightness of fit, unclean surface, or frost and to allow for equilibration between hydrostatic and atmospheric pressures. The caps will be designed to fit securely enough to preclude debris and insects from entering the monitoring well.

Well centralizers will be used in construction of all monitoring wells that are installed within open boreholes exceeding approximately 6.1 m (20.0 ft) in depth to prevent the PVC well casing from deforming. Well centralizers will be attached to the well casing at regular and equal intervals with stainless steel fasteners or strapping. Centralizer placement will be determined in the field at the time of monitoring well installation based on the total depth of each well. Centralizers will not be attached to well screens or to portions of well casings exposed to the granular filter pack or bentonite seal. Centralizers will be oriented to allow unrestricted passage of the tremie pipe used to place monitoring well construction materials within the annular space between the well and the borehole wall.

5.4.2.2.2 Well Installation Materials: Filter Pack, Bentonite, And Grout

The granular filter pack used during the AOC-specific investigations for monitoring well installation will comply with requirements defined in the *Monitoring Well Design, Installation, and Documentation at Hazardous and/or Toxic Waste Sites* (USACE 1994) and will be approved by the U.S. Army Project Manager prior to beginning fieldwork (Figure 5-2). A 500-cm^3 (1-pint) representative sample of the granular filter pack material proposed for use will be submitted to the USACE, Louisville District; RVAAP; or other U.S. Army Project Manager for approval, if requested. Based on the screen slot size of 0.025 cm (0.010 inches) to be used for monitoring well construction, the granular filter pack material used will generally be Global Supply No. 7 (size equals 0.047 cm [0.0188 inches]) sand. Global Supply No. 5 alternately may be used with prior approval from the U.S. Army Project Manager and Ohio EPA if conditions warrant.

The granular filter pack material will be visually clean (as seen through a 10-power hand lens), free of material that would pass through a No. 200 sieve, inert, siliceous, and composed of rounded grains. The filter material will be packaged in bags or buckets by the supplier and delivered. Filter pack material in pre-packed screens also will meet these criteria.

Bentonite will be used during the AOC-specific investigations for one or more of the following purposes:

- Creation of an annular seal during monitoring well construction between the lower granular filter pack and the upper grout seal;

- Additive in the grout mixture used to create the upper grout seal during monitoring well construction;

- Additive in the grout mixture used to abandon boreholes not converted into monitoring wells; and/or

- Abandonment of surficial boreholes and pilot holes.

Table 5-1. Summary of Drilling Scenarios for Monitoring Well Installation at RVAAP AOC-Specific Investigations

Scenario Summary	Soil Drilling	Surface Casing Placement	Bedrock Drilling	Monitoring Well Size	Protective Casing Size
Borehole through overlying contaminated soil and into underlying non-contaminated bedrock	Hollow-Stem Auger Method: nominal 12.25-inch ID, 17.0-inch OD augers for primary (surface) casing borehole Alternate method – increase primary casing borehole diameter using minimum 14.0-inch diameter solid stem auger/hole-opening device	10.0-inch ID primary casing grouted in place	Air Rotary Method: 6.5-inch tricone bit Bedrock Coring: N-series core	2.0-inch ID PVC screen and casing	6.0-inch ID iron or steel casing
	Air Rotary Method: nominal 10.625-inch diameter tricone bit; increase primary casing borehole diameter using minimum 14.0-inch diameter hole-opening device	10.0-inch ID casing grouted in place			
Borehole through overlying soil and underlying contaminated shallow bedrock with monitoring interval completion in a deeper non-contaminated stratigraphic interval	Hollow-Stem Auger Method: nominal 12.25-inch ID, 17.0-inch OD augers for primary (surface) casing borehole; nominal 8.25-inch ID, 12.0-inch OD augers used for secondary (intermediate) casing borehole Alternate method – increase primary casing borehole diameter using minimum 14.0-inch diameter solid stem auger/hole-opening device	10.0-inch ID primary casing grouted in place; 8.0-inch ID secondary casing	Air Rotary Method: Nominal 12.25-inch tricone bit for secondary (intermediate) casing borehole; nominal 6.5-inch tricone bit for inner casing and screen borehole Bedrock Coring: N-series core	2.0-inch ID PVC screen and casing	6.0-inch ID iron or steel casing
	Air Rotary Method: nominal 10.625-inch diameter tricone bit; increase primary casing borehole diameter using minimum 14.0-inch diameter hole-opening device	10.0-inch ID casing grouted in place; 8.0-inch ID secondary casing			

Table 5-1. Summary of Drilling Scenarios for Monitoring Well Installation at RVAAP AOC-Specific Investigation (continued)

Scenario Summary	Soil Drilling	Surface Casing Placement	Bedrock Drilling	Monitoring Well Size	Protective Casing Size
Borehole through overlying unstable soil and into underlying bedrock	Hollow-Stem Auger Method: nominal 8.25-inch ID, 12.0-inch OD augers for secondary casing borehole Alternate method – increase primary casing borehole diameter using minimum 12.0-inch diameter solid stem auger/hole-opening device	8.0-inch ID casing	Air Rotary Method: 6.5-inch tricone bit Bedrock Coring: N-series core	2.0-inch ID PVC screen and casing	6.0-inch ID iron or steel casing
	Air Rotary Method: 12.25-inch diameter tricone bit	8.0-inch ID casing			
Borehole through overlying non-contaminated stable soil and into underlying bedrock	Hollow-Stem Auger Method: nominal 4.25-inch ID, 8.0-inch OD augers	Not required	Air Rotary Method: 6.5-inch tricone bit Bedrock Coring: N-series core	2.0-inch ID PVC screen and casing	6.0-inch ID iron or steel casing
	Air Rotary Method: nominal 6.5-inch diameter tricone bit	Not required			
Borehole into overlying unstable soil	Hollow-Stem Auger Method: nominal 4.25-inch ID, 8.0-inch OD augers	Not required	Not applicable	2.0-inch ID PVC screen and casing	6.0-inch ID iron or steel casing
	Air Rotary Method: nominal 8.5-inch diameter tricone bit to temporary surface casing set point; nominal 6.5-inch diameter tricone bit for inner casing and screen borehole	Nominal 8.0-inch ID temporary surface casing			

AOC = Area of concern
OD = Outside diameter
RVAAP = Ravenna Army Ammunition Plant
ID = Inside diameter
PVC = Polyvinyl chloride

GRANULAR FILTER PACK APPROVAL

Project for Intended Use:

Filter Material Brand Name:

Lithology:

Grain Size Distribution:

Source/pit or quarry of origin:

Manufacturer:

Manufacturer address:

Processing method:

Slot Size of Intended Screen:

SUBMITTED BY:

Company:

Person:

Telephone Number:

Date

FOR APPROVAL (A)/DISAPPROVAL (D)	(circle one)	
Project Officer/Date:	A	D
Project Geologist/Date:	A	D
U.S. Army Project Manager/Date:	A	D

Figure 5-2. Granular Filter Pack Description and Approval Form

Bentonite material used during the AOC-specific investigations for monitoring well installation will comply with requirements defined in the *Monitoring Well Design, Installation, and Documentation at Hazardous and/or Toxic Waste Sites* (USACE 1994) and will be approved by the U.S. Army Project Manager prior to beginning fieldwork (Figure 5-3). A 500-cm^3 (1-pint) representative sample of each type of bentonite material proposed for use will be submitted to the U.S. Army Project Manager for approval, if requested. Compressed powdered bentonite pellets or chips, generally measuring 0.63 cm (0.25 inches) in size, will be used for annular seal applications. Powdered or granular bentonite will be used for grout additive applications.

Grout used during AOC-specific investigations for monitoring well installation or borehole abandonment will be composed of Type I portland cement, approximately 6 lb dry weight bentonite per 42.6-kg (94-lb) sack of dry cement, and a maximum of 0.02 to 0.03 m^3 (6 to 7 gal) of approved water per sack of cement. The amount of water used to prepare grout mixtures will be minimized to the greatest extent possible.

All grout materials will be combined in an above-ground rigid container or mixer and mechanically blended on-site to produce a thick, lump-free mixture throughout the mixing vessel. The grout will be placed using a tremie pipe of rigid construction extended to the bottom of the borehole for vertical control of pipe placement. The tremie pipe may be equipped with side discharge holes rather than an open end to help maintain the integrity of the underlying material onto which the grout is placed. Grout will be pumped slowly into the borehole to avoid increased pressure on underlying material and the borehole.

5.4.2.2.3 Surface Completion

The well protection assembly used for monitoring well construction during AOC-specific investigations will be composed of new iron/steel protective casing. All monitoring wells should be constructed as above-grade installations where possible.

Protective casings associated with above-grade well installations will be equipped with locking iron/steel covers, while those associated with flush-mount installations will be equipped with flush (not threaded) manhole-type iron/steel covers.

Covers on the protective casings will be designed to minimize water leakage. Protective casings installed as flush-mounts or above grade will be surrounded by a minimum of three new iron/steel guard posts centrally located around the monitoring well to help in location and avoidance.

All locks on protective casings installed during each investigation will be opened by a single key and, if possible, will match the locks present on existing monitoring wells within the AOC. If this is not possible, the locks on the existing wells may be replaced with the type used for the new monitoring wells installed during the investigation. Currently, all wells installed and sampled at RVAAP have a common key. All well locks will be issued by RVAAP.

BENTONITE APPROVAL

Project for intended use:
Bentonite Material Brand Name:
Annular seal:
Grout additive:
Manufacturer:
Manufacturer’s Address
Manufacturer’s Telephone Number(s):
Product Description:
Intended Use of Product:
Potential Effects on Subsequent Chemical Analyses:

SUBMITTED BY:

Company:
Person:
Telephone Number:
Date

FOR APPROVAL (A)/DISAPPROVAL (D)	(circle one)	
Project Officer/Date	A	D
Project Geologist/Date:	A	D
U.S. Army Project Manager/Date:	A	D

Figure 5-3. Bentonite Description and Approval Form

All protective casings will be 15.2 cm (6.0 inches) in diameter. The length of protective casing used for above-grade well installations will be 2.4 m (8.0 ft), approximately 1.5 m (5.0 ft) of which will extend bgs. The length of protective casing used for flush-mount well installations will be 1.5 m (5.0 ft), the entire length of which will extend bgs. The guard posts installed around above-grade protective casings will be at least 7.6 cm (3.0 inches) in diameter, and the top of each post modified to preclude the entry of water. The guard post length will be 1.8 m (6.0 ft), approximately 0.6 m (2.0 ft) of which will extend bgs, leaving 1.2 m (4.0 ft) exposed above grade.

5.4.2.2.4 Water Source

Water will be used during the AOC-specific investigations for the following:

- Prepare grout mixtures used to install monitoring wells or abandon boreholes;
- Prepare cement mixtures used to construct monitoring well surface completions; and
- Decontaminate drilling and sampling equipment.

The water source used for each investigation will be evaluated by collecting a sample from each source used prior to starting fieldwork. Procedures for collecting, preserving, shipping, and documenting this sample, and other related requirements, are defined in the subsequent sections of this FWFSP and in Appendix C of the *Requirements for the Preparation of Sampling and Analysis Plans* (USACE 2001b). One QC trip blank will be placed in the cooler used to transport the sample from the field to the contracted laboratory. The water sample will be submitted to the contracted laboratory for RVAAP full-suite analysis and for analysis of any additional contaminants to be evaluated during the investigation. The water source only will be used if analytical results indicate that the source is free of contaminants.

If an approved water supply is available and current analytical data document its suitability, this water source may be used without additional analyses.

The water source used for the project also will comply with other requirements defined in Section 3-9, Subsection b, Items #1a through #1f of the *Monitoring Well Design, Installation, and Documentation at Hazardous and/or Toxic Waste Sites* (USACE 1994) and will be approved by the U.S. Army Project Manager prior to use (Figure 5-4). Field personnel will transport and store the approved water required for investigation needs in a manner to avoid the chemical contamination or degradation of the approved water once obtained.

5.4.2.2.5 Delivery, Storage, and Handling of Materials

All monitoring well construction materials will be supplied and delivered to the AOC by the subcontracted drilling company retained for each AOC-specific investigation. Upon delivery, the Field Operations Manager will inspect and ensure the required types of materials have been delivered and the materials have not been damaged or contaminated during transport. During this inspection, the Field Operations Manager will collect and file any material certification documentation attached to or accompanying the materials. All material certification documentation will be maintained on-site until project completion, at which time it will be transferred to the project evidence file. All materials will be stored in a dry and secure location until used for monitoring well construction.

All well screens and well casings used for monitoring well construction will be free of foreign matter (e.g., adhesive tape, labels, soil, grease) and will be washed with approved water before use. However, if the materials have been packaged by the manufacturer and remain so up to the time of installation, no prewashing will be conducted. Pipe nomenclature stamped or stenciled directly on well screens and/or solid casings to be located within and below the bentonite seal will be removed by sanding, unless removable by approved water washing. Washed screens and casing will be stored in plastic sheeting until immediately before placement into the borehole. All well screens and casings used for construction will be free of unsecured couplings, ruptures, and other physical breakage and/or defects.

All protective casing materials will be steam cleaned before placement; free of extraneous openings; and devoid of any asphaltic, bituminous, encrusting, and/or coating materials (with the exception of black paint or primer applied by the manufacturer). Washed protective casing materials will be stored in plastic sheeting until immediately before placement around monitoring well casings.

WATER APPROVAL

Project for intended use:

Water Source:

Owner:

Address:

Telephone Number:

Water Tap Location:

Operator:

Aquifer:

Well Depth:

Static water level from ground surface:

Date measured:

Type of treatment or filtration prior to tap:

Type of access:

Cost per cubic gallon charged for use:

Results and dates of chemical analyses for past 2 years:

Results and dates of chemical analyses for project analytes:

SUBMITTED BY:

Company:
Person:
Telephone Number:
Date

FOR APPROVAL (A)/DISAPPROVAL (D)	(circle one)	
Project Officer/Date	A	D
Project Geologist/Date	A	D
U.S. Army Project Manager /Date:	A	D

Figure 5-4. Water Description and Approval Form

5.4.2.3 Installation

Monitoring wells installed as part of the AOC-specific investigations are anticipated to be constructed as above-grade installations. Flush-mounted installations may be preferable in some circumstances. Furthermore, boreholes for both types of installation may be completed in either overlying soil material or the underlying bedrock. The current revision(s) of the *Technical Guidance Manual for Hydrogeologic Investigations and Groundwater Monitoring* (Ohio EPA 2009), USACE *Monitoring Well Design, Installation, and Documentation at Hazardous and/or Toxic Waste Sites* (USACE 1994) and ASTM D5092-04e1, *Standard Practice and Design and Installation of Ground Water Monitoring Wells* (ASTM 2004) will be referenced for proper installation of monitoring wells. The criteria guiding the construction type will be the depth of local groundwater encountered at each monitoring well borehole location and the area type (e.g., remote area versus traffic area) where each well is to be installed. All wells installed at RVAAP should be constructed as above-grade installations where possible. Figures 5-5, 5-6, and 5-7 conceptually illustrate three types of monitoring well construction that may be completed during the AOC investigations. A discussion of the monitoring well installation process is presented below.

5.4.2.3.1 Test Holes

In the event that test holes are required to be drilled before monitoring well installation during the AOC-specific investigations, these holes will be drilled in accordance with the procedures defined within this FWFSP.

5.4.2.3.2 Soil Sampling and Rock Coring During Drilling

Soil sample collection for physical, geotechnical, and/or chemical analyses during monitoring well installation activities conducted during AOC-specific investigations will be performed in accordance with the procedures defined in Sections 5.5.2.4 and 5.5.2.5 of this FWFSP.

All rock coring will be conducted in a manner to obtain maximum intact recovery of bedrock. The minimum core size will be “N” series, which is 50.0 mm (2.0 inches) in diameter.

To the extent possible, bedrock coring will be accomplished without adding potable water. However, coring in unsaturated bedrock may require adding approved water to the formation to cool the cutting surface and facilitate the extension of the borehole. Circulation of this water may be lost to the surrounding formation if it is porous and permeable. If the monitoring well installed in this borehole is a low-yield well, the potable water volume lost is generally not recoverable during well development. During the course of bedrock coring to advance a monitoring well boring, the Contractor Field Operations Manager will contact the U.S. Army Project Manager and the Ohio EPA, Division of Drinking and Ground Waters in the event that drilling and coring conditions result in a loss of circulation of potable water.

Rock cores will be stored in 10-ft intervals in covered 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 in cases of multiple boxes. Any core box known or suspected to contain contaminated core material will be appropriately marked on the borehole log, the core box cover, and the ends. The weight of each fully loaded box will not exceed 34.0 kg (75.0 lb).

The core within each completed box will be photographed after the core surface has been cleaned and wetted. Each core box will be photographed close-up with a 35-mm camera loaded with color print film or a digital camera and will contain a legible scale for reference. Each core box will be oriented so that the top of the core is at the top of the photograph. Each photograph will have the project name, well/borehole number, core box number, cored depths illustrated, and photographed date visibly in the photograph. Thirty-five-mm photographs will be, minimally, 12.7 by 17.8 cm (5 by 7 inches) in size and will be provided to the U.S. Army Project Manager after coring activities are completed. The film negatives or data disks also will be provided to the U.S. Army Project Manager after receipt of the photograph prints. Digital photographs of core boxes will be provided electronically to the U.S. Army Project Manager.

Details regarding rock core disposal or retention and the storage, packaging, and shipping method for core samples designated for laboratory analyses will be defined in the investigation-specific addenda to this FWFSP. Rock cores will not be disposed of without RVAAP and USACE approval.

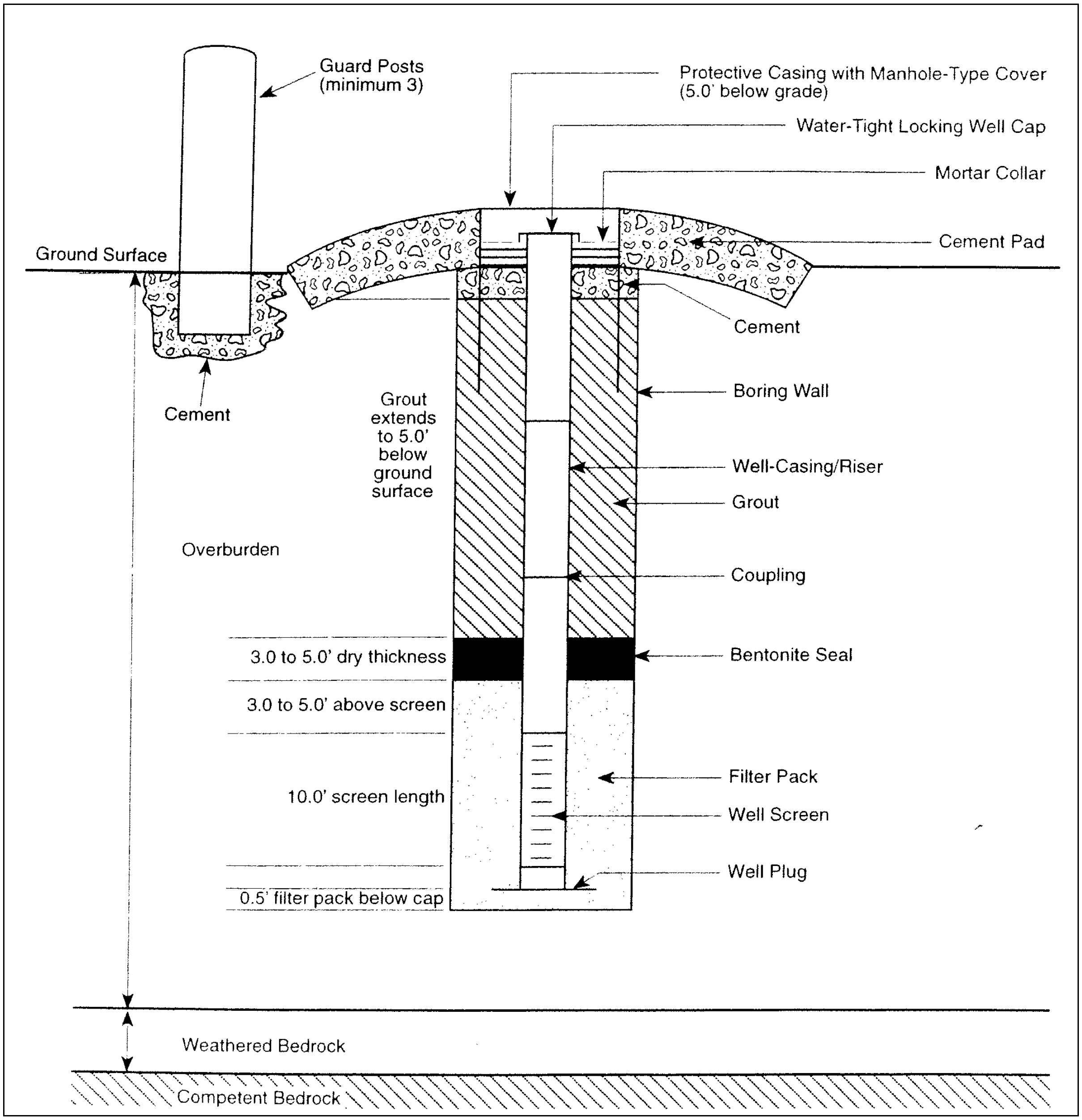


Figure 5-5. Example of Monitoring Well Completed in Overlying Unstable Soil (Overburden) with a Flush-mount Installation

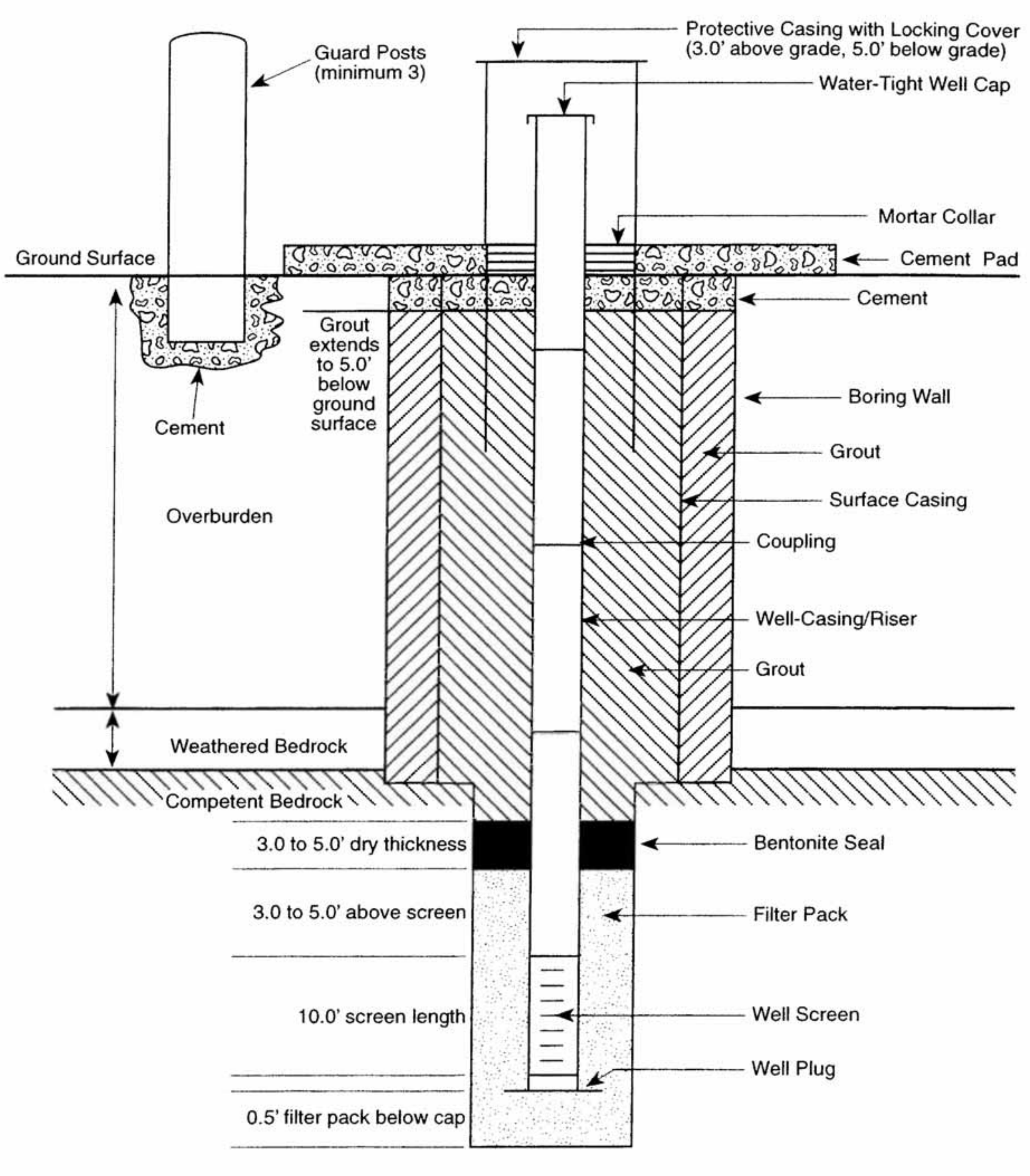


Figure 5-6. Example of Monitoring Well Completed in Underlying Bedrock with an Above-grade Installation (Overlying Unstable Soil [Overburden] is Contaminated)

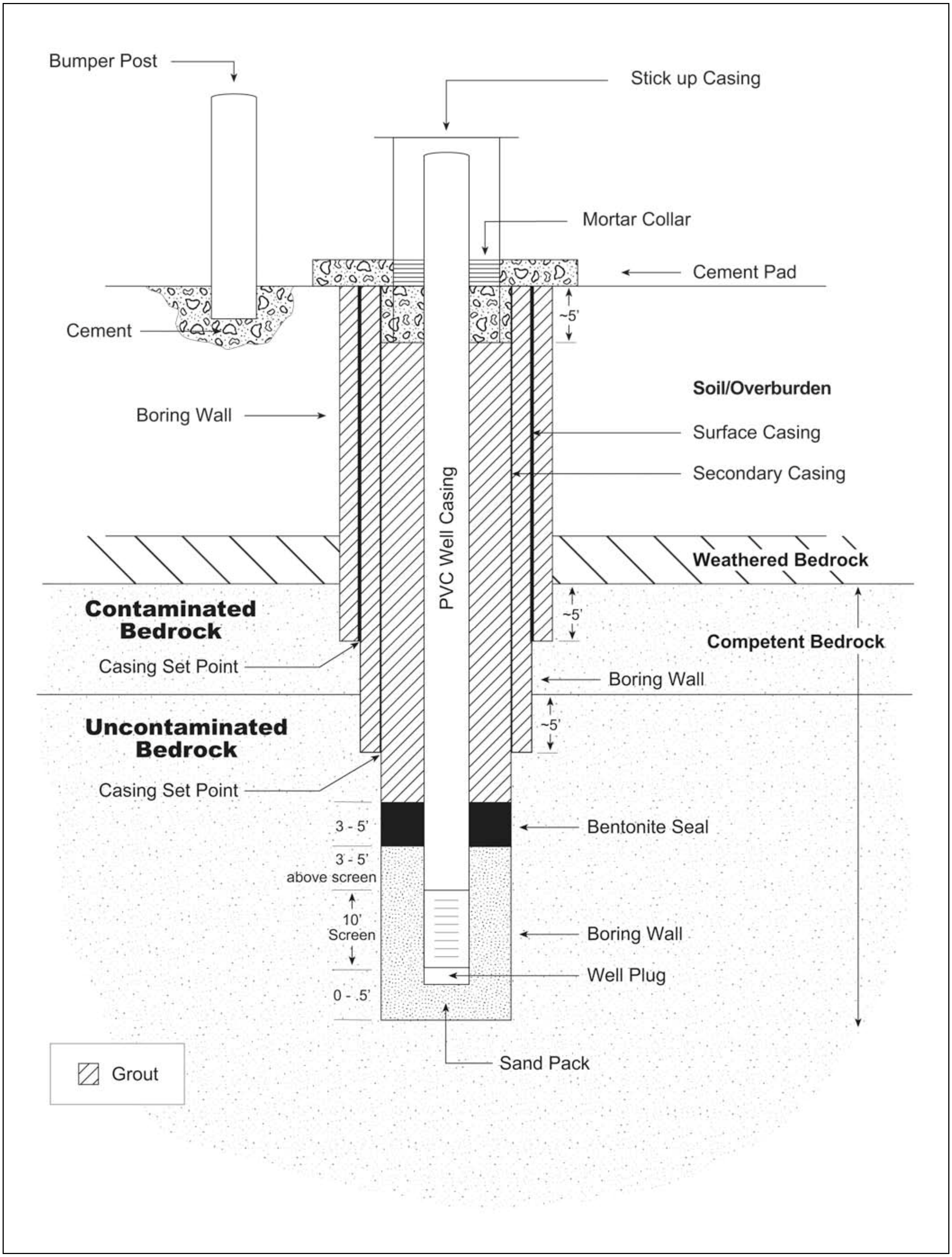


Figure 5-7. Example of Monitoring Well Completed in Underlying Bedrock with an Above-grade Installation (Overlying Unstable Soil [Overburden] is Contaminated)

5.4.2.3.3 Borehole Diameter and Depth

Monitoring wells installed for contaminant characterization during the AOC-specific investigations will be constructed of 5.0-cm (2.0-inch) PVC casing and screen. For monitoring wells of this size, the borehole drilled will be of sufficient diameter to permit at least 5.0 cm (2.0 inches) of annular space between the borehole wall and all sides of the well (centered screen and casing). Additional information regarding borehole drilling scenarios that may be implemented during the AOC investigations is discussed in Section 5.4.2.1.3 of this FWFSP.

The anticipated borehole depths for monitoring wells will be defined in the investigation-specific addenda to this FWFSP. However, borehole depths for monitoring wells drilled for the initial AOC-specific investigations to be conducted at RVAAP are currently estimated to be 6.0 to 12.1 m (20.0 to 40.0 ft).

Each borehole will be advanced through the overlying soil material, and into the underlying bedrock if required, until groundwater is encountered. Drilling will be terminated at a depth of from 1.5 to 3.0 m (5.0 to 10.0 ft) below the groundwater table. If sufficient groundwater to support a functional monitoring well is found to be present in the borehole, a monitoring well will be constructed. However, if insufficient groundwater is found to present, the borehole will be abandoned per procedures in Section 5.4.2.5 unless additional drilling is authorized by the U.S. Army Project Manager.

5.4.2.3.4 Screen and Well Casing Placement

Monitoring wells will be installed per guidance in Chapter 5 of the *Monitoring Well Design, Installation, and Documentation at Hazardous and/or Toxic Waste Sites* (USACE 1994). All screens used for monitoring well construction will be installed such that the bottom of each well screen is placed no more than 0.9 m (3.0 ft) above the bottom of the drilled borehole. The screen bottom will be securely fitted with a threaded PVC cap. The threaded cap will be within 15.2 cm (6.0 inches) of the open portion of the screen. The standard length of screen used for all RVAAP monitoring wells will be 3.0 m (10.0 ft). The casing used to construct above-grade monitoring well installations will be of sufficient length to allow for 0.7 m (2.5 ft) of the casing to extend above the ground surface. The casing used to construct flush-mounted monitoring well installations will be of sufficient length to allow for location of the casing top 5.0 cm (2.0 inches) bgs. Silt traps that extend below the screen will not be used. The top of each installed monitoring well casing will be level so that the difference in elevation between the highest and lowest points on the top of the well casing is less than or equal to 0.6 cm (0.2 inches). The north side of the casing will be marked or etched in an identifiable manner.

5.4.2.3.5 Filter Pack Placement

Approved granular filter pack material used for monitoring well construction will be placed within the annular space around the monitoring well screen. If approved water is used to place the filter pack, the amount of this water will be recorded and added to the volume of water to be removed during well development. The filter pack will extend from the bottom of the borehole to 0.9 to 1.5 m

(3.0 to 5.0 ft) above the top of the well screen. In addition, 15.2 cm (6.0 inches) of filter pack will be placed under the bottom of the well screen to provide a firm footing. The final depth to the top of the filter pack will be measured directly with a weighted tape and recorded.

5.4.2.3.6 Bentonite Seal

The type of bentonite material used to construct monitoring well seals will be composed of commercially available pellets or chips. Bentonite seals will be from 0.9 to 1.5 m (3.0 to 5.0 ft) thick, as measured immediately after placement, without allowance for swelling. Granular bentonite may be an alternative if the seal is set in a dry condition. Tremie pipes are not recommended for installing bentonite. A weighted tape will be used to prevent bridging during placement and to measure bentonite. A small volume of approved water will be used to hydrate the pellets, and the hydration time for the pellets will be a minimum of 1 hr. The bentonite seal should be placed in 0.15- to 0.3-m (6-inch to 1-ft) lifts, with each lift hydrated for a period of 30 min, rather than installing the entire seal at one time. In addition, a weighted tape will be used to prevent bridging during placement and to measure bentonite placement. An adequate bentonite seal should be allowed to form (ideally waiting overnight) before placing the grout to protect the screen and filter pack from downhole grout. The final depth to the top of the hydrated bentonite seal will be measured directly with a weighted tape and recorded.

5.4.2.3.7 Cement/Bentonite Grout Placement

All prescribed portions of grout material used for monitoring well construction will be combined in an above-ground rigid container and mechanically blended to produce a thick, lump-free mixture throughout the mixing vessel. The grout will be placed from within a decontaminated rigid grout tremie pipe, initially located just over the top of the bentonite seal, in such a manner as to minimize disturbance of the seal.

Before exposing any portion of the borehole above the seal by removal of any surface casings (to include hollow-stem augers), the annulus between the surface casing and well casing will be filled with sufficient grout to allow for planned surface casing removal. If all surface casing is to be removed in one operation, the grout will be pumped through the grout pipe until undiluted grout flows from the annulus at the ground surface. During the surface casing removal, the grout pipe will be periodically reinserted as needed for additional grouting.

If the surface casing is to be incrementally removed with intermittent grout addition, the grout will be pumped through the grout pipe until it reaches a level that will permit at least 3.0 m (10.0 ft) of grout to remain in the annulus after removing the selected length of surface casing. Using this method, the grout pipe will be reinserted only to the base of the casing yet to be removed before repeating the process. After grouting has been completed to within approximately 3.0 m (10.0 ft) of the ground surface, the remaining surface casing will be removed from the borehole and the remaining annulus will be grouted to 1.5 m (5 ft) bgs.

Grout for monitoring wells to be completed both as above-grade and flush-mounted well installations will be added until it is present at 1.5 m (5 ft) bgs.

When initiating the grouting operation, the process will be conducted continuously until all of the surface casing or hollow-stem augers, if present, have been removed and all annular spaces are grouted to the required levels as noted above. After 24 hrs, the AOC will be checked for grout settlement, and more grout will be added at that time to fill any depression. This process will be repeated until firm grout remains within 1.5 m (5 ft) of the ground surface. Incremental quantities of grout added in this manner will be recorded on the well construction diagram.

5.4.2.3.8 Protective Cover and Well Pad Placement

A 0.15-cm (6-inch) protective iron/steel casing will be installed around each monitoring well the same day as initial grout placement around the well. The protective casing's exterior will be pre-primed before being brought to RVAAP. The protective casing used for above-grade well installations will be set approximately 1.5 m (5 ft) below grade and will extend approximately 0.9 m (3 ft) above the ground surface. The protective casing used for flush-mounted well installations will be set approximately 1.5 m (5 ft) bgs with the top of the casing flush to grade. All protective casings will be installed so that the distance between the top of the protective casing and the top of the well casing is no more than 6.0 cm (2.4 inches).

For monitoring wells constructed as flush-mounted well installations, the remaining annulus formed between the outside of the protective casing and borehole, or permanent surface casing if present, will be filled to the ground surface with concrete on the day that firm grout is found to be present in the borehole. A sloping concrete pad measuring approximately 0.76 by 0.76 m^2 (30 by 30 $inches^2$) will be poured around the exterior of the protective flush-mount casing. Concurrently, an internal mortar collar will be poured within the annulus between the protective casing and the well casing from the top of the firm grout to approximately 2.5 cm (1.0 inch) below the top of the well casing. The mortar mix will be (by weight) one part cement to two parts sand, with minimal approved water for placement.

For monitoring wells constructed as above-grade well installations, the mortar collar will be poured on the day firm grout is found in the borehole. The mortar collar will be poured within the annulus between the protective casing and the well casing from the ground surface to approximately 15.2 cm (6.0 inches) above the ground surface. After placing the mortar collar, the remaining annulus formed between the outside of the protective casing and the borehole, or permanent casing if present, will be filled with concrete to the ground surface and extended onto the apron around the well head to form a square-cornered concrete pad measuring approximately 0.76 by 0.76 m^2 (30 by 30 $inches^2$).

For flush-mounted installations, the pad will be sloped away from the casing and recessed into the ground approximately 12 cm (0.5 ft). For both types of installations, the thickness of each concrete pad will be uniform and no less than 10.2 cm (4.0 inches). Following placement and curing of the concrete pad, a drainage port measuring approximately 0.6 cm (0.25 inches) in diameter will be drilled into the above grade protective casing 0.3 cm (0.12 inches) above the top of the internal mortar collar.

Once the protective cover for above-grade well installations is in place, a minimum of three, preferably four, steel guard posts will be radially located 1.2 m (4.0 ft) around each monitoring well. The guard post length will be 1.8 m (6.0 ft), approximately 0.6 m (2.0 ft) of which will be set in cement below ground level. All of the guard posts, as well as the steel protective casing including the hinges and cover/cap, will be painted orange or yellow with a paint brush and will be completely dry before sampling of the well. Monitoring wells with slip-joint aluminum covers do not require painting.

5.4.2.3.9 Well Identification

For each monitoring well installed during the AOC-specific investigations, the well designation number will be painted, using white or black paint, on the outside of the protective casing (after application and drying of the orange/yellow paint), and/or a metal tag bearing the designation will be attached to the protective casing or well casing depending upon the type of installation (e.g., above grade or flush-mounted). The well designation number may also be stamped or etched into the monitoring well lid.

At AOCs where no existing monitoring wells are present, wells installed during the investigations will be numbered consecutively beginning with the designation XXXmw-001 (XXX = AOC designator). At AOCs where existing monitoring wells are present, wells installed during the investigations will be numbered consecutively beginning with the next highest unused number (i.e., if four existing wells designated as XXXmw-001 through XXXmw-004 are present, then numbering of the new investigation wells would begin with XXXmw-005). Boreholes drilled for monitoring well installation, but subsequently abandoned, also will be numbered consecutively beginning with the designation XXXSB-001. If boreholes previously have been drilled at the AOC, then numbering will begin with the next highest unused number. The well identification system will be consistent with the location/sample identification naming convention specified in Section 6.3 of this FWFSP.

5.4.2.3.10 Well Development

The development of monitoring wells installed at the AOC will be initiated not sooner than 48 hr after nor longer than 7 days beyond internal mortar collar placement or the final grouting of the wells. If existing monitoring wells must be redeveloped, then the integrity of each well developed will be checked prior to development. If the integrity of the well is questionable, the well will not be developed. The integrity of the well will be checked by visual inspection of the surface casing and riser pipe and by performing an alignment test in accordance with Section 5.4.2.3.11 of this FWFSP. All well development will follow procedures outlined in Chapter 6 of the *Monitoring Well Design, Installation, and Documentation at Hazardous and/or Toxic Waste Sites* (USACE 1994); ASTM D5521-05, *Standard Guide for Development of Ground-Water Monitoring Wells in Granular Aquifers* (ASTM 2005c); and Chapter 8 of the *Technical Guidance Manual for Hydrogeologic Investigations and Groundwater Monitoring* (Ohio EPA 2009).

5.4.2.3.10.1 Pump and Bailer Usage

Monitoring well development will be accomplished using one of the following non-dedicated devices: a bottom discharge/filling Teflon® or stainless steel bailer, a submersible pump, or a peristaltic pump. The use of bailers is most effective on shallow wells. During development operations utilizing a bailer, the bailer will be rapidly surged up and down within the screen section of the well to agitate and mobilize particulates around the well screen during removal of groundwater from the well. During development operations utilizing a pump, the pump will be alternately started and stopped during groundwater removal, thus allowing the well to equilibrate and creating a surging action. The pump will be used at a higher rate than water will be extracted during purging or sampling events. During development, water should be removed throughout the entire water column in the well by periodically raising and lowering the pump. In situations where a high percentage of fine material is suspended in the groundwater, a surge block may be used in coordination with the noted devices to mobilize particulates drawn into the granular filter pack. Under no circumstances should air or chemicals be forced downhole to aid in development.

5.4.2.3.10.2 Development Record

For each monitoring well developed during the AOC-specific investigations, a record will be prepared to include the following information:

- Project name and location;

- Well designation and location;

- Date(s) and time(s) of monitoring well installation;

- Date(s) and time(s) of monitoring well development;

- Static water level from top of well casing before and 24 hr after completion of well development with dates and times of measurements;

- Quantity of water lost during drilling, removed before well insertion, and added during granular filter placement;

- Quantity of standing water contained with the well and within the saturated annulus (assuming 30% porosity) before well development;

- Field readings of pH, conductivity, turbidity, and temperature measured before, during, and after completion of well development using an appropriate device and method in accordance with USEPA Procedure 600/4-79-020, *Methods for Chemical Analysis of Water and Wastes* (USEPA 1983) (see Section 5.4.3 of this FWFSP for a description of the instrument and procedure to be utilized for field measurements);

- Depth from the top of the well casing to the bottom of the well;

- Length of the well screen;

- Depth from the top of the well casing to the top of sediment inside the well, both before and after development, as measured directly at the time of development;

- Physical character of the removed water, including changes during development in clarity, color, particulates, and any noted odor;

- Type and size/capacity of the bailer or pump used for development;

- Description of the surge technique used during development;

- Height of the well casing above ground surface as measured directly at the time of development;

- Estimated recharge rate into the well at the time of development; and

- Quantity of water removed from the well during the development operation and the time for removal, present as both incremental and total values).

5.4.2.3.10.3 Development Criteria

Monitoring well development will be documented and will proceed until each of the following criteria is achieved:

- A turbidity reading of 5 nephelometric turbidity units (NTUs) or less is achieved using a turbidity meter, or the water is clear to the unaided eye as natural turbidity levels in groundwater may exceed 5 NTU.

- The sediment thickness remaining within the well is less than 3.0 cm (0.1 ft) or less than 1% of the well screen.

- A minimum removal of five times the standing water volume in the well (to include the well screen and casing plus saturated annulus, assuming 30% annular porosity) has been achieved.

  The well volume will be calculated as follows:

  Vt = Total Well Volume Vc = Riser Casing Volume Vf = Filter Pack Volume
  Vt = Vc + Vf
  Vc = (Height of water column) x (Volume of Casing per Foot)
  Vf = (((Saturated thickness of filter pack) x (Volume of Borehole per Foot)) x .3) – ((Saturated thickness of filter pack) x (Volume of casing per foot)))

- Indicator parameters have stabilized for three consecutive readings to within criteria defined by ASTM D6771-02, *Standard Practice for Low-Flow Purging and Sampling for Wells and Devices Used for Ground-Water Quality Investigations* (ASTM 2002) and Chapter 8 of the *Technical Guidance Manual for Hydrogeologic Investigations and Groundwater Monitoring* (Ohio EPA 2009).
    - ±0.2 for pH;
    - ±3% for conductivity;
    - ±0.5°C for temperature;
    - ±10% turbidity (when turbidity is greater than 5 NTU);
    - ±20 mV for oxidation reduction potential (ORP); and
    - ±10% or 0.2 mg/L (whichever is greater) for dissolved oxygen (DO).

- In addition to the "five times the standing water volume" criteria, five times the amount of any water unrecovered from the well during installation will also be removed. Under specific circumstances, such as bedrock coring in dry rock, potable water may be introduced to the formation.

During well development, the U.S. Army Project Manager will be contacted for guidance if well recharge is slow such that the required volume of water cannot be removed during 48 consecutive hr of development, if persistent water discoloration is observed after completion of the required volume removal, or if excessive sediment remains after completion of the required volume removal.

5.4.2.3.10.4 Development Water Sample

For each monitoring well developed at an AOC, a 500-cm^3 (1-pint) sample of the last water to be removed during development will be placed into a clear glass jar and labeled with the well number and date. Each sample will be individually agitated and immediately photographed close up with a 35-mm camera loaded with color print film or a digital camera using a back-lit setup to show water clarity. These photographs will be identified individually with project name, well number, and photograph date and will be provided to the U.S. Army Project Manager after development of all AOC wells. Thirty-five-mm camera photograph prints will be, minimally, 5 by 7 inches and digital photographs will be submitted in electronic format. The film negatives or data disks also will be provided to the U.S. Army Project Manager after receipt of the photograph prints. After the development water samples have been photographed, the samples will be disposed of in the same manner as the other water removed from the monitoring wells during the development operation. All well development water must be containerized, characterized, stored, and disposed of in accordance with Section 8.0 of the FWFSP. Well development activities should be completed at least 14 days before groundwater sampling, as discussed in Section 5.4.2.3.10.

5.4.2.3.10.5 Monitoring Well Washing

As part of each monitoring well development operation, the entire well cap and the interior of the well casing between the water table and the ground surface will be washed using water from the well. The purpose of this activity is to remove extraneous materials (e.g., grout, bentonite, sand) from the interior of the well. The monitoring well washing activity will be conducted during the overall development operation.

5.4.2.3.10.6 Well Survey

A topographic survey of the horizontal and vertical locations of newly installed groundwater monitoring wells at the AOCs will be conducted after completion of well installation. The topographic survey will be lead/conducted by an individual licensed in an appropriate classification within the state of Ohio for the specific work anticipated to be conducted. This license will be current and active throughout the term of performance during the project.

5.4.2.3.10.6.1 Horizontal Control

Each required survey element will be topographically surveyed to determine its map coordinates referenced to the Ohio State Plane (OSP) Coordinate System. The survey will be connected to the OSP by third-order, Class II control surveys in accordance with the *Standards and Specifications for Geodetic Control Networks* (Federal Geodetic Control Committee 1984). All elements surveyed will have an accuracy of at least 0.3 m (1.0 ft) within the chosen system. Specific projects may require greater accuracy. Locations of monitoring wells will be measured at the rim of the uncapped well casing (not the protective casing).

5.4.2.3.10.6.2 Vertical Control

Each required survey element will be topographically surveyed at the notched or marked point on the north side of the solid well casing (not the protective casing). The ground surface elevation (not the pad surface) adjacent to each well will also be measured. The location of the ground surface point surveyed will be marked using a driven hub with a nail and flagging affixed. The survey will be connected by third-order leveling to the National Geodetic Vertical Datum of 1929 in accordance with the *Standards and Specifications for Geodetic Control Networks* (Federal Geodetic Control Committee 1984). All elements surveyed will have an accuracy of at least 0.3 cm (0.01 ft). Specific projects may require greater accuracy.

5.4.2.3.10.6.3 Field Data

The topographic survey will be completed as near as possible to the time when the last monitoring well is installed at the AOC. Survey field data (as corrected), to include loop closures and other statistical data in accordance with the standards and specifications referenced above, will be provided to the U.S. Army Project Manager. Closure will be within the horizontal and vertical limits referenced above. The following data will be clearly listed in tabular form: coordinates (and system) and elevation (ground surface and top of well), as appropriate, for all boreholes, wells, and reference marks. All permanent and semi-permanent reference marks used for horizontal and vertical control (e.g., benchmarks, caps, plates, chiseled cuts, rail spikes) will be described in terms of their name, character, physical location, and reference value.

5.4.2.3.11 Alignment Testing

Alignment tests will be conducted on each monitoring well installed during the AOC-specific investigations. This testing will be conducted to ensure that deformation and/or bending of the PVC well casing and screen is minimal. The testing will be performed using a pump or bailer with a diameter no less than 2.5 cm (1.0 inch) smaller than the well casing and screen diameter. A nylon rope will be attached to the pump/bailer, and the unit will be lowered to the bottom of the well and retrieved. The alignment test will be considered successful if the pump/bailer can be lowered and retrieved without bridging within the well. If a monitoring well fails an alignment test as described, the well will be abandoned in accordance with Section 5.4.2.5 of this FWFSP.

5.4.2.4 Documentation

5.4.2.4.1 Logs and Well Installation Diagrams

5.4.2.4.1.1 Boring Logs

Each borehole log generated during the AOC-specific investigations will fully describe the subsurface environment and the procedures used to gain that description. All borehole data will be recorded in the field by the site geologist on Engineer Forms 5056-R and 5056A-R (Figures 5-8 and 5-9, respectively). Guidance on field logging of soil and rock may be found in ASTM D5434-09, *Standard Guide for Field Logging of Subsurface Explorations of Soil and Rock* (ASTM 2009a). Because of the large quantity of information routinely required on logs, a scale of 2.5 cm (1.0 inch) on the log equaling 0.3 m (1.0 ft) of borehole is recommended for borehole log preparation. Each original borehole log will be submitted to the U.S. Army Project Manager, along with the corresponding original well construction diagram, as soon as the field effort has been completed. Original borehole logs and well construction diagrams will be of sufficient legibility and contrast so as to provide comparable quality in reproduction and will be recorded directly in the field without transcribing from a field book or other document.

All borehole logs generated during the AOC-specific investigations will contain the following:

- Unique borehole/monitoring well number and location denoted on a sketch map as part of the log.

- Depths or heights recorded in feet and decimal fractions thereof (tenths of feet).

- Field estimates of soil classification (Unified Soil Classification System) in accordance with ASTM D2488-09a, *Standard Practice for Description and Identification of Soils (Visual Manual Procedure)* (ASTM 2009b) prepared in the field at the time of sampling by the site geologist.

- Full description of each soil sample collected, including the parameters noted in Table 5-2.

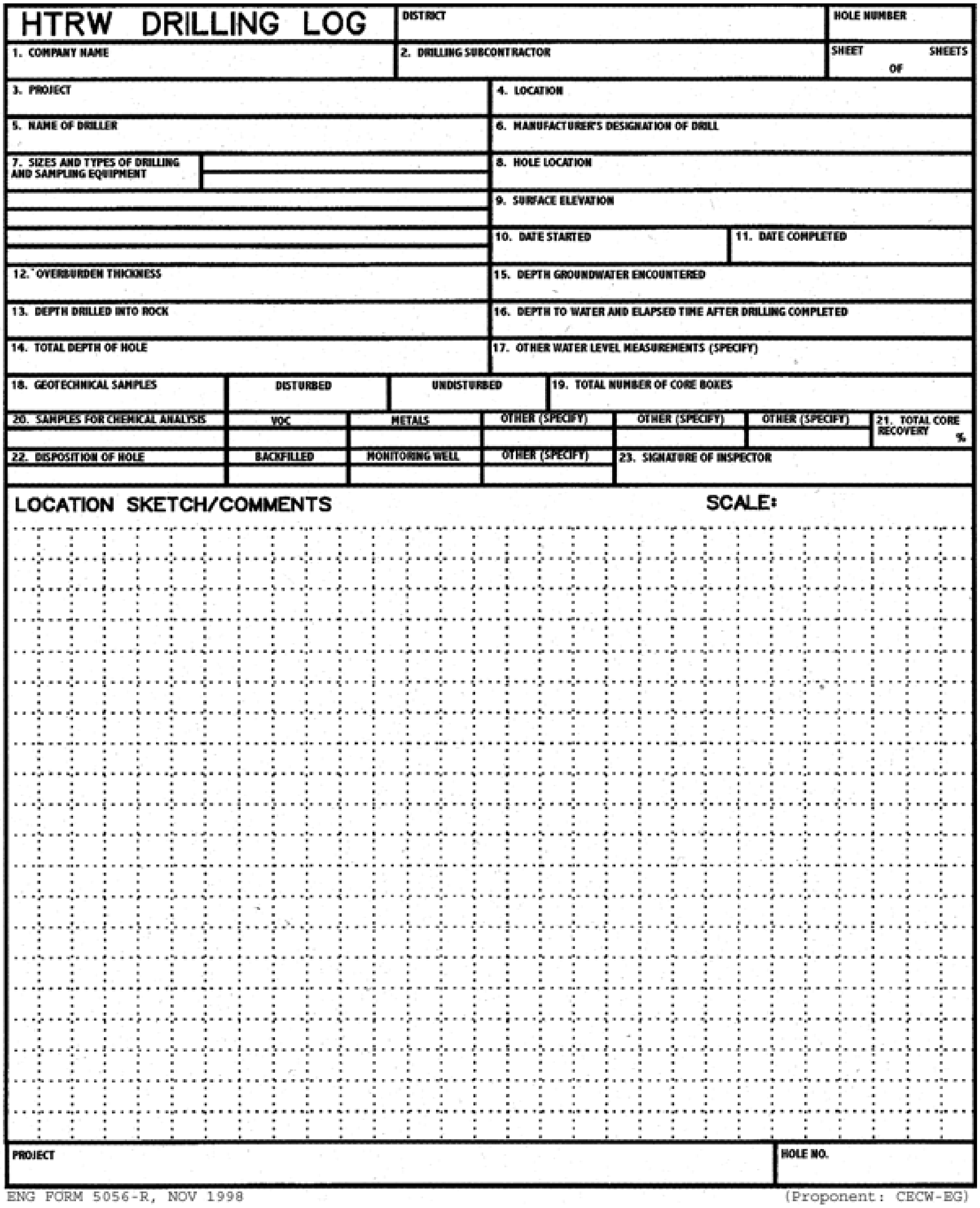
- Visual numeric estimates of secondary soil constituents and quantitative definitions of description terms (e.g., trace, little, some) recorded on the log.

- Full description, to the greatest extent practical, of bedrock material encountered, including the parameters noted in Table 5-2.

- Description of disturbed samples (if used to supplement subsurface description) in terms of the appropriate soil/rock parameter, to the extent practical. At a minimum, classification along with a description of drill action for the corresponding depth will be recorded. Notations will be made on the log that these descriptions are based on observations of disturbed material rather than intact samples.

- Visual numeric estimates of secondary soil constituents and quantitative definitions of description terms (e.g., trace, little, some) recorded on the log.

- Full description, to the greatest extent practical, of bedrock material encountered, including the parameters noted in Table 5-2.



HTRW DRILLING LOG

DISTRICT

HOLE NUMBER

1. COMPANY NAME

2. DRILLING SUBCONTRACTOR

SHEET OF SHEETS

3. PROJECT

4. LOCATION

5. NAME OF DRILLER

6. MANUFACTURER'S DESIGNATION OF DRILL

7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT

8. HOLE LOCATION

9. SURFACE ELEVATION

10. DATE STARTED

11. DATE COMPLETED

12. OVERBURDEN THICKNESS

15. DEPTH GROUNDWATER ENCOUNTERED

13. DEPTH DRILLED INTO ROCK

16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED

14. TOTAL DEPTH OF HOLE

17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)

18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES

20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OTHER (SPECIFY)	OTHER (SPECIFY)	OTHER (SPECIFY)	21. TOTAL CORE RECOVERY %

22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHER (SPECIFY)	23. SIGNATURE OF INSPECTOR

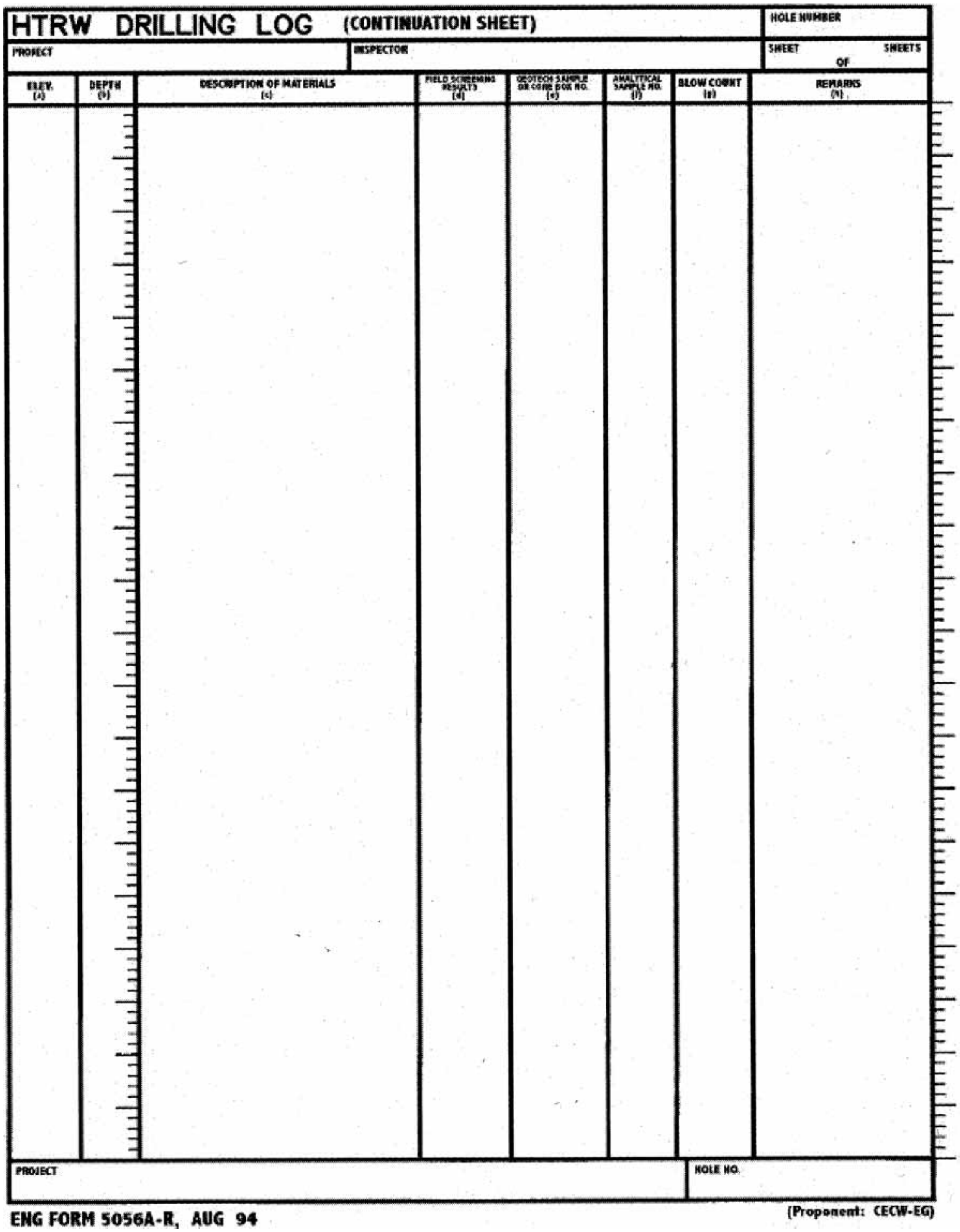
LOCATION SKETCH/COMMENTS **SCALE:**

PROJECT

HOLE NO.

ENG FORM 5056-R, NOV 1998 (Proponent: CECW-EG)

Figure 5-8. Engineer Form 5056-R for Borehole Logging



HTRW DRILLING LOG (CONTINUATION SHEET)

HOLE NUMBER

PROJECT

INSPECTOR

SHEET OF SHEETS

ELEV. (a)	DEPTH (b)	DESCRIPTION OF MATERIALS (c)	FIELD SCREENING RESULTS (d)	GEOTECH SAMPLE OR CORE BOX NO. (e)	ANALYTICAL SAMPLE NO. (f)	BLOW COUNT (g)	REMARKS (h)

PROJECT

HOLE NO.

ENG FORM 5056A-R, AUG 94

(Proponent: CECW-EG)

Figure 5-9. Engineer Form 5056A-R for Borehole Logging

Table 5-2. Soil and Rock Parameters to be Recorded on Borehole Logs

Soil Parameters	Rock Parameters
USCS classification	Rock type
Depositional environment and formation, if known	Formation
ASTM D 2488 group symbol	Modifier denoting variety (e.g., shaly, micaceous)
Secondary components and estimated percentages	Bedding/banding characteristics (e.g., cross bedded)
Color (using Munsell Soil or GSA Rock Color Chart). Give both the narrative and numerical description and note which chart was used	Color (same as for soil)
	Hardness
	Degree of cementation
Plasticity	Texture (e.g., dense, coarse grained, glassy, crystalline)
Consistency (cohesive soil, very soft, soft, medium stiff, stiff, very stiff, hard)	Structure of orientation (e.g., dipping, highly fractured)
Density (non-cohesive soil, loose, medium dense, dense, very dense)	Degree of weathering
Moisture content in relative terms: Dry – crumbly Damp – between crumbly and plastic limit Moist – between plastic limit and liquid limit Wet – greater than liquid limit Saturated – runny, all voids filled with water	Solution or void conditions
Structure and orientation	Primary and secondary permeability, include estimates and rationale
Grain angularity	Lost core interval and reason for loss

ASTM = American Society for Testing and Materials
GSA = Geological Society of America
USCS = Unified Soil Classification System

- Description of drilling equipment, including such information as auger size (inner and outer diameter), bit types, compressor type, rig manufacturer, and model.

- Sequence of drilling activities.

- Any special problems encountered during drilling and their resolution.

- Dates and times for the start and completion of the borehole along with notation by depth for drill crew shifts and individual days.

- Each sequential boundary between various soil types and individual lithologies.

- For a rock core, a scaled graphic sketch of the core should be provided on or with the log denoted by depth location, orientation, and nature (natural or coring-induced) of all core breaks. If fractures are too numerous to be individually shown, their location may be drawn as a zone and described on the log.

- Intervals of lost core.

- The depth of first encountered free water along with the method of determination and any subsequent distinct water level(s) encountered thereafter. Before proceeding, the first encountered water will be allowed to partially stabilize (from 5 to 10 min) and recorded along with the time between measurements.

- Interval by depth for each sample collected, including the length of sampled interval, length of sample recovery, blow counts, and the sampler type and size (diameter and length).

- Total depth of drilling and sampling.

- Results of soil core organic vapor scan readings and soil sample organic vapor headspace readings (Section 5.5.2.3). Notation will include interval sampled, corresponding vapor readings, and key to the specific instrument used to obtain readings. A general note will be made on the log indicating the manufacturer, model, serial number, and calibration information for each instrument used.

- Definition of any special abbreviations used at the first occurrence of their usage.

In addition to the original borehole logs prepared for each AOC-specific investigation, the contractor will also create an electronic geological database. Information will be entered into this database in accordance with USACE, Louisville District's Data Standards for Environmental Restoration Sites (Appendix A). Information required to complete the database not recorded on original borehole logs will be recorded in the project logbook. The geological database will be submitted to the U.S. Army Project Manager in ASCII format.

5.4.2.4.1.2 Well Construction Diagrams

Each monitoring well installed during the AOC-specific investigations will be depicted in an as-built well construction diagram (Figure 5-10). Each diagram will be attached to the original borehole log for that installation and will graphically denote, by depth from the ground surface, the following information:

- Location of the borehole bottom and borehole diameter(s);
- Location of sump;
- Location of the well screen;
- Location of any joints;
- Location of the granular filter pack;
- Location of the bentonite seal;
- Location of grout;
- Location of centralizers;
- Height of riser (stickup), without cap/plug, above the ground surface;

- Height and width of the protective casing, without cap/cover, above the ground surface;
- Depth of protective casing base below the ground surface;
- Location and size of the drainage port;
- Location of the internal mortar collar;
- Sloped concrete pad height and diameter;
- Protective post configuration; and
- Water level 24 hr after completion of installation with date and time of measurement.

Additional information described on each as-built well construction diagram includes the following:

- Actual quantity and composition of the grout, bentonite seal, and granular filter pack used for monitoring well construction;

- The screen slot size in inches, slot configuration, total open area per foot of screen, outside diameter, nominal inside diameter, schedule/thickness, composition, and manufacturer;

- Type of material located between the bottom of the borehole and the bottom of the screen;

- The outside diameter, nominal inside diameter, schedule/thickness, composition, and manufacturer of the well casing;

- The joint design and composition;

- The design and composition and centralizers;

- Depth and description of any permanent pump or sampling device installed within the monitoring well;

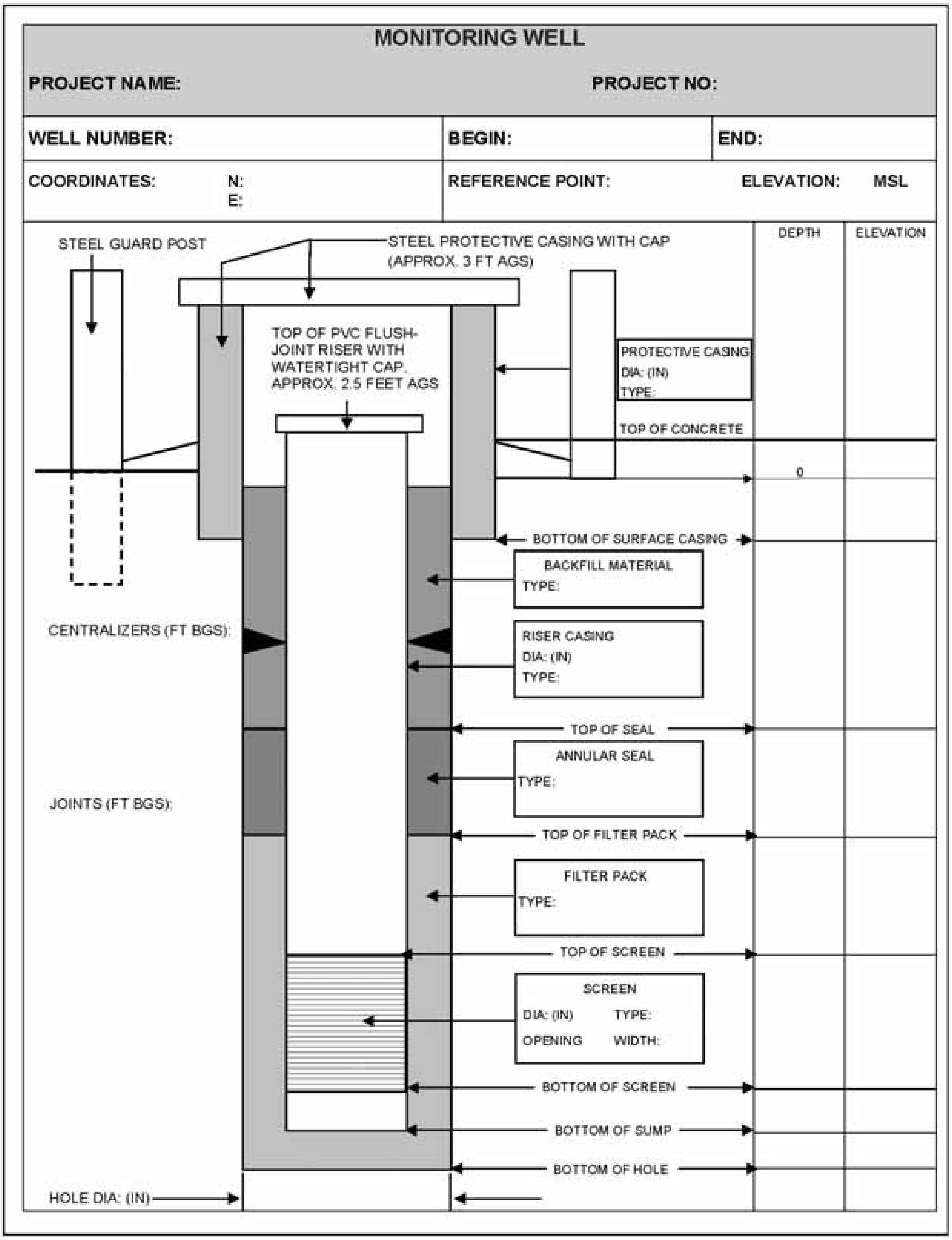
- The composition and nominal inside diameter of protective casing;

- Any special problems encountered during well construction and their resolution;

- Dates and times for the start and completion of monitoring well installation; and

- Definition of any special abbreviations used at the first occurrence of their usage.

Each original well construction diagram will be submitted to the U.S. Army Project Manager as soon as the field effort is completed. Each diagram will be attached to the corresponding original borehole log for that location. In addition to the original well construction diagrams, the Contractor will enter well information into the electronic geological database in accordance with USACE, Louisville District's Data Standards for Environmental Restoration Sites (Appendix A). Information required to complete the database not recorded on original well construction diagrams will be recorded in the project logbook.



MONITORING WELL

PROJECT NAME:		**PROJECT NO:**
WELL NUMBER:	**BEGIN:**	**END:**
COORDINATES: N: E:	**REFERENCE POINT:**	**ELEVATION:** MSL

Recorded by:______________________________ QA performed by:______________________________

Figure 5-10. Example of Well Construction Diagram Used in Logbooks

5.4.2.4.2 Photographs

For each photograph taken during the AOC-specific investigations, the following items will be noted in the field logbook:

- Date and time;
- Photographer (name and signature);
- Name of the AOC;
- General direction faced and description of the subject taken; and
- Sequential number of the photograph and the roll number.

While not required, it is recommended that all sampling points be documented via photographs. These photographs will include two or more permanent reference points to facilitate relocating the point at a later date. In addition to the information recorded in the field logbook, one or more site photograph reference maps will be prepared as required. An example of this map type is presented in Figure 5-11.

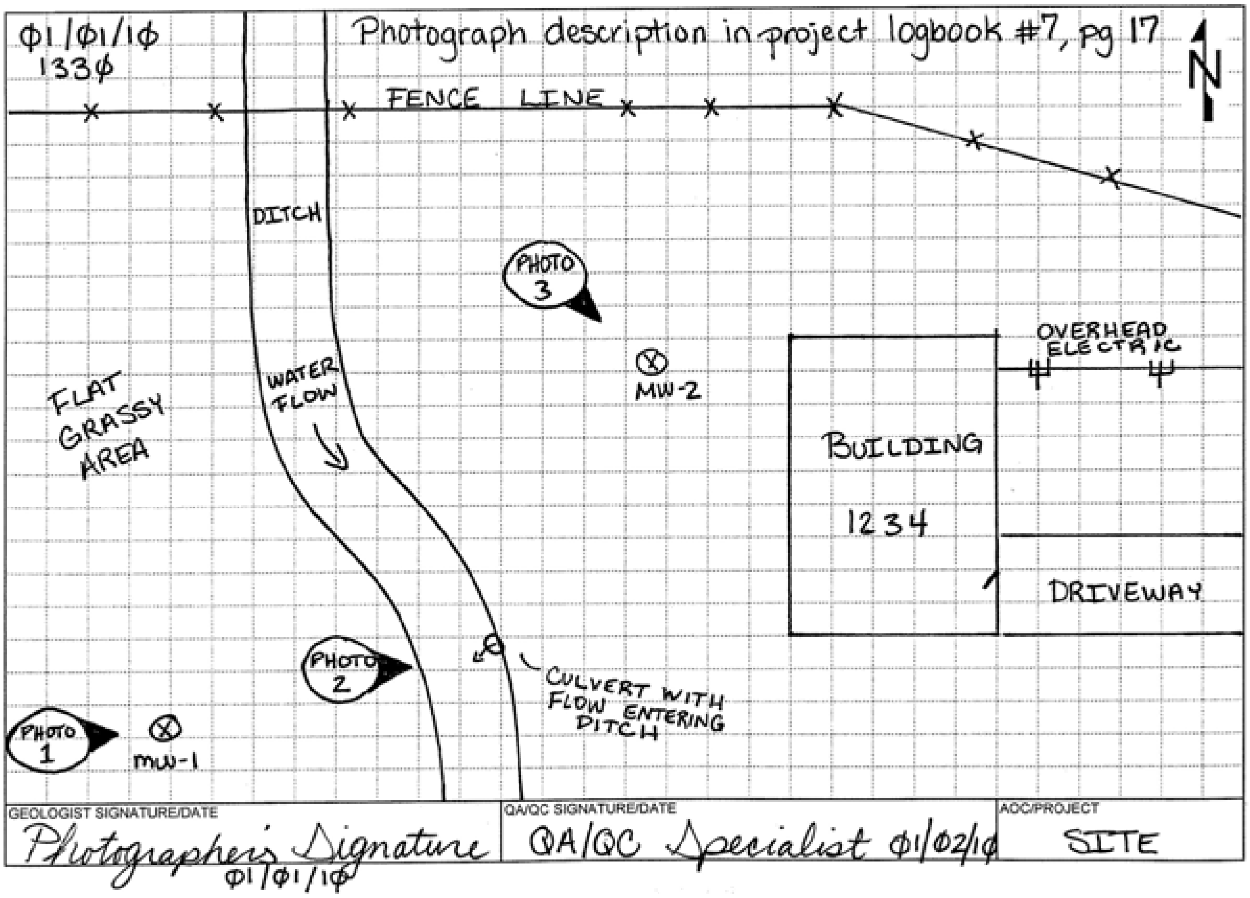


Figure 5-11. Example of Photograph Map to be Recorded in Field Logbooks

5.4.2.5 Well and Borehole Abandonment

Abandonment, also termed decommissioning, of monitoring wells and soil boreholes during the AOC-specific investigations will be conducted in a manner precluding any current or subsequent fluid media from entering or migrating within the subsurface environment along the axis or from the endpoint of the well/borehole. The chosen sealing material should not react with contaminants, groundwater, or geologic materials; have a hydraulic conductivity comparable to or lower than the in-situ material; and form a tight bond with the borehole and well casing, be resistant to cracking and shrinking, be of sufficient structural strength to withstand subsurface pressures, and be capable of being placed at the appropriate depth. Abandonment at RVAAP will be accomplished by filling the entire volume of the well/borehole with grout composed of Type I Portland cement, 6 lb dry bentonite per 42.6-kg (94-lb) sack of dry cement, and a maximum of 0.02 to 0.03 m^3 (6 to 7 gal) of approved water per sack of cement. If a different method is recommended for monitoring well abandonment, it will be outlined and supported in the project's SAP addenda.

The abandonment of each well/borehole will follow field procedures outlined in Chapter 9 of the *Technical Guidance Manual for Hydrogeologic Investigations and Groundwater Monitoring* (Ohio EPA 2009). Well abandonment consists of removing the casing and screen, overdrilling the well borehole with a drilling bit at least 1.5 times greater than the original diameter of the borehole, and grouting to the surface. A tremie pipe will be placed to the bottom of the borehole and will be used to fill the borehole from the bottom up as the drilling stem is removed. The grout must extend from the bottom of the borehole to at least 3 ft bgs. The top 3 ft (above the frost line) can be filled with bentonite and topped with appropriate non-contaminated topsoil or gravel.

Ohio Revised Code 1521.05(B)(9) requires that a well sealing report be filed with Ohio Department of Natural Resources (Figure 5-12). For each abandoned well/borehole, a record containing the following information will be prepared and submitted to the U.S. Army Project Manager:

- Project and well/borehole designation and location coordinates;

- Location with respect to the replacement well or borehole (if any);

- Open depth of well/borehole before grouting;

- Screen material, length, and total depth;

- Casing or items left in borehole by depth, description, composition, and size (if applicable);

- Copy of the borehole log;

- Copy of the construction diagram for the abandoned well (if applicable);

- Reason for abandonment;

- Description and total quantity of grout used initially;

- Description of the grout composition and mixing method;

- Description and daily quantities (volumes) of grout used to compensate for settlement;

- Dates of grouting;

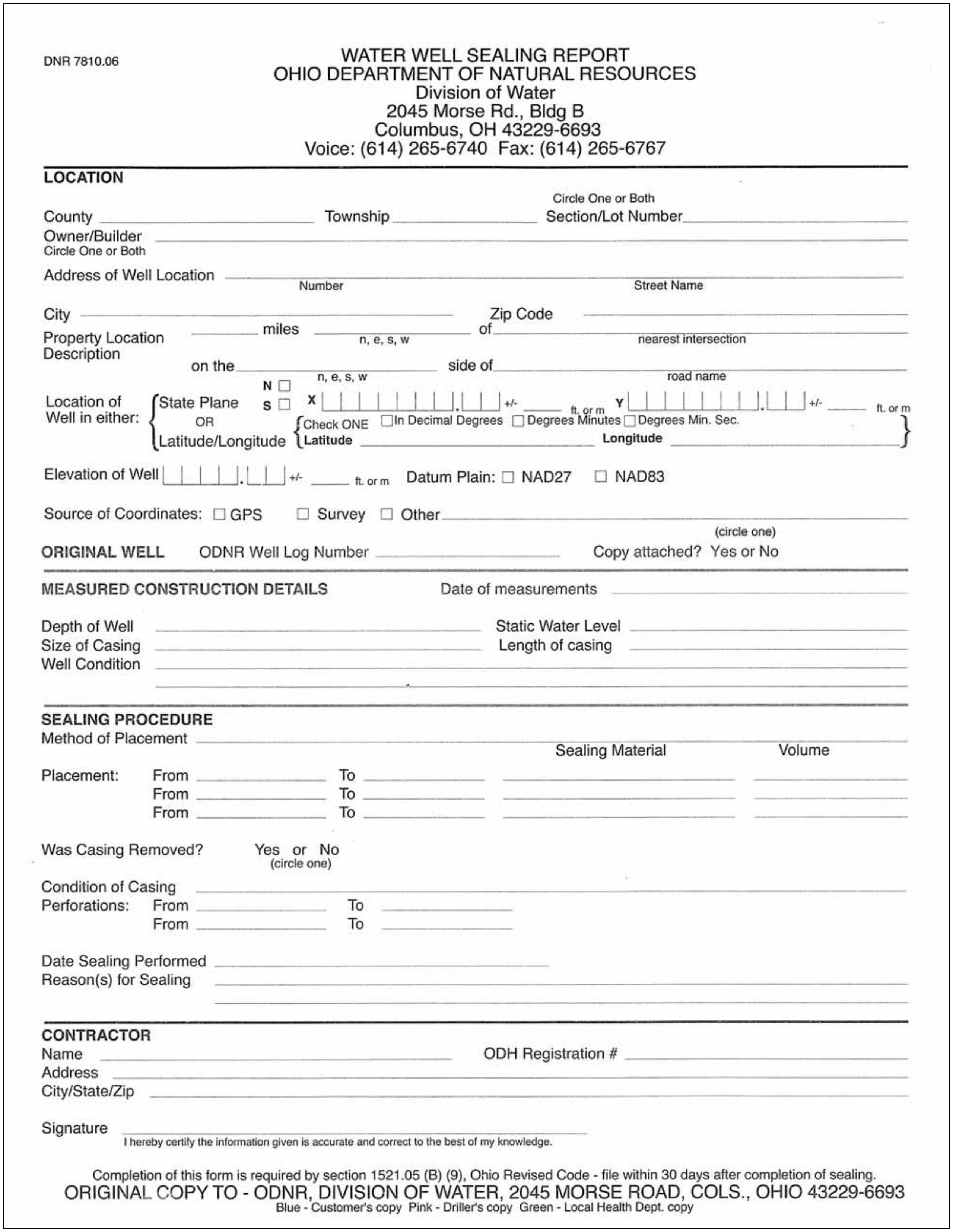
- Disposition of materials removed/displaced (e.g. materials, soil, groundwater);

- Types and concentrations of contaminants present, if any;

- Water or mud level prior to grouting and date measured; and

- Remaining casing above ground surface: type (e.g., well, drill, or protective), height above ground, size, and composition of each (if applicable).

All depths reported in the borehole abandonment record will be designated in feet from ground surface. Original borehole abandonment records will be submitted to the U.S. Army Project Manager. Any replacement wells/boreholes installed during the AOC-specific investigations will be offset at least 6.0 m (20.0 ft) from any abandoned AOC in a presumed up- or cross-gradient groundwater direction.



DNR 7810.06

WATER WELL SEALING REPORT
OHIO DEPARTMENT OF NATURAL RESOURCES
Division of Water
2045 Morse Rd., Bldg B
Columbus, OH 43229-6693
Voice: (614) 265-6740 Fax: (614) 265-6767

LOCATION

County ______ Township ______ Section/Lot Number ______ (Circle One or Both)

Owner/Builder ______ (Circle One or Both)

Address of Well Location ______ Number ______ Street Name

City ______ Zip Code ______

Property Location Description ______ miles ______ n, e, s, w of ______ nearest intersection

on the ______ n, e, s, w side of ______ road name

Location of Well in either: State Plane N ☐ S ☐ X |_|_|_|_|_|_|_|_|.|_|_| +/- ______ ft. or m Y |_|_|_|_|_|_|_|_|.|_|_| +/- ______ ft. or m

OR

Latitude/Longitude: Check ONE ☐ In Decimal Degrees ☐ Degrees Minutes ☐ Degrees Min. Sec.

Latitude ______ Longitude ______

Elevation of Well |_|_|_|_|.|_|_| +/- ______ ft. or m Datum Plain: ☐ NAD27 ☐ NAD83

Source of Coordinates: ☐ GPS ☐ Survey ☐ Other ______

ORIGINAL WELL ODNR Well Log Number ______ Copy attached? Yes or No (circle one)

MEASURED CONSTRUCTION DETAILS Date of measurements ______

Depth of Well ______ Static Water Level ______

Size of Casing ______ Length of casing ______

Well Condition ______

SEALING PROCEDURE

Method of Placement ______

				Sealing Material	Volume
Placement:	From ______	To ______		______	______
	From ______	To ______		______	______
	From ______	To ______		______	______

Was Casing Removed? Yes or No (circle one)

Condition of Casing ______

Perforations: From ______ To ______

From ______ To ______

Date Sealing Performed ______

Reason(s) for Sealing ______

CONTRACTOR

Name ______ ODH Registration # ______

Address ______

City/State/Zip ______

Signature ______

I hereby certify the information given is accurate and correct to the best of my knowledge.

Completion of this form is required by section 1521.05 (B) (9), Ohio Revised Code - file within 30 days after completion of sealing.

ORIGINAL COPY TO - ODNR, DIVISION OF WATER, 2045 MORSE ROAD, COLS., OHIO 43229-6693

Blue - Customer's copy Pink - Driller's copy Green - Local Health Dept. copy

Figure 5-12. ODNR Well Sealing Report

5.4.3 Field Measurement Procedures and Criteria

Groundwater field measurements performed during the AOC-specific investigations will include the static water level, pH, conductivity, DO concentration, and temperature, at a minimum. Table 5-3 describes the field instrument and associated calibration requirements and performance checks to be used for field measurements. All field instruments should be properly decontaminated as appropriate. A summary of the procedures and criteria to be used for field measurements is presented below.

Table 5-3. Summary of Field Instruments and Calibration/Performance Requirements for RVAAP AOC-Specific Investigations

Instrument and Use	Calibration	Performance
Water level meter used to determine static water level	Calibrated by manufacturer	±0.01 ft
Water quality instrument used to determine groundwater pH	Two points using pH 4.0 and 7.0 standard solutions on a daily basis	±0.1 units
Water quality instrument used to determine groundwater conductivity	One point using 0.01 m KCl or equivalent standard solution on a daily basis. Standard solutions should be close to the range of groundwater sampled	±0.1 µmhos/cm
Water quality instrument used to determine groundwater turbidity	One point using a 0.0 NTU or equivalent standard solution on a daily basis	0.1 NTU
Water quality instrument used to determine dissolved oxygen	One point using standard solution or manufacturer's DO chart	10%
Thermometer used to determine groundwater temperature	Calibration by manufacturer	±1°C
Photoionization detector used to determine organic vapor concentrations emitted from subsurface material	One point using 100-ppm isobutylene calibration gas on a daily basis	±0.1 ppm

AOC = Area of concern. KCl = Potassium chloride (solution). ppm = Parts per million.
RVAAP = Ravenna Army Ammunition Plant.

5.4.3.1 Static Water Level

Static water level measurements will be made using an electronic water level indicator prior to well purging. Initially, the indicator probe will be lowered into each monitoring well, without touching the probe to the well casing, until the alarm sounds and/or the indicator light illuminates. The probe will then be withdrawn several feet and slowly lowered again until the groundwater surface is contacted as noted by the alarm and/or indicator light. All probe cords used for measurement will be incrementally marked at 0.003-m (0.01-ft) intervals. Water level measurements will be estimated to the nearest 0.003 m (0.01 ft) based on the difference between the nearest probe cord mark and the top of the well casing.

The distance between the top of casing and the groundwater surface will be recorded to within 0.3 cm (0.01 ft). The static water level measurement procedure will be repeated two or three times to ensure that the water level measurements are consistent (± 0.3 cm or 0.01 ft). If this is the case, then the first measured level will be recorded as the depth to groundwater. If this is not the case, the procedure will be repeated until consistent readings are obtained from three consecutive measurements.

5.4.3.2 pH, Conductivity, Dissolved Oxygen, and Temperature

pH, conductivity, DO, and temperature measurements will be made using a combination meter designed to measure these parameters. A groundwater sample will be retrieved from each monitoring well and immediately poured into a clean container placed onto a stable surface at the well. The sample also may be continuously filtered through a flow cell. With the combination meter set in the appropriate mode, the meter electrode will be swirled at a slow constant rate within the sample until the meter reading reaches equilibrium.

Sample pH will be recorded to the nearest 0.1 pH unit. All recorded conductivity values will be converted to conductance at 25ºC. Sample conductivity will be recorded to the nearest 10 μmhos/cm and the temperature to the nearest 0.1ºC. Stabilization criteria will follow the *Technical Guidance Manual for Hydrogeologic Investigations and Groundwater Monitoring* (Ohio EPA 2009) recommendations. Effective 2006, the measurements are considered stable when three consecutive readings produce less than 0.1 pH units variation, less than 3% variation for conductance, and less than 0.5ºC variation for temperature. DO content will be recorded to the nearest 0.01 mg/L. DO readings will be considered stable when three consecutive readings produce less than 0.3 mg/L variance (Ohio EPA 2009). Subsequent revisions to the *Technical Guidance Manual for Hydrogeologic Investigations and Groundwater Monitoring* (Ohio EPA 2009), Chapter 10 recommendations will be used in lieu of 2006 information published in this FWFSP.

5.4.3.3 Air Quality Instruments

Air quality meters, including but not limited to photoionization detectors (PIDs) and multi-gas meters, will be used during subsurface drilling activities to ensure the health and safety of on-site personnel. All air quality meters will be calibrated according to manufacturers' specifications daily. Equipment calibration forms and information is detailed in Section 6.0. Use of air quality meters is further detailed in the FWSHP.

5.4.4 Sampling Methods For Groundwater – General

The *Monitoring Well Design, Installation, and Documentation at Hazardous and/or Toxic Waste Sites* (USACE 1994) recommends that well development be completed at least 14 days prior to sampling. This hiatus theoretically allows time for the chemical equilibrium between the aquifer and the filter pack to be established. However, this rule of thumb is unsubstantiated by scientific data. If a different duration is proposed, based on technical data or overall project considerations, it should be used as deemed appropriate and such proposal should be included in the investigation-specific addendum to this FWFSP.

Groundwater sample collection from monitoring wells during the AOC-specific investigations will involve three general steps: (1) measuring field parameters, (2) well purging, and (3) collecting the samples. All of the activities would normally be accomplished within a 2- to 4-hr period per monitoring well. Procedures and criteria for the measurement of field parameters were previously discussed in Section 5.4.3 of this FWFSP. Purging and sampling of monitoring wells will be accomplished using either a Teflon® or stainless steel bailer or a bladder pump. Further guidance on well purging is provided in Appendix C of the *Requirements for the Preparation of Sampling and Analysis Plans* (USACE 2001b). If an existing monitoring well must be sampled, the integrity of the well will be checked prior to purging. Alignment testing also is recommended to ensure that the well has not been obstructed or otherwise damaged since the previous sampling event. The integrity of the well will be checked by visual inspection of the surface casing and riser pipe and by performing an alignment test in accordance with Section 5.4.2.3.11 of this FWFSP. If a monitoring well is questionable, the well will not be purged and sampled. If required, a new well will be installed as directed by the U.S. Army Project Manager.

5.4.4.1 Conventional Well Purging

After initial measurement of field parameters, including measurement of the water level, purging of each monitoring well will commence until pH, conductivity, DO, and temperature have reached equilibrium, as specified in Section 5.4.3.2. Equilibrium will be established by three consecutive readings, where one well casing volume is purged between each reading following the initial measurement consisting of the first flush of groundwater. A well casing volume for conventional well purging is defined as the total of the well casing plus the saturated filter pack annulus assuming a porosity of 30%. A discussion on calculating well volumes is presented in Section 5.4.2.3.10.3. However, purging will be terminated before establishment of equilibrium if one of the following conditions is met: (1) five well volumes, including the saturated filter pack assuming a porosity of 30%, have been removed from the well; or (2) the well is purged to dryness. Each bailer used for purging/sampling will be equipped with a nylon retrieval cord that will be properly discarded upon completion of the purging and sampling activities.

Monitoring well sampling will begin immediately after purging. When a bailer is used, the device will be lowered slowly until it contacts the groundwater surface, allowed to sink to the bottom of the monitoring well and fill with a minimum of surface disturbance, and raised slowly to the surface. The sample then will be transferred to the appropriate sample bottles by tipping the bailer so that a slow discharge of sample flows gently from the top of the bailer down the side of the sample bottle with minimum entry disturbance. Bottles designated for volatile organic analysis will be filled first and in a manner so that no headspace remains. Immediately after each sample is collected and the bottles are labeled, each sample container will be placed into a sealable plastic bag and placed in an ice-filled cooler to ensure preservation.

If a monitoring well is purged to dryness, sampling will be delayed for a time period of a minimum of 1 hr and up to 24 hr to allow for recharge. During the delay period, the atmosphere of the well will be isolated to the greatest extent possible from the surface atmosphere. Upon sufficient recharge of groundwater into the well (i.e., if the well recharges to 90% of its initial water level within 1 hr), a sample will be collected without additional well purging. If sufficient well recharge does not occur within 24 hr after the initial purging, the U.S. Army Project Manager will be contacted for guidance.

5.4.4.2 Micro-Purging

To collect a representative sample of current groundwater conditions and minimize the quantity of liquid IDW generated as a result of well purging, wells will be micro-purged where conditions permit, in accordance with the ASTM D6771-02, *Standard Practice for Low-Flow Purging and Sampling for Wells and Devices Used for Ground-Water Quality Investigations* (ASTM 2002) and the *Technical Guidance Manual for Hydrogeologic Investigations and Groundwater Monitoring* (Ohio EPA 2009), Chapter 10, as follows:

- A decontaminated or dedicated bladder or submersible pump attached to dedicated Teflon® tubing will be used for purging;

- The intake depth and stabilized extraction rates should be duplicated as closely as possible for subsequent sampling events;

- The purge rate will not exceed 100 mL/min unless it can be shown that higher rates will not disturb the stagnant water column above the well screen (i.e., will not result in drawdown greater than 0.3 ft) with a maximum flow rate of 500 mL/min;

- The volume purged will be either two pump and tubing volumes or a volume established in AOC-specific addenda, a minimum of 30 minutes, and stabilization of water quality parameters as outlined in Section 5.4.3.2; and

- Sample collection shall occur immediately after micro-purging.

If micro-purging cannot be accomplished for any reason, purging will be conducted in accordance with the procedures for conventional purging described above.

When a bladder pump is used, the device will be lowered slowly until it contacts the groundwater surface, and then will continue to be lowered until the pump intake is located at the midpoint of the monitoring well screen. All bladder pumps will be driven by compressed air or nitrogen. The pump then will be activated and allowed to operate until a steady flow of groundwater is expelled from the Teflon® return line at the ground surface. The pump rate is established once drawdown has been stabilized. Purging will continue until drawdown is stabilized, a minimum of two pump and tubing volumes have been withdrawn, 30 minutes of purging have occurred, and water quality parameters have stabilized for three consecutive readings per specifications in Section 5.4.3.2. Water quality parameters will be recorded commencing with the first flush of water through completion of sample collection. Each bladder pump used for purging/sampling will be equipped with a Teflon®-coated or nylon retrieval line that will be decontaminated or discarded upon completion of purging and sampling activities. Teflon® tubing used at each monitoring well will be stored in the well casing between sampling events.

Sampling of the monitoring well will begin immediately after purging. The pump should remain on between purging and sample collection, including filtration of samples. The discharge line will not be allowed to touch any part of the interior of the sample container or the sample matrix within the container. The sample will be collected and preserved in the same manner as described in Section 5.4.5. Details regarding the general groundwater sampling methods to be used for investigations will be presented in the investigation-specific addenda to this FWFSP. Following completion of groundwater sampling a final set of groundwater quality parameters will be collected and recorded.

5.4.4.3 Minimum/No Purge Sampling

Monitoring wells that have a tendency to go dry when utilizing low-flow or conventional purge techniques are best suited for minimum or no purge sampling. Minimum/no purge sampling should be conducted only when volumetric or low-flow sampling is not feasible. With minimum/no purge sampling, indicator parameters are not monitored. However, an initial and final set of indicator measurements will be collected for regulatory requirements and evaluation of general groundwater quality. A sample will be obtained from within the well screen, and the smallest volume of water will be purged prior to sample collection, generally the volume of the tubing. Drawdown should be measured during sampling to ensure that the water above the screened interval is not collected for analytical sample. The amount of drawdown should be no more than the distance from the top of the screen and the position of the pump intake minus 2 ft. In accordance with guidance presented in ASTM Standard D4448, a bladder pump, or low-flow submersible pump, is recommended for collecting minimum/no purge samples. Minimum/no purge sampling will be outlined in investigation-specific addenda and approved by the U.S. Army and Ohio EPA prior to use. Further guidance is provided in the *Technical Guidance Manual for Hydrogeologic Investigations and Groundwater Monitoring* (Ohio EPA 2009), Chapter 10.

5.4.5 Sample Containers and Preservation Techniques

Information regarding sample containers and preservation techniques for groundwater samples collected for chemical analyses during the AOC-specific investigations is presented in Section 5.0 of the FWQAPP. All sample containers will be provided by contracted laboratories, who will place into the containers or provide separately, the required types and quantities of chemical preservatives. All groundwater sample containers will be stored at 4°C (±2°C) immediately after sample collection and will be maintained at this temperature until the samples are received at the contracted laboratory. Generally, groundwater samples are discrete grab samples representative of a specific location at a given point in time. Sample parameters will be collected in the following order unless further defined by investigation-specific addenda:

1. Volatile Organic Compounds(VOCs);
2. Purgeable organic carbon;
3. Total organic carbon;
4. Semi-volatile organic compounds (SVOCs);

5. PCBs;
6. Pesticides;
7. Explosives;
8. Propellants;
9. Total metals;
10. Dissolved metals;
11. Perchlorate;
12. Phenols;
13. Cyanide;
14. Sulfate, sulfide, and chloride;
15. Turbidity; and
16. Nitrate, nitrite, and ammonia.

A full suite sample is defined as collection of VOCs, SVOCs, PCBs, Pesticides, Explosives, Propellants (nitroglycerine, nitroguanidine and nitrocellulose), and target analyte list (TAL) metals (including mercury) collected for chemical analysis.

5.4.6 Sampling Methods for Groundwater – Filtration

The method used to collect filtered groundwater samples from monitoring wells will depend on whether a bailer or bladder pump is used for the sample collection. Regardless of which of the two sampling devices is used, the measurement of field parameters and purging of the well will be conducted in the same manner as described in Section 5.4.4 of this FWFSP.

When a bailer is used for groundwater sampling, the device will be lowered into the monitoring well, filled with groundwater, and raised to the surface. The collected sample then will be slowly poured into a decontaminated holding vessel. The groundwater sample will be filtered using a hand-operated pump equipped with Teflon® intake and discharge tubing. A disposable, pre-sterilized 0.45-µm pore size filter assembly will be attached to the end of the Teflon® discharge tubing. The Teflon® intake tubing will be placed into the holding vessel and the groundwater sample will be pumped through the tubing and disposable filter. The filter will be rinsed with approximately 100 mL of native groundwater. Care should be taken to purge all air from the filter prior to sampling. For perchlorate sampling, an additional 0.2-µm pore size filter assembly will be attached to the end of the 0.45-µm pore size filter. After the filter is rinsed, sample bottles will be filled with discharge exiting the disposable filter. Filters will be replaced as they become restricted by solids buildup and between sample collection sites. Immediately after samples are collected and bottles are labeled, each sample container will be placed into a sealable plastic bag and then placed in an ice-filled cooler to ensure preservation.

When a bladder pump is used for groundwater sampling, a disposable, pre-sterilized 0.45-µm pore size filter will be attached to the end of the pump's Teflon® return line. Groundwater then will be pumped through the tubing and disposable filter. The filter will be rinsed with native groundwater for a minimum of four cycles in one minute or approximately 100mL. During this flushing operation, the pumping rate will be adjusted as necessary to minimize turbulence. Care should be given to purge all air from the filter prior to sampling. After the system is flushed, sample bottles will be filled with discharge exiting the disposable filter. For perchlorate sampling, an additional 0.2-µm pore size filter assembly will be attached to the end of the 0.45-µm pore size filter. The sample bottles will be packaged and preserved in the same manner as described above. The disposable filters used to collect filtered groundwater samples will be discarded after each use.

5.4.7 Field Quality Control Sampling Procedures

Generally, up to six different types of QA/QC samples will be collected during performance of the AOC-specific investigation groundwater sampling activities: duplicates, MS/MSDs, equipment rinsate blanks, trip blanks, source blanks, and field blanks. QC samples collected will be sent to the contracted laboratory to provide data for use in determining the quality of the analytical results reported for the associated environmental samples. QA samples collected will be sent to an U.S. Army QA laboratory for independent analysis and evaluation of analytical results reported by the contracted laboratory.

A duplicate sample is collected along with a field sample at the same sampling location and is placed into a separate container labeled with a unique sample number. The duplicate is submitted as “blind” to the laboratory and is used to determine whether the field sampling technique is reproducible and to check the accuracy of reported laboratory results. Duplicate groundwater samples will be collected during the AOC-specific investigations using the same procedures defined for field groundwater samples as discussed in Sections 5.4.4 and 5.4.5. Locations used for QA samples may be chosen based on criteria including but not limited to unexpected detection or concentration of certain constituents in the past. Information regarding the total number, collection frequency, and analytical parameters for duplicate samples will be defined in the investigation-specific addenda to this FWFSP. However, the number of duplicate samples will typically represent 10% of the total number of field samples collected for each AOC-specific investigation.

An MS is an aliquot of a sample spiked with known quantities of specified target analytes and subjected to the entire analytical procedure. It is used to measure method accuracy and to indicate matrix effects. An MSD is a second aliquot of the sample spiked with known quantities of the same compounds. The purpose of the MSD, when compared with the MS, is to determine the precision for the method, field procedures, and matrix. If required, extra volume of sample is collected along with the field sample at the sampling location. In instances where the primary sample contains enough volume to perform MS/MSD analysis, no extra volume is required. The number of MS/MSDs will typically represent 5% of the total number of field samples, as discussed in Section 9.0 of the FWQAPP. Investigation-specific addenda will specify differences to the QA/QC sampling plan.

An equipment rinsate blank is collected in the field from the final decontamination water rinse of field sampling equipment. The equipment rinsate blank is used to determine the effectiveness of the decontamination process in avoiding carryover contamination from one sampling location to the next. An equipment rinsate blank will be collected from the device used to collect groundwater samples from monitoring wells after it has undergone decontamination. Equipment rinsate blanks should include contact with all parts of the sampling equipment. Disposable equipment including bailers and Teflon® pump tubing may be sampled prior to use to ensure the sterile quality of the prepackaged sampling equipment without decontamination as this equipment is prepackaged and disposed after a single use. Upon completion of the decontamination procedure, ASTM Type I or equivalent water will be poured over and through the device and collected directly into appropriate sample containers. Information regarding the total number, collection frequency, and analytical parameters for equipment rinsate blanks will be defined in the investigation-specific addenda to this FWFSP. Typically, equipment rinsate blanks are collected at a frequency of 10% or one per event per matrix. Equipment rinsate frequencies will be defined in investigation-specific addenda to this FWFSP. When dedicated sampling equipment is used, equipment rinsate blanks are not required. Investigation-specific addenda to the FWQAPP will list any equipment rinsates to be collected.

A trip blank consists of a sealed container of ASTM Type I or equivalent water that originates at the laboratory, travels to the field with the sample containers, and back from the field to the laboratory with aqueous field samples for VOC analysis. The trip blank receives the same treatment as the field sample containers and is used to identify contamination that may occur to the field samples during transport. Trip blanks will be prepared by the contracted laboratory and shipped with sample bottles to be used for collection of field, duplicate, and rinsate samples. Therefore, no sampling procedures are applicable to these blanks. Trip blanks will be included in each sample cooler containing aqueous samples for VOC analysis.. Information regarding the total number and analytical parameters for trip blanks will be defined in the investigation-specific addenda to the FWQAPP. Typically, one trip blank is collected per day per matrix when VOCs are analyzed (the investigation-specific addenda will specify exceptions).

In addition, source blanks collected from potable water sources used in the decontamination and field investigation process are analyzed for the parameters of interest. Source blank samples are analyzed to determine the potential for contamination in source water used during field activities such as in grout mixtures or to hydrate a boring. Field blanks are collected by pouring analyte-free, deionized water into appropriate containers at designated sample locations. Field blank samples are analyzed to determine the potential for contamination of a sample due to contaminant sources (e.g. airborne dust, exhaust fumes) unrelated to the specific sources being investigated. Field blanks will be collected only if these types of contaminant sources are expected to be present in the field. All field QC samples will be collected as required by investigation-specific addenda depending on the anticipated field conditions, intended use of the data, and the contaminant types under investigation.

5.4.8 Decontamination Procedures

Non-dedicated equipment used to measure static water levels, develop and purge monitoring wells, and collect groundwater samples during the AOC-specific investigations will be decontaminated within a temporary decontamination area. The decontamination area will be designed so that all decontamination liquids are segregated in containers by type, contained from the surrounding environment, and can be recovered for disposal as IDW. Non-dedicated equipment will be decontaminated after each well is developed and again after each well is purged and sampled. The decontamination procedure will follow current guidance provided in Chapter 10 of the *Technical Guidance Manual for Hydrogeologic Investigations and Groundwater Monitoring* (Ohio EPA 2009). Solvent and acid rinses may be necessary only if high levels of contamination are expected. Further procedures will be defined in investigation-specific addenda. Individual dedicated containers should be used for each step of the decontamination process. Gloves should be changed between various stages of decontamination. The procedure for equipment decontamination is as follows:

1. Wash with approved water and phosphate-free detergent using various types of brushes required to remove particulate matter and surface films.

2. Rinse thoroughly with approved potable water.

3. If analyzing for metals and expecting high levels of contamination, rinse thoroughly with hydrochloric acid (2% solution) or nitric acid (10% solution).

4. Rinse thoroughly with ASTM Type I or equivalent deionized/distilled water with analytical certification.

5. If analyzing for organics and expecting high levels of contamination, rinse thoroughly with solvent-pesticide grade isopropanol, acetone, or methanol, depending on analytes of interest.

6. Rinse thoroughly with ASTM Type I or equivalent deionized/distilled water with analytical certification.

7. Allow equipment to air dry as long as possible.

8. Place equipment on clean, dry plastic if it is to be used immediately or wrap in aluminum foil to prevent contamination if storage is required.

In addition to the well development and sampling equipment, field measurement instruments will be decontaminated between monitoring well locations. Only those portions of each instrument that come into contact with potentially contaminated environmental media will be decontaminated. Due to the delicate nature of these instruments, the decontamination procedure will involve only initial rinsing of the instruments with approved water, followed by a final rinse using ASTM Type I or equivalent water. Field measurement instruments will be rinsed with source water at the next sampling location. All solutions used in steps 3 - 6 should be dispensed from Teflon® spray bottles or dispensers.

5.4.9 Monitoring Well Redevelopment and Well Inspection

Each time a monitoring well is sampled, it should be inspected to determine if there is a need for maintenance. A decrease in total well depth, a drop in yield during purging, changes in water level fluctuations, or increases in turbidity over time may indicate a possible change in hydraulic connection of the well to the aquifer or siltation in the monitoring well. Slug tests may be conducted as part of the well evaluation. Well maintenance should be inspected and recorded at least annually. Inspections should note changes in water level trends; changes in depth to bottom or observed siltation; yield changes; turbidity; and external physical condition of the well, protective casing, and well pad internal integrity. At a minimum, monitoring wells will be re-developed when 10% of the well screen is occluded by sediment or records indicate a change in yield and turbidity. Well redevelopment will follow the procedures outlined in Section 5.4.2.3.10.

5.5 SUBSURFACE SOIL

5.5.1 Rationales

As defined in Section 4.0, investigation-specific addenda will be developed to identify unique elements of each investigation not addressed in this FWFSP. Therefore, rationales related to soil borehole locations, discrete or composite soil sampling requirements, sample collection, field and laboratory analyses, determination of background values, and QA/QC sample collection and frequency will be addressed within each of the investigation-specific addenda as appropriate. ISM in the environmental industry is being developed for subsurface soil sampling. This concept may be used and will be described in investigation-specific addenda to this FWFSP

5.5.2 Procedures

5.5.2.1 Drilling Methods

5.5.2.1.1 Equipment Condition and Cleaning

The condition of all drilling, trenching, sampling, and support equipment used for subsurface soil sampling associated with each AOC-specific investigation and the equipment cleaning procedures will be the same as defined in Section 5.4.2.1.1 of this FWFSP. Additional information regarding the decontamination of drilling and sampling equipment used for soil sample collection is presented in Section 5.5.2.8.

5.5.2.1.2 Hollow-Stem Auger Drilling Method

The hollow-stem auger drilling method may be used during the AOC-specific investigations for drilling of subsurface soil boreholes from which soil samples are to be collected for physical and/or chemical analyses. This method will be implemented as a dry drilling method for the investigations. The standard equipment used for borehole drilling will be hollow-stem augers with a 15.2- to 16.5-cm (6.125- to 6.625-inches) outside diameter. Sections 5.5.2.4 and 5.5.2.5 present information regarding the methods and equipment to be used for collecting subsurface soil samples from boreholes drilled using the hollow-stem auger method.

Soil drilling using the hollow-stem auger method will be accomplished using a truck-mounted auger rig of sufficient size and power to advance augers to the required drilling depth. The total depth of each subsurface borehole will be dictated by the target depth(s) for sampling and will be contingent upon the constraints of the maximum drilling depth for boreholes defined by the U.S. Army for each AOC-specific investigation. A discussion of these constraints will be presented in the investigation-specific addenda to this FWFSP.

5.5.2.1.3 Trenching Method

The trenching method is anticipated to be used to collect subsurface soil samples and examine buried waste materials to characterize landfills and subsurface structures during AOC-specific investigations. Prior to trenching, personnel should determine, to the extent practical, that no potential exists for unexploded ordnances (UXO) and that adequate provisions for worker health and safety are addressed in the AOC-specific Safety and Health Plan (SHP). Groundwater elevation must be known and concurrence from Ohio EPA must be obtained before trenching begins.

The depth interval over which material will be collected using this method is expected to be limited to the interval located from the land surface (after removal of surface debris) to a depth of 4.5 m (15.0 ft) bgs. However, to avoid the potential for contaminating groundwater and the hazard of collapse caused by digging into saturated material, trenches will not be excavated below the local groundwater table. Trenching will be stopped at the first indication of groundwater, and the trench will be immediately backfilled with at least 0.6 m (2 ft) of material. If subsurface soil samples must be collected at depths greater than 4.5 m (15.0 ft), or below the local groundwater table, these samples will be obtained using the hollow-stem auger or hydraulic direct-push drilling methods.

Trenches will be excavated using a backhoe or other type of excavation equipment (e.g., clam shell, trench excavator). Soil material in each trench will be removed in layers measuring approximately 0.6 to 0.9 m (2.0 to 3.0 ft) in thickness. Soil will be removed in this fashion until the trench has been excavated to the required depth designated for the sampling location. The total depth of each trench will be dictated by the target depth(s) for sampling and will be contingent upon the depth of groundwater constraints of the maximum excavation depth for trenches defined by the U.S. Army for each AOC-specific investigation.

Under no circumstances will project personnel enter trenches deeper than 1.22 m (4 ft) unless sloping and/or benching is provided as discussed in the FWSHP.

All soil and solid waste removed from trenches will be placed beside each trench on plastic sheeting and segregated by the layers in which it was excavated, if necessary, so that potentially hazardous materials are not commingled with non-hazardous materials. Segregation of the materials by layers allows the material to be placed back into the trench in the position that it was excavated. All soil and buried materials, except for materials determined to be hazardous, will be returned to the excavation of its origin immediately after each trench is completed. Any hazardous material encountered will not be placed back into the excavation but will be containerized for treatment, storage, and disposal in accordance with Section 8.0 of this FWFSP and the investigation-specific SAP addenda. If, as a result of trenching operations, a release of contamination occurs, corrective measures will be initiated immediately to abate the release.

A discussion of these constraints and the equipment to be used for trench excavation will be presented in the investigation-specific addenda to this FWFSP.

5.5.2.1.4 Bucket Hand Auger Method

The bucket hand auger method is a third method to be used during the AOC-specific investigations for collecting subsurface soil samples. The bucket hand auger collection method will be accomplished using a 3-inch-diameter stainless steel bucket auger head attached to an extension rod and T-shaped bar. The auger will be advanced continuously over 10.1- to 15.2-cm (4.0- to 6.0-inch) intervals into the soil to the required depth designated for the sampling location. Material collected in the bucket cylinder in each interval will be removed to the greatest extent possible using a stainless steel spoon. Each sample interval will be sampled using a new bucket hand auger, even if at the same sampling location.

Soil will be homogenized in a stainless steel bowl. Discrete samples for VOC analyses will be taken from the middle of the sample interval without being homogenized.

The bucket auger will be decontaminated after sample collection is completed; however, the auger will not be decontaminated after material is removed from each interval augered at a location unless multiple discrete samples are collected from a single location at different depth intervals.

The diameter of the bucket hand auger used for the investigations will depend upon the quantity of soil or sediment sample required to be collected from each sampling location to fulfill chemical analyses requirements. In general, a 3-inch diameter stainless steel bucket auger head should be used. Further specifications for the bucket hand auger to be used for surface soil and sediment sampling will be presented in the investigation-specific addenda to this FWFSP. Additional information regarding the methods used for collecting surface soil and sediment samples using the bucket hand auger method is presented in Sections 5.6.2.1.1 and 5.6.2.5.1.

Bucket hand augers are best suited for shallow subsurface borings and are usually limited to a depth less than 10 ft bgs. This method will be implemented in the same manner as described in Section 5.6.2.1.1 of this FWFSP.

5.5.2.1.5 Hydraulic Direct-Push Method

Subsurface soil samples may be collected with hydraulic direct-push samplers (e.g., Geoprobe®). Soil sampling completed using hydraulic direct-push methods will follow the *Technical Guidance Manual for Hydrogeologic Investigations and Groundwater Monitoring* (Ohio EPA 2009) and the *Standard Guide for Direct Push Soil Sampling for Environmental Site Characterizations* (ASTM 2005d). The hydraulic device may be used where continuous shallow subsurface lithologic and stratigraphic information is needed to characterize an AOC. Geoprobe® may be equipped with hollow-stem auger technology and may be used to advance Shelby tubes for the collection of undisturbed geotechnical samples. In some circumstances, Geoprobe® may be used to collect discrete or composite samples for chemical analyses. Hydraulic direct-push samplers are best used for boreholes less than 50 ft. Soil types and consistency may reduce this depth significantly.

Hydraulic-push borings will be created using a truck-mounted or track hydraulic system of sufficient size and power to advance the macro-core or dual tube to the required depth. The total depth of each borehole will be determined by the target depth(s) for sampling for each AOC. These parameters will be discussed in the investigation-specific addenda to this FWFSP.

5.5.2.2 Boring Logs

Information regarding the preparation and contents of borehole logs for the AOC-specific investigations is presented in Section 5.4.2.4.1.1 of this FWFSP.

5.5.2.3 Field Measurement Procedures and Criteria

Field measurements performed on subsurface soil samples during the AOC-specific investigations may include determination of volatile organic headspace gas concentrations, field screening for the presence of TNT and other explosives, and field determinations of metals concentrations.

A description of the field instrument and associated calibration requirements and performance checks to be used for headspace gas measurements is presented in Table 5-3. Headspace gas concentration measurements will be made using a field organic vapor analyzer. Each soil sample collected from an investigation borehole will be placed into a glass jar, leaving some air space, and the jar will be covered with plastic cling wrap or aluminum foil to create an air-tight seal. The sample will then be immediately placed into an empty cooler and allowed to volatilize for a minimum of 15 min. The sealed jar will then be punctured with the organic vapor analyzer probe and headspace gas will be drawn until the meter reading is stable. The concentration of the headspace gas will be recorded to the nearest 0.1 ppm. All soil samples utilized for field measurements will be allowed to volatilize for an equal period of time before screening.

Field screening for explosives will be performed using the *Standard Operating Procedure for Field Colorimetric Analysis of Explosives* (USACE 1991). Field screening for metals will be conducted with the X-ray fluorescence (XRF) method detailed in USEPA Method SW846 6200- Field Portable X-Ray Fluorescence for the Determination of Elemental Concentrations in Soil and Sediment.

5.5.2.4 Sampling For Physical/Geotechnical Analyses

5.5.2.4.1 Hollow-Stem Auger Drilling Method

Soil samples designated for physical and geotechnical analyses will be collected from AOC investigation boreholes using a thin-walled (Shelby) tube sampler device. Samples will be collected using this device as part of hollow-stem auger drilling of boreholes. Other undisturbed samples including California samplers may be defined as part of the project scope. The size (both diameter and length) and type of undisturbed sampler to be used and the intervals over which soil samples will be collected will be defined in the investigation-specific addenda to this FWFSP.

During the drilling of investigation boreholes, the lead hollow-stem auger will be advanced to the top of the soil interval to be sampled. The Shelby tube sampler will then be inserted into the auger string and hydraulically pushed to the bottom of the soil interval to be sampled. Upon retrieval of the sampler, the percentage of recovery will be recorded and the ends of the sampler will be sealed with wax or rubber packers to preserve moisture content. The sampler will be packed to prevent movement and disturbance to the sample. The preparation of Shelby tube samplers will be conducted in accordance with ASTM D 1587, *Standard Practice for Thin-Walled Tube Sampling of Soils for Geotechnical Purposes* (ASTM 2008).

5.5.2.4.2 Trenching and Bucket Hand Auger Methods

Subsurface soil samples collected using the trenching or bucket hand auger methods would be classified as disturbed sample types. Therefore, physical and geotechnical analyses of samples collected using these methods would be limited to those analyses for disturbed samples (e.g., grain size, Atterberg limits, moisture content). Samples collected using these methods would not be utilized for the determination of in-situ permeability values.

A sample will be collected from the required depth using either trench excavation equipment or a bucket hand auger as described in Sections 5.5.2.1.3 and 5.5.2.1.4 of this FWFSP. When trench excavation equipment is used, the sample will be placed onto polyethylene sheeting located at least 1.22 m (4.0 ft) from the edge of the collection trench. When a bucket hand auger is used, the sample will be placed into a decontaminated stainless steel bowl at the sampling location. The quantity of the sample required for physical and geotechnical analyses will be collected from the soil stockpile or stainless steel bowl using a stainless steel spoon and placed into sample containers.

5.5.2.5 Sampling for Chemical Analyses

5.5.2.5.1 Hollow-Stem Auger Drilling Method

Subsurface soil samples designated for chemical analyses will be collected from AOC investigation boreholes using either split-spoon or split-barrel sampling devices. Samples will be collected using these devices as part of hollow-stem auger drilling of boreholes. The size (both diameter and length) of the split-spoon or split-barrel device to be used and the intervals over which soil samples will be collected using one or both of these devices will be defined in the investigation-specific addenda to this FWFSP.

When drilling investigation boreholes, the lead hollow-stem auger will be advanced to the top of the soil interval to be sampled. The selected soil sampling device then will be inserted into the auger string and advanced to the bottom of the soil interval. When using a split-spoon sampler, this device will be advanced to the required depth using a 63.5-kg (140-lb) hammer or continuously advanced with the auger string. When using a split-barrel sampler, this device will be hydraulically pushed to the required depth. A clean sampling device will be used to collect soil core from each sampled interval of the investigation boreholes.

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. Samples designated for laboratory analysis will be collected from the core using a stainless steel scoop. The scoop will either be used to retrieve an isolated section(s) of the soil core or will be run lengthwise down the core to collect a sample representative of the entire core interval. The portion of the sample designated for volatile organic analyses will be placed into laboratory sample containers first, followed by placement of the remaining portion of the sample into containers designated for other types of chemical analyses. Sample containers designated for volatile organic analyses will be filled so that minimal headspace in present in the containers. No portion of the soil core that was in contact with the sampling device wall will be included in the sample collected for laboratory analysis.

If composite subsurface soil samples are collected as part of an AOC investigation, VOC samples will be collected prior to the compositing process. No samples for volatile organic analysis will be collected from composited or homogenized sample volumes. An equal quantity of each discrete sample will be placed into a decontaminated stainless steel bowl. The total quantity of the discrete samples selected for compositing will be sufficient to perform all required laboratory analyses. The soil placed into the bowl will initially be split into quarters, and each quarter will be mixed thoroughly in the center in the bowl using a stainless steel spoon. All four quarters will be mixed together until the single composite sample has a consistent physical appearance. Upon completion of the compositing process, the sample will be divided in half and containers filled by scooping sample material alternately from each half.

Immediately after discrete or composite samples are collected and bottles are labeled, each sample container will be placed into a sealable plastic bag and then placed into an ice-filled cooler to ensure preservation. Remaining soil will be managed as IDW.

5.5.2.5.2 Trenching and Bucket Hand Auger Methods

Subsurface soil samples designated for chemical analyses will be collected using either trenching equipment or bucket hand augers in the same manner as described in Section 5.5.2.4.2 of this FWFSP. Samples will be collected in accordance with ASTM D6907-05, *Standard Practice for Sampling Soils and Contaminated Media with Hand-Operated Bucket Augers* (ASTM 2010). When subsurface samples are collected at a location where a composite surface soil sample was collected (for explosives and propellants), the subsurface sample location will be in the approximate center of the three surface soil composite samples as described in Section 5.6.2.1.1. All VOC samples will be collected as discrete aliquots from the middle of the subsurface interval without homogenization using a stainless steel spoon. All remaining samples will be collected from homogenized soil from the bucket hand auger over the depth interval. No portion of the sample that was in contact with the sampling equipment or device will be included in the sample collected for laboratory analysis.

Immediately after discrete or composite samples are collected and bottles are labeled, each sample container will be placed into a sealable plastic bag and then placed into an ice-filled cooler to ensure preservation.

5.5.2.5.3 Hydraulic Direct Push Method

The standard equipment for subsurface sample collection will be a 5-cm (2-inch) outside-diameter macro-core sampling device, advanced using 2.54-cm (1-inch)-diameter steel rods attached to the hydraulic device. Each macro-core section is approximately 1.524 m (5 ft) long. The borehole is advanced by attaching additional lengths of extension rod to the macro-core barrel and pushing the entire pipe string downward. The macro-core sampler may be fitted with a clear acetate sleeve for ease of retrieving samples. In lieu of a macro-core sampler, a 4-inch outside-diameter dual-tube sampling device with a 2-inch interior sample liner may be used in unstable soil or below the groundwater table.

Immediately after discrete or composite samples are collected and bottles are labeled, each sample container will be placed into a sealable plastic bag and then placed into an ice-filled cooler to ensure preservation.

5.5.2.6 Sample Containers and Preservation Techniques

Information regarding sample containers and preservation techniques for subsurface soil samples collected for chemical analyses during the AOC-specific investigations is presented in Section 5.0 of the FWQAPP. Contracted laboratories will provide all sample containers. All sample containers will be stored at 4ºC (±2ºC) immediately after collection and will be maintained at this temperature until the samples are received at the contracted laboratory.

5.5.2.7 Field Quality Control Sampling Procedures

Duplicate QC samples, MS/MSD samples, equipment rinsate blanks, and trip blanks will be collected in association with subsurface soil samples during the AOC-specific investigations. Duplicate subsurface soil and MS/MSD samples (if extra volume is required for MD/MSD analysis) will be collected during the investigations using the same composited material as the primary sample, and using procedures defined for field subsurface soil samples in Section 5.5.2.5 of this FWFSP. Equipment rinsate blanks and trip blanks will be collected as described in Section 5.4.7, with the exception that subsurface soil sampling equipment will be rinsed for the equipment rinsate blanks. Information regarding the total number, collection frequency, and analytical parameters for duplicate samples will be defined in the investigation-specific addenda to the FWFSP and in Section 9.0 of the FWQAPP.

In addition, source blanks collected from potable water sources used in the decontamination and field investigation process are analyzed for the parameters of interest. Source blank samples are analyzed to determine the potential for contamination in source water used during field activities such as in grout mixtures or to hydrate a boring. Field blanks are collected by pouring analyte-free, deionized water into appropriate containers at designated sample locations. Field blank samples are analyzed to determine the potential for contamination of a sample due to contaminant sources (e.g. airborne dust, exhaust fumes) unrelated to the specific sources being investigated. Field blanks will be collected only if these types of contaminant sources are expected to be present in the field. All field QC samples will be collected as required by investigation-specific addenda depending on the anticipated field conditions, intended use of the data, and the contaminant types under investigation.

5.5.2.8 Decontamination Procedures

Equipment used to drill boreholes and collect subsurface soil samples during the AOC-specific investigations will be decontaminated within a temporary decontamination pad constructed at the AOC. The decontamination pad will be designed so that all decontamination liquids are contained from the surrounding environment and can be recovered for disposal as IDW. Drilling equipment will be decontaminated after each borehole is completed. Solvent and acid rinses may be necessary only if high levels of contamination are expected. Further procedures will be defined in investigation-specific addenda. The decontamination procedure for drilling equipment is as follows:

1. Remove caked soil material from the exterior of the augers and cutting heads using a rod and/or brush.

2. Steam clean the equipment interior and exterior with approved water using a brush where steam cleaning is not sufficient to remove all soil material.

3. Rinse thoroughly with approved potable water.

4. Allow equipment to air dry as long as possible.

5. Place equipment on clean plastic if it will be used immediately or wrap in plastic to prevent contamination if storage is required.

Non-dedicated sampling equipment will be decontaminated after each use during borehole interval sampling. The procedure for decontamination of sampling equipment will be as follows:

1. Wash with approved water and phosphate-free detergent using various types of brushes required to remove particulate matter and surface films.

2. Rinse thoroughly with approved potable water.

3. If analyzing for metals and expecting high levels of contamination, rinse thoroughly with hydrochloric acid (2% solution) or nitric acid (10% solution).

4. Rinse thoroughly with ASTM Type I or equivalent deionized/distilled water with analytical certification.

5. If analyzing for organics and expecting high levels of contamination, rinse thoroughly with solvent-pesticide grade isopropanol, acetone, or methanol, depending on analytes of interest.

6. Rinse thoroughly with ASTM Type I or equivalent deionized/distilled water with analytical certification.

7. Allow equipment to air dry as long as possible.

8. Place equipment on clean plastic if immediate use is anticipated or wrap in aluminum foil to prevent contamination if storage is required.

5.5.2.9 Borehole Abandonment

All discrete subsurface boreholes completed using direct-push technology or hollow-stem augers completed above bedrock will be backfilled with U.S. Army-approved bentonite chips at the completion of sampling activities (Figure 5-3). Bentonite chips are used because of their ability to fall through the water column if encountered at a borehole. Bentonite chips will be added through the augers or dual tube as they are removed to prevent bridging within the borehole. Care will be taken to ensure that bridging does not occur in any soil boreholes by tamping and thoroughly hydrating the chips with an USACE-approved water source every 5 ft until the boring is filled. The top 0.076 m (0.25 ft) of each boring will be covered lightly with surrounding soil.

5.6 SURFACE SOIL AND SEDIMENT

5.6.1 Rationales

As defined in Section 4.0, investigation-specific addenda to this FWFSP will be developed to identify unique elements of each investigation not addressed in this FWFSP. Therefore, rationales related to surface soil and sediment sample locations, discrete or composite sampling requirements, sample collection, field and laboratory analyses, determination of background values, and QA/QC sample collection and frequency will be addressed within each of the investigation-specific addenda as appropriate.

5.6.2 Procedures

5.6.2.1 Sampling Methods for Surface Soil/Dry Sediment

5.6.2.1.1 Bucket Hand Auger Method

The bucket hand auger method is one method that can be used during the AOC-specific investigations to collect surface soil and sediment samples. Surface soil samples will be collected from the ground surface to a depth of 30.5 cm (12 inches), unless otherwise specified in the investigation-specific addenda.

The bucket hand auger collection method will be accomplished using a 3-inch-diameter stainless steel bucket auger head attached to an extension rod and T-shaped bar. The auger will be advanced continuously over 10.1- to 15.2-cm (4.0- to 6.0-inch) intervals into the soil to the required depth designated for the sampling location. Material collected in the bucket cylinder in each interval will be removed to the greatest extent possible using a stainless steel spoon. Each sample interval will be sampled using a new bucket hand auger, even if at the same sampling location.

When collecting explosives and propellants samples from surface soil, a specific augering procedure must be used. All surface soil samples (0 to 0.3 m [0 to 1 ft]) collected for explosives and propellants analyses will be composited and homogenized from three subsamples collected with the hand auger about 0.9 m (3 ft) from one another in a roughly equilateral triangle pattern. Equal portions of soil from each of the three subsamples will be homogenized in a stainless steel bowl. Remaining surface soil samples (e.g., metals, semi-volatile organics, and others) will be collected with the hand auger from a point located in the approximate center of the triangle. Discrete samples for VOC analyses will be taken from the middle of the sample interval from the center of the triangle without being homogenized.

The bucket auger will be decontaminated after sample collection is completed; however, the auger will not be decontaminated after material is removed from each interval augered at a location unless multiple discrete samples are collected from a single location at different depth intervals.

The diameter of the bucket hand auger used for the investigations will depend upon the quantity of soil or sediment sample required to be collected from each sampling location to fulfill chemical analyses requirements. In general, a 3-inch-diameter stainless steel bucket auger head should be used. Further specifications for the bucket hand auger to be used for surface soil and sediment sampling will be presented in the investigation-specific addenda to this FWFSP. Additional information regarding the methods used for collecting surface soil and sediment samples using the bucket hand auger method is presented in Sections 5.5.2.4 and 5.5.2.5.

5.6.2.1.2 Trowel/Spoon Method

The trowel/spoon method is a second method that may be used to collect surface soil and sediment samples during the AOC-specific investigations. The depth interval over which material will be collected using this method will be limited to the interval located from the land surface (after removal of surface debris) to a depth of 15.2 cm (6.0 inches) below ground level.

The trowel collection method will be accomplished using a stainless steel trowel or spoon. This instrument will be used to manually dig into the subsurface material to the required depth designated for the sampling location. The trowel may be necessary to collect composite samples as described in Section 5.6.2.1.1. The trowel will be decontaminated after digging is completed at each sampling location. Additional information regarding methods used to collect surface soil and sediment samples using the trowel method is presented in Sections 5.5.2.4 and 5.5.2.5.

5.6.2.1.3 Incremental Sampling Method

ISM is frequently used to characterize surface soil. An ISM sample is designed to provide a statistical average chemical concentration over a selected sample unit (e.g., decision or exposure unit). To provide the requisite statistical confidence (95%) a minimum of 30 matrix aliquots of similar mass are collected from a depth of 0 to 1 ft to form a representative sample within the defined sampling area. Any point on the ground surface within the boundary of the ISM area is a possible sample location, and each point has an equal chance of selection. ISM in the environmental industry is being developed for subsurface soil sampling. This concept may be used and will be described in investigation-specific addenda to this FWFSP.

The corners (or boundaries) of each of the designated ISM areas will be located using digital global positioning system and marked using wooden stakes or pin flags. Approximately equal sample volume aliquots will be collected using small-diameter push probes (≤ 1 inch in diameter). A sufficient number of aliquots will be collected to provide statistical confidence that the average concentration of a particular constituent within a designated area is represented by the ISM sample. No less than 30 aliquots for each sample will be collected to provide the requisite statistical confidence (95%).

These aliquots will be selected on a random basis over the ground surface of the designated ISM area, thus assuring coverage over the entire sample area and providing repeatability and accuracy. Three sampling procedures are established and accepted for collection of aliquots; simple random, systematic random, and stratified random sampling (USACE 2009). To collect the aliquots within a defined ISM area, systematic random sampling is the preferred method. While, any point on the ground surface within the boundary of the ISM area is a possible sample location, and each point has an equal chance of selection, a systematic random sampling scheme will ensure that the aliquots are spread out relatively equally across the decision or exposure unit. This may involve equally dividing the decision unit into rows or cells with a certain amount of aliquots to be collected at random from each row or cell, but from the same relative location within each of the rows or cells. If systematic random sampling is not feasible due to size or shape of a sampling area, then stratified random sample collection will be utilized. This method also ensures aliquots are equally divided at random across the sampling area. For stratified random sample collection, a grid would be established by field personnel across the sample area and then a random location would be selected in each sub-unit. Simple random sampling is not recommended as it does not ensure relatively equal distribution of aliquots across the decision unit. Sample points will not be pre-located Specific methodologies will be specified in project specific addenda.

All aliquots collected from each ISM area will be placed in a labeled container for transport to the laboratory. At the laboratory, the sample will be dried, sieved, and finely ground for specified non-volatile constituent analyses.

Duplicate QC and QA split samples will be collected from the ISM areas at the frequency listed in Section 5.6.2.8. The field duplicates and split samples are taken from the same source that equally represent the medium at a given time and location. The field duplicate samples are to be submitted as "blind" to the laboratory and are used to determine whether the field sampling technique is reproducible and as an indicator of sample heterogeneity. MS/MSDs will be used to verify the accuracy of the laboratory results. The QC sample will be sent to the laboratory under contract with SAIC. The QA split samples will be sent to an U.S. Army QA laboratory for independent analysis and evaluation of analytical results by the contracted laboratory.

To statistically evaluate sampling precision, QA and QC samples will be collected as completely separate replicate ISM samples. The QA and QC samples will be collected, using the same methods as the original sample, from a set of random locations. Aliquots for QA and QC samples will be collected in separate containers or bowls and placed into separate labeled sample container for transport to the laboratory. These QA and QC samples will be prepared and analyzed in the same manner as the initial ISM sample.

If a sample is designated for VOC analysis, then one discrete sample will be collected from within the ISM area using the bucket hand auger method. The specific location of the discrete sample will be biased toward the area most likely to contain volatile compounds or, if no such area is observed, the location will be randomly chosen. Soil portions designated for VOC analysis will be placed directly in the sample container and will not be composited or further processed in the field. ISM in the environmental industry is being developed for VOC analysis. This concept may be used and will be described in investigation-specific addenda to this FWFSP.

Field instruments (e.g., PID, flame ionization detector, and XRF) will not be used to measure chemical concentrations or bias sample collection, unless it is determined that chemical concentration measurements are needed for the protection of workers' health and safety.

5.6.2.2 Sampling Methods for Underwater Sediment from Ponds, Lakes, Streams, and Lagoons

5.6.2.2.1 Trowel/Spoon Method

The trowel/spoon method is one method that may be used during the AOC-specific investigations to collect sediment samples located underwater. This method will be used in situations where the water depth is less than 15.2 cm (6.0 inches), and it will be implemented in the same manner as described in

Section 5.6.2.1.2. Sediment samples will be collected from the sediment water interface to a depth of 15 cm (6 inches), unless otherwise specified in the investigation-specific addenda.

5.6.2.2.2 Ponar/Ekman Sampler

Ponar and Ekman samplers are capable of trapping most types of sediment and sludges in open areas and are best used for collection in open water areas. These samplers can be used in situations where sample depth is from 0 to 6 inches. The Ponar and Ekman samplers are clamshell-type scoops activated by a counter lever. The Ponar sampler is lighter and typically smaller than an Ekman sampler, thus making it easier for field sample collection. When tension is released from a lowering cable, a latch releases and the reverse lifting action forces the clamshell to close. Once the sampler has been retrieved, liquid can be drained from screens in the top of the sampler, thus preserving the sediment inside. VOC samples should be collected immediately from the center mass of the sediment obtained. A minimum of three aliquots should be collected from the sample area to obtain adequate sample volume and create a representative sediment composite. Ponar and Ekman samplers are only capable of collecting disturbed samples, and sampling equipment must be decontaminated between sampling stations. Figures 5-13 and 5-14 present diagrams of a Ponar and Ekman sampler, respectively.

5.6.2.2.3 Hand Core Sampler Method

The hand core sampler method is another method that may be used to collect sediment samples located underwater during the AOC-specific investigations. This method will be used in situations where the water depth is greater than 15.2 cm (6.0 inches) but less than 3.0 m (10.0 ft). If a particular AOC investigation requires sediment sampling to be conducted where water depths are greater than 3.0 m (10.0 ft), the method to be implemented to accomplish this sampling will be presented in the investigation-specific addenda to this FWFSP.

Hand core sediment samplers consist of a stainless steel sample barrel with either an auger bit or core tip mounted on the leading end of the device. In either configuration, a self-closing valve and/or core catcher will be installed to retain the sample obtained with the device. Extension rods will be attached to the core sampler and used to lower the device through the body of water to the sample point. Upon reaching the top of the sediment, the core sampler will be pushed or augered into the sediment to the required depth designated for the sampling location. The core sampler and extension rods will be decontaminated after coring is completed at each sampling location.

The diameter of the core sampler used for the investigations will depend upon the quantity of sediment sample required to be collected from each sampling location to fulfill chemical analyses requirements. Therefore, the specifications for the core sampler used for sediment sampling will be presented in the investigation-specific addenda to this FWFSP. Additional information regarding methods used to collect sediment samples using the hand core sampler method is presented in Sections 5.6.2.5 and 5.6.2.6.

Figure 5-13. Illustration of Ponar Sampler Device

Figure 5-14. Illustration of Ekman Sampler Device

5.6.2.3 Boring Logs

All surface and subsurface boreholes will have a complete record of borehole information. Information regarding the preparation and contents of borehole logs for the AOC-specific investigations is presented in Section 5.4.2.4.1.1. For ISM, a general description for the entire ISM unit will be generated, as each aliquot will not have a separate description. Differences in units and physical characteristics throughout the ISM area will be noted (e.g., slag and gravel).

5.6.2.4 Field Measurement Procedures and Criteria

Field measurements performed on surface soil and dry sediment samples during the AOC-specific investigations may include determination of volatile organic headspace gas concentrations, field screening for the presence of 2,4,6-trinitrotoluene (TNT) and other explosives, and field determinations of metals concentrations.

Headspace measurements will be performed in the same manner as described in Section 5.5.2.3. Field measurement of volatile organic headspace gas concentrations will not be performed on sediment samples collected at underwater locations due to interferences resulting from the saturated condition of these samples.

Field screening for explosives will be performed using the *Standard Operating Procedure for Field Colorimetric Analysis of Explosives* (USACE 1991). Field screening for metals will be conducted with the XRF method detailed in USEPA Method SW846 6200- Field Portable X-Ray Fluorescence for the Determination of Elemental Concentrations in Soil and Sediment.

5.6.2.5 Sampling For Physical/Geotechnical Analyses

5.6.2.5.1 Bucket Hand Auger and Trowel Methods

Surface soil and sediment samples collected using the bucket hand auger or trowel/spoon methods are classified as disturbed samples. Therefore, physical and geotechnical analyses would be limited to those analyses for disturbed samples (e.g., grain size, Atterburg limits, moisture content). Samples collected using these methods would not be utilized for the determination of in-situ permeability values.

A sample will be collected from the required depth using either a bucket hand auger or trowel as described in Sections 5.6.2.1.1 and 5.6.2.1.2. The sample will be placed into a decontaminated stainless steel bowl, and the quantity of the sample required for physical and geotechnical analyses will be placed into sample containers using a stainless steel spoon.

5.6.2.5.2 Hand Core Sampler Method

Sediment samples collected using the hand core sampler are classified as undisturbed samples. Physical and geotechnical analyses would include those for disturbed samples (e.g., grain size, Atterberg limits, moisture content,) and analyses for undisturbed samples (i.e., in situ permeability).

A stainless steel retaining liner will be placed into the core sampler device. Next, the device will be pushed rapidly into the sediment material to a depth sufficient to completely fill the retaining liner. The device will be rotated to shear off the sample at the leading edge of the sampler and retrieved from the sampling location. Upon retrieval, the retaining liner will be removed from the sampler device, and the ends of the liner sealed with wax or rubber packers to preserve moisture content. The preparation of liners will be conducted in accordance with ASTM D1587-08, *Standard Practice for Thin-Walled Tube Sampling of Soils for Geotechnical Purposes* (ASTM 2008).

5.6.2.6 Sampling for Chemical Analyses

Surface soil and sediment samples designated for chemical analyses will be collected using either bucket hand auger, trowel, or hand core sampler devices in the same manner as described in Section 5.6.2.1.

When explosives and propellants samples are collected from surface soil, a specific augering procedure must be used. All surface soil samples (0 to 0.3-m [0- to 1-ft]) collected for explosives and propellants analyses will be composited and homogenized from three subsamples collected with the hand auger about 0.9 m (3 ft) from one another in a roughly equilateral triangle pattern. Equal portions of soil from each of the three subsamples will be homogenized in a stainless steel bowl. Remaining surface soil samples (e.g., metals, SVOCs, and others) will be collected from a point located in the approximate center of the triangle. VOC samples will be collected prior to the compositing process. Discrete samples for VOC analyses will be taken from the middle of the sample interval from the center of the triangle without being homogenized. Sample containers designated for volatile organic analyses will be filled so that minimal headspace is present in the containers. No portion of the sample that is in contact with the sampling device will be included in the sample collected for laboratory analysis.

Immediately after discrete or composite samples are collected and bottles are labeled, each sample container will be placed into a sealable plastic bag and then into an ice-filled cooler to ensure preservation.

5.6.2.7 Sample Containers and Preservation Techniques

Information regarding sample containers and preservation techniques for surface soil and sediment samples collected for chemical analyses during the AOC-specific investigations is presented in Section 5.0 of the FWQAPP. Contracted laboratories will provide all chemical sample containers. All sample containers will be stored at 4ºC (±2ºC) immediately after collection and will be maintained at this temperature until the samples are received at the contracted laboratory.

5.6.2.8 Field Quality Control Sampling Procedures

Duplicate QC samples, MS/MSD samples, equipment rinsate blanks, and trip blanks will be collected in association with surface soil and sediment samples during the AOC-specific investigations. Duplicate surface soil and sediment samples and MS/MSD samples (if extra volume is required for MS/MSD analysis) will be collected during the investigations using the same composited material as the primary sample , and using procedures defined for field surface soil and sediment samples in Section 5.6.2.6 of this FWFSP and in Section 9.0 of the FWQAPP. Equipment rinsate blanks and trip blanks will be collected as described in Section 5.4.7, with the exception that surface soil sampling equipment will be rinsed for the equipment rinsate blanks. Information regarding the total number, collection frequency, and analytical parameters for surface soil and sediment duplicate samples will be defined in the investigation-specific addenda to this FWFSP.

In addition, source blanks collected from potable water sources used in the decontamination and field investigation process are analyzed for the parameters of interest. Source blank samples are analyzed to determine the potential for contamination from source water used during field activities such as in grout mixtures or to hydrate a boring. Field blanks are collected by pouring analyte-free, deionized water into appropriate containers at designated sample locations. Field blank samples are analyzed to determine the potential for contamination of a sample due to contaminant sources (e.g. airborne dust, exhaust fumes) unrelated to the specific sources being investigated. Field blanks will be collected only if these types of contaminant sources are expected to be present in the field. All field QC samples will be collected as required by investigation-specific addenda depending on the anticipated field conditions, intended use of the data, and the contaminant types under investigation.

5.6.2.9 Decontamination Procedures

Equipment used to collect surface soil and sediment samples during the AOC-specific investigations will be decontaminated in the same manner as described for non-dedicated sampling equipment in Section 5.5.2.8. This equipment will be decontaminated after sampling activities are completed at each surface soil or sediment sampling location.

5.7 SURFACE WATER

5.7.1 Rationales

As defined in Section 4.0, investigation-specific addenda will be developed to identify unique elements of each investigation not addressed in this FWFSP. Therefore, rationales related to surface water sample locations, discrete or composite sampling requirements, sample collection, field and laboratory analyses, determination of upgradient sample locations, and QA/QC sample collection and frequency will be addressed within each of the investigation-specific addenda as appropriate.

5.7.2 Procedures

5.7.2.1 Sampling Methods for Surface Water – General

5.7.2.1.1 Hand-Held Bottle Method

Directly filling a sample container is one of the most efficient methods of surface water collection. It is the preferred method if the samples are being collected for volatile organic analyses. Collecting surface water samples using the hand-held bottle method is accomplished by submerging the appropriate sample container with the cap in place into the body of water. Bottles containing preservative will not be submerged; rather, they will be filled by pouring water from an unpreserved container collected via submersion into the preserved sample container, including VOCs. The container is then slowly and continuously filled using the cap to regulate the rate of sample entry into the container. The sample container should be filled such that a minimum of bubbling (and volatilization) occurs. The sample container will be retrieved from the water body with minimal disturbance to the sample. Immediately after the sample is collected and the bottle is labeled, each sample container will be placed into a sealable plastic bag and then into an ice-filled cooler to ensure preservation.

5.7.2.1.2 Dipper and Pond Sampler Method

Dipper and pond samplers perform similar functions and vary only in the length of the handle attached to the sampling vessel (usually a beaker). Figure 5-15 illustrates a pond sampler. Before sampling begins, a handle of appropriate length is attached to the dipper or pond sampler. Collection of surface water samples using the dipper or pond sampler method is accomplished by slowly submerging the device into the water so that the open end of the device is facing upstream. The sampler device is retrieved from the water body with minimal disturbance to the sample, which then will be transferred into appropriate sample containers. Immediately after the sample is collected and the bottle is labeled, each sample container will be placed into a sealable plastic bag and then into an ice-filled cooler to ensure preservation. Further details on the dipper and pond sampler method are available in the ASTM D5358-93, *Standard Practice for Sampling with a Dipper or Pond Sampler* (ASTM 2009c).

5.7.2.1.3 Kemmerer Sampler Method

The Kemmerer sampler is a messenger-activated water sampling device that is used to sample water from a specific depth. Figure 5-16 illustrates a standard Kemmerer sampler assembly. Collection of surface water samples using the Kemmerer sampler method is accomplished by removing the upper and lower stoppers and lowering the sampler to the designated sampling depth. Upon reaching this depth, the messenger will be used to close the lower stopper and the sampler will be retrieved. Upon recovery of the sampler, the water sample will be transferred into appropriate sample containers using the lower stopper drain. Immediately after the sample is collected and bottle is labeled, each sample container will be placed into a sealable plastic bag and then into an ice-filled cooler to ensure preservation. Further discussion on this method can be found in ASTM D 6759, *Standard Practice for Sampling Liquids Using Grab and Discrete Depth Samplers* (ASTM 2009d) and *Standard Operating Procedure 2013, Surface Water Sampling* (USEPA 1994).

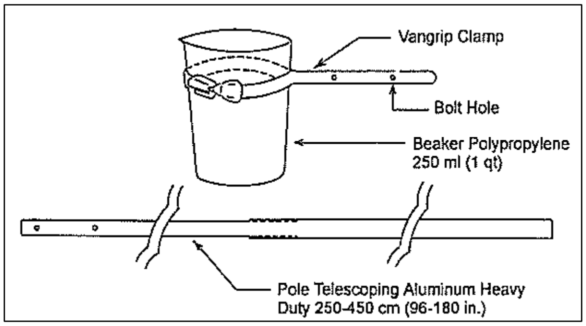


Figure 5-15. Illustration of Pond Sampler Device (USACE EM 200 1-3 [2001]b)

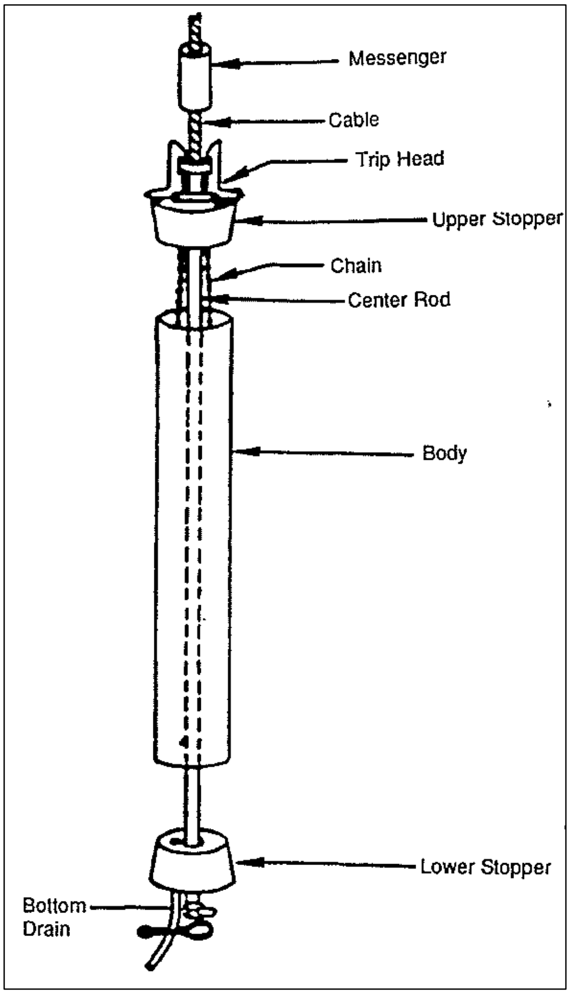


Figure 5-16. Illustration of Kemmerer Sampler Device (USACE EM 200 1-3 [2001b])

5.7.2.1.4 Peristaltic Pump Method

The peristaltic pump allows for easy decontamination through removal and replacement of flexible tubing. This method allows the sampler to reach certain depths, whether downhole or a certain depth below the water surface. Collection of surface water samples using a peristaltic pump is accomplished by placing new tubing into the sampler for each sample location and lowering the sampler to the designated sampling depth. Once the pump is in operation, approximately one tubing volume will be flushed through the tubing prior to sample collection. Samples will be collected directly from the tubing while ensuring the tubing does not come in contact with the sample containers. VOCs require special care when sampling with a peristaltic pump as the suction pump may have a potential degassing effect. For VOC collection using a peristaltic pump, the “straw method” will be utilized. The sampler will be turned on and enough water will fill the tubing before entry into the silicone suction pump tubing. Prior to entry into the suction housing, the pump will be turned off. The suction will hold the water in the line. At this time, the tubing will be removed from the water with care. Once the bottom of the tubing is in place over the appropriate VOC sample containers, the pump will be turned on in reverse, pushing the water back through the bottom of the tubing instead of through the pump housing where degassing may occur. Immediately after the sample is collected and the bottle is labeled, each sample container will be placed into a sealable plastic bag and then into an ice-filled cooler to ensure preservation.

5.7.2.2 Sampling Methods for Surface Water – Filtration

The equipment used to collect filtered surface water samples are a hand-operated pump or peristaltic pump and disposable 0.45-μm barrel filters, as described in Section 5.4.6. A peristaltic pump will not be used to collect VOCs as degassing may occur. Immediately after the sample is collected and the bottle is labeled, each sample container will be placed into a sealable plastic bag and then into an ice-filled cooler to ensure preservation.

5.7.2.3 Field Measurement Procedures and Criteria

Surface water field measurements performed during the AOC-specific investigations will include pH, conductivity, DO, turbidity, temperature, and ORP. These measurements are performed in the same manner as described in Section 5.4.3.

5.7.2.4 Sample Containers and Preservation Techniques

Information regarding sample containers and preservation techniques for surface water samples collected for chemical analyses during the AOC-specific investigations is presented in Section 5.0 of the FWQAPP. All sample containers will be provided by contracted laboratories, who will place into the containers or provide separately, the required types and quantities of chemical preservatives. All sample containers will be stored at 4ºC (±2°C) immediately after collection and will be maintained at this temperature until the samples are received at the contracted laboratory.

5.7.2.5 Field Quality Control Sampling Procedures

Up to six types of field QC samples will be collected or used with surface water samples during the AOC-specific investigations. The three types of field QC samples are duplicates, MS/MSDs, equipment rinsate blanks, and trip blanks. Duplicate surface water samples will be collected during the investigations using the same procedures defined for field surface water samples in Section 5.7.2.1. Equipment rinsate blanks will be collected and trip blanks used in the same manner as described in Section 5.4.7 of this FWFSP and in Section 9.0 of the FWQAPP. Information regarding the total number, collection frequency, and analytical parameters for surface water QC samples will be defined in the investigation-specific addenda to this FWFSP.

In addition, source blanks collected from potable water sources used in the decontamination and field investigation process are analyzed for the parameters of interest. Source blank samples are analyzed to determine the potential for contamination from source water used during field activities such as in grout mixtures or to hydrate a boring. Field blanks are collected by pouring analyte-free, deionized water into appropriate containers at designated sample locations. Field blank samples are analyzed to determine the potential for contamination of a sample due to contaminant sources (e.g. airborne dust, exhaust fumes) unrelated to the specific sources being investigated. Field blanks will be collected only if these types of contaminant sources are expected to be present in the field. All field QC samples will be collected as required by investigation-specific addenda depending on the anticipated field conditions, intended use of the data, and the contaminant types under investigation.

5.7.2.6 Decontamination Procedures

Non-disposable equipment used to collect surface water samples during the AOC-specific investigations will be decontaminated in the same manner as described for non-dedicated sampling equipment in Section 5.4.8 of this FWFSP. This equipment will be decontaminated after sampling activities are completed at each surface water sampling location.

In addition to the surface water sampling equipment, field measurement instruments will also be decontaminated between sampling locations. Only those portions of each instrument that come into contact with potentially contaminated environmental media will be decontaminated.

5.8 OTHER MATRICES

Sampling of other matrices not addressed in this FWFSP is not anticipated to be routinely included within the scopes of work for the AOC-specific investigations. If sampling of other matrices is required, rationales and procedures for these activities will be presented in the investigation-specific addenda to this FWFSP.

5.9 MUNITIONS AND EXPLOSIVES OF CONCERN (MEC) AVOIDANCE

For environmental field activities within munitions response sites (MRSs) or in other areas where munitions and explosives of concern (MEC) hazards may reasonably be expected (former ordnance disposal sites), MEC avoidance protocols will be implemented as outlined in Sections 3.0 and 10.16 of the FWSHP and any additional project-specific requirements stated in the Facility-Wide Sampling and Analysis Plan (FWSAP) and/or FWSHP addenda. UXO personnel will survey the area (visual and instrument-assisted) prior to work, establish appropriate controls, and accompany field teams during project execution. Environmental work may be conducted in association with an activity requiring an Explosives Safety Submittal (ESS). In this event, the project addenda will reference the ESS and field investigation activities must be performed in accordance with all applicable ESS requirements.

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6.0 SAMPLE CHAIN OF CUSTODY/DOCUMENTATION

6.1 FIELD LOGBOOK

All information pertinent to on-site environmental task activities, including field instrument calibration data, will be recorded in field logbooks or field forms. All logbooks or field forms will be completed in accordance with instruction defined in Appendix F of the *Requirements for the Preparation of Sampling and Analysis Plans* (USACE 2001b). The logbooks will be bound and the pages will be consecutively numbered. Field forms, which are a project-specific collection of forms, will be bound by a three-ring binder, comb-binding, or equivalent or contained in electronic format (i.e., field sheet on a tablet computer) and will capture specific field data, similarly to a field logbook. Logbooks and field forms should be produced on waterproof paper when possible. Entries in the logbooks or forms will be made in black waterproof ink and must be clear, objective, and legible. Entries will include, at a minimum, a description of each day's activities, individuals involved in environmental task activities, date and time of drilling or sampling, weather conditions, any problems encountered, significant events, and all field measurements. Dates are recorded in the month/date/year format; time is recorded in the 24-hr military clock format. Changes will be made by striking through the original entry in a manner that does not obliterate the original entry. The person making the change will initial and date the change.

Calibration logs will include instrument name, serial number, calibration data, and date of calibration. Lot numbers, manufacturer name, and expiration dates of standard solutions used for field instrument calibration also will be recorded. Examples of an equipment calibration log and a calibration standards log are illustrated in Figure 6-1 and Figure 6-2 respectively.

Sufficient information will be recorded in the logbooks to permit reconstruction of all environmental task activities conducted. Information recorded on other project documents (e.g., boring logs, well construction diagrams, well development records, electronic records) will not be repeated in the logbooks except in summary form where determined necessary. All field logbooks will be kept in the possession of field personnel responsible for completing the logbooks, or in a secure place when not being used during fieldwork. All electronic forms of data collection will be backed-up a minimum of once per day. All logbooks will have a distinct project identification number and an inventory will be maintained. Upon completion of the field activities, all logbooks will become part of the project evidence file. The title page of each logbook will be labeled with the following information:

- Logbook title;
- Project name;
- Logbook inventory identification number;
- USACE, Louisville District/other U.S. Army contract number and project delivery order number;
- Start date for field activities; and
- End date for field activities.

Logbook and field form entries will be a compilation of relevant, factual events as they occur. Entries recorded in logbooks can include, but not be limited to, the following information:

- Name and title of author, date, and times of arrival at and departure from the work site;
- Purpose of the drilling, sampling and/or remedial activity;
- Name and contact information of the field manager;
- Names and responsibilities of field crew members;
- Names and titles of any AOC visitors;
- Weather and site conditions;
- Field observations;
- Sample collection or task accomplishment method;
- Amount of materials used or removed;
- Number and volume of sample(s) collected;
- Sample identification number(s);
- Date and time of sample collection, and name of collector;
- Sampling type and methodology, including a distinction between grab and composite samples;
- Sample preservation methods;
- Details of the sampling location, including a sketch map illustrating the sampling location;
- Location, description, and log of sampling point photographs;
- References for all maps and photographs of the sampling site(s);
- Information regarding drilling decisions not recorded on the boring log;
- Types of field instruments used and the purpose of use, including calibration methods and results;
- Any field measurements made (e.g., pH, conductivity, temperature, and static water level);
- Sample documentation information, including
  - COC record numbers; and
  - Number of shipping containers packaged (including contained COC records) and the shipping method employed (noting applicable tracking numbers).
- Sample distribution and transportation (e.g., name and address of the laboratory and courier);
- Name and address of the U.S. Army QA laboratory for the project and the associated project Laboratory Information Management System (LIMS) number, where applicable;
- Information from containers, labels of reagents used, deionized and organic-free water used;
- Decontamination procedures;
- Type, matrix, and containerization method for IDW generated;
- IDW documentation information, including
  - Types of containers/drums;
  - Contents, type, and approximate volume of waste;
  - Type of contamination and predicted level of contamination based on available information (i.e., generator knowledge);
  - Weekly visual inspection information.
- Summary of daily task (including costs where appropriate) and documentation on any cost or scope or work changes required by field conditions;
- Information regarding sampling changes, scheduling modifications, and change orders;

- Information regarding access agreements, if applicable;
- Signature and date of personnel responsible for recorded observations; and
- Signature and date of personnel responsible for verifying the QC review of the logbook and/or field form, including but not limited to, accuracy, completeness, legibility, consistency, and clarity.

EQUIPMENT CALIBRATION

IDENTIFIER	DESCRIPTION	BACKGROUND READING	PRE	ADJUSTMENT (IF NEEDED)	POST	NAME	DATE

Figure 6-1. Equipment Calibration Log

CATEGORY 1 CALIBRATION STANDARDS LOG

PROJECT NAME:

DELIVERY ORDER NO:

INCLUSIVE DATES FOR CALIBRATION MATERIAL USAGE	INSTRUMENT DESCRIPTION	CALIBRATION MATERIAL *	Psi/BOTTLE	NIST # LOT # AND MANUFACTURER	PERSON (INITIALS)
Start: Finish					
Start: Finish					
Start: Finish					
Start: Finish					
Start: Finish					
Start: Finish					
Start: Finish					
Start: Finish					
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Revision 0, 11/22/96, QAAP 12.1

Figure 6-2. Calibration Standards Logs

6.2 PHOTOGRAPHS

Information regarding the documentation of photographs is presented in Section 5.4.2.4.2.

6.3 SAMPLE NUMBERING SYSTEM

A unique sample numbering scheme will be used to identify each sample designated for laboratory analysis. The purpose of this numbering scheme is to provide a tracking system for the retrieval of analytical and field data for each sample. Sample identification numbers will be used on all sample labels or tags, field data sheets and/or logbooks, COC records, and all other applicable documentation used during the AOC-specific investigations. A listing of all sample identification numbers will be maintained in the field logbook.

The sample numbering scheme used for field samples also will be used for duplicate samples so that the sample type will not be discernible by the laboratory. However, other types of field QC samples (e.g., equipment rinsate, trip blank) will be numbered so that they can be readily identified from other sample types. The USACE, Louisville District location/sample identification naming conventions will be used for all AOC-specific investigations. Figure 6-3 summarizes these naming conventions. The sample number scheme used for each project will be presented in the investigation-specific addenda to this FWFSP. Follow-up sampling at a given AOC will begin with sample numbers that follow the last number in the sequence from the initial phase of work. If a sample is not collected or is re-assigned to a different location, a specific reason and notation will be noted in the project field logbook.

6.4 SAMPLE DOCUMENTATION

6.4.1 Sample Labels

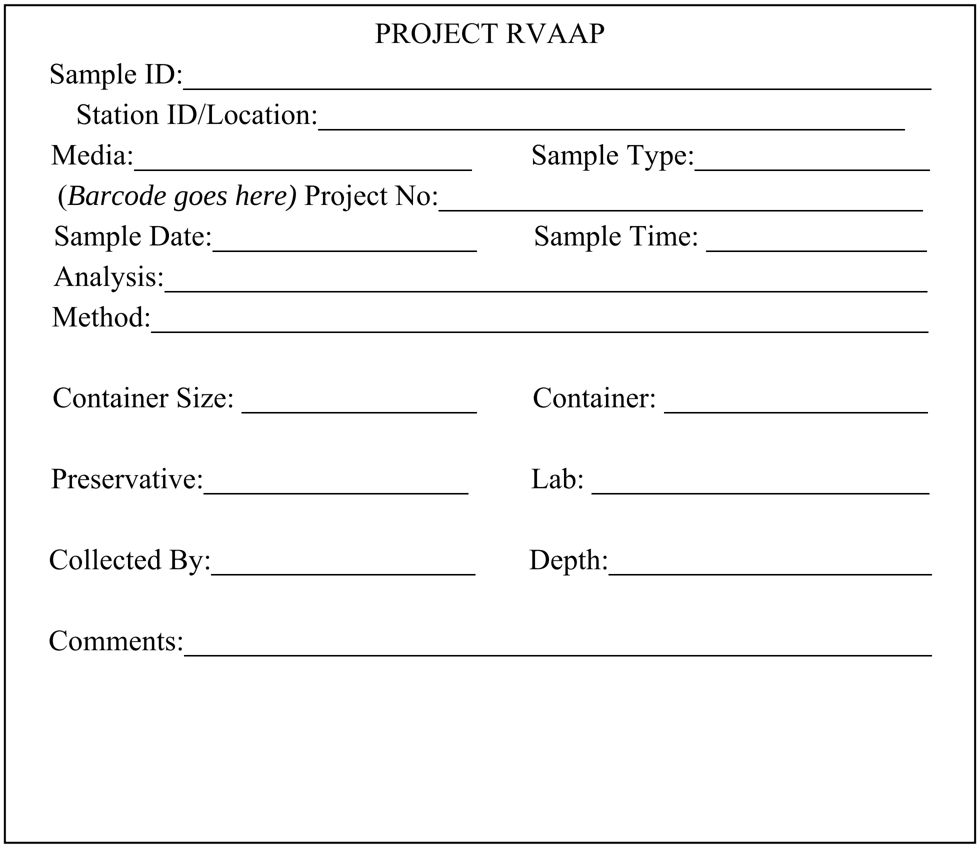
All sample containers provided by the contracted analytical laboratory for use during the AOC-specific investigations will be shipped with sample labels pre-affixed to the containers, or the labels will be affixed to the bottles upon delivery to the investigation area (Figure 6-4). Information will be recorded on each sample container label at the time of sample collection. Sample labels will be completed with black indelible ink. However, if pre-printed labels are used, only field-specific information not already on the labels will be recorded at the time of sample collection. After labeling, if waterproof labels are not used, the label should be covered with wide clear tape to preserve the label during shipment. Labels and tape should not be affixed over the lid seal of VOC containers but should be affixed solely to the sample container. The information to be recorded on the labels will be as follows:

- Contractor name;
- Project name/sampling activity name;
- Sample identification number;
- Sample type (discrete or composite);

- Sample media;
- AOC name and/or sampling station number;
- Analysis to be performed;
- Associated sample methods;
- Volume of containers;
- Type of containers;
- Type of chemical preservative present in container;
- Destination laboratory name;
- Date and time of sample collection;
- Comments and special precautions; and
- Sampler(s) name and initials.

Sampling Location Identification: XXXmm-NNN(n)					
XXX	=	Area Designator	Examples		
			TNT	-	TNT Manufacturing Area
			P11	-	Pond #11
mm	=	Sample Location Type	Examples		
			MW	-	Groundwater Monitoring Well
			SB	-	Soil Boring
			SW	-	Surface Water Location
			SD	-	Sediment Sample Location
			SS	-	Surface Soil Location
			TR	-	Trench Location
			SP	-	Seep Sample
			WP	-	Groundwater Well Point
NNN(n) =		Sequential Sample Location Number	Examples		
Unique, sequential number for each sample location beginning with the following number from the last number used from previous investigation stations and extending into any subsequent investigative phases			004 012 099 107		
(n) Special identifier- Optional use (as needed) to identify special sample matrices or sample location characteristics. For example: Use a D to identify the well as an adjacent deep zone/aquifer well (004D) Use a B to identify the well as a background location (012B) Use an A to identify an abandoned well (099A) Use a M to identify an ISM (107M)					
Sample Identification: XXXmm-NNN(n)-####-tt					
###	=	Sequential Sample Number	Examples		
[must be unique for entire project site/AOC]			0001 0002 0003		
tt	=	Sample Type	Examples		
			GW	-	Groundwater Sample (unfiltered)
			GF	-	Groundwater Sample (filtered)
			SO	-	Soil Sample
			SW	-	Surface Water Sample
			SD	-	Sediment Sample
			PR	-	Free Product Sample
			SP	-	Seep Sample
			TB	-	Trip Blank
			FB	-	Field Blank
			ER	-	Equipment Rinsate

Figure 6-3. USACE, Louisville District Location/Sample Identification Naming Conventions



PROJECT RVAAP

Sample ID:____

Station ID/Location:____________________________________

Media:____________________ Sample Type:______________

(*Barcode goes here)* Project No:_______________________________

Sample Date:________________ Sample Time: ______________

Analysis:____

Method:____

Container Size: ______________ Container: ________________

Preservative:________________ Lab: _____________________

Collected By:________________ Depth:____________________

Comments:____

Figure 6-4. Example of Sample Container Label

6.4.2 Sample Analysis Request Form

A separate sample analysis request form will not be utilized. Sample analysis request information will be recorded on a single combination analysis request and COC form, which is discussed below.

6.4.3 Chain-Of-Custody Records

RVAAP will utilize USEPA Region 5 COC protocols for the AOC-specific environmental sampling activities as described in the *Manual of Custody and Non-Custody Sample Handling Procedures* (USEPA 1978) and COC instructions defined in Appendix F of the *Requirements for the Preparation of Sampling and Analysis Plans* (USACE 2001b). COC procedures implemented for the investigations will be in three parts: documenting the handling of each sample from the time of collection, through completion of laboratory analysis, and delivery of final evidence files. The COC form serves as a legal record of sample possession. A unique number printed or entered on the form will identify each COC. A sample or evidence file is considered to be under custody if when it is:

- In the sampler's physical possession;
- In the sampler's view after being in possession;
- In the sampler's possession and then was secured so any tampering can be detected; or
- In a designated secure area.

Custody will be documented throughout the AOC-specific investigation field sampling activities by the COC form initiated for each day during which samples are collected. This COC will accompany the samples from the AOC to the laboratory and will be returned to the Contractor Laboratory Coordinator with the final analytical report. The field sampler is responsible for the care and custody of the samples until they are transferred or properly dispatched. All personnel with sample custody responsibilities will be required to sign, date, and note the time on the COC form in indelible ink when relinquishing samples from their immediate custody (except in the cases where samples are placed into designated secure areas for temporary storage before shipment). As few people as possible should handle the samples. All shipments will be accompanied by the COC record identifying the contents. The original record will accompany the shipment and copies will be retained by the sampler for return to project management and the project file. Bills of lading or airbills will be used as custody documentation during times when the samples are being shipped from the AOC to the laboratory and they will be retained as part of the permanent sample custody documentation. Whenever co-located or split samples are collected for comparison analysis by the U.S. Army QA Laboratory or a government agency, a separate COC will be prepared for those samples and marked to indicate with whom the samples are being split.

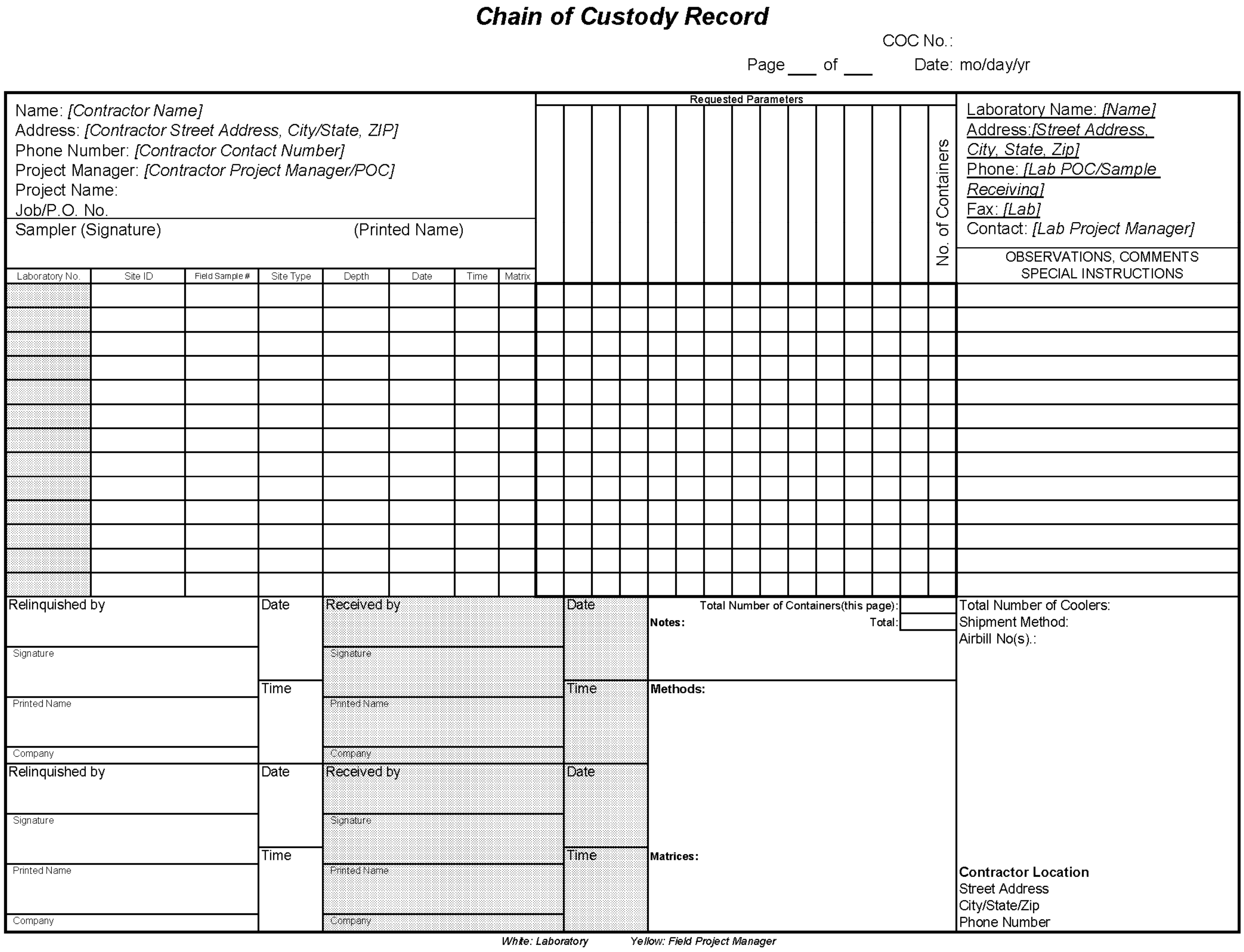
COC forms will be used to document the integrity of all samples collected. To maintain a record of sample collection and transfer between personnel, shipment, and receipt by the laboratory, COC forms will be filled out for sample sets as determined appropriate during the course of fieldwork. An example of the COC form used for the AOC-specific investigations is illustrated in Figure 6-5.

The following information will be recorded on all COC forms:

- Project name (and USACE delivery order number);
- Name of Contractor;
- Name of Contractor Project Manager and contact information;
- Sample number (for each sample in shipment);
- Sample station (for each sample in shipment);
- Collection date and time (for each sample in shipment);
- Number of containers for each sample;
- Sample description (i.e., environmental medium);
- Sample type (discrete or composite);
- Analyses required for each sample;
- Sample methods;
- Sample preservation technique(s);
- COC or shipment number;
- USACE LIMS number (only on COC records for U.S. Army QA sample shipments);
- Shipping address of the laboratory;
- Name of subcontractor laboratory QA/QC manager and contact information;
- Date, time, method of shipment, courier, and airbill number; and
- A space to be signed as custody is transferred between individuals.

The individual shipping the samples from the field to the laboratory is responsible for completing the COC form and noting the date and time of shipment. A field sampling team member or project QA/QC manager will also inspect the form for completeness and accuracy. In addition, this individual determines the shipping classification for samples under United States Department of Transportation (DOT) HM126F, 49 *Code of Federal Regulations (CFR)*, Subtitle B, Chapter 1, Subchapter C, Hazardous Materials Regulations, and International Air Transport Association (IATA) dangerous goods regulations. After the form has been inspected and determined to be satisfactorily complete, the responsible individual signs, dates, and notes the time of transfer to the approved shipping company on the form. If samples are shipped to a laboratory in the local area, samples just collected and stored on ice may not have sufficient time to cool to the required temperature of 4°C (±2°C). The responsible individual will make note of this on the COC form. The COC form then is placed in a sealable plastic bag and placed inside the cooler used for sample transport after the field copy of the form has been detached. If a local courier service is used, the documentation can be given to the courier directly. The field copy of the form will be appropriately filed and kept at RVAAP for the duration of the AOC activities.

In addition to the COC form, custody seals will be placed on each cooler used for sample transport. These seals consist of a tamper-proof adhesive material placed across the lid and body of the coolers in such a manner that if the cooler is opened, the seals will be broken. The custody seals ensure no sample tampering occurs between the time the samples are placed into the coolers and the time the coolers are opened for analysis at the laboratory. Cooler custody seals are signed and dated by the individual responsible for completing the COC form contained within the cooler. The signature and date are written on both the cooler lid and cooler body portions of the seals.



Chain of Custody Record

COC No.:

Page ___ of ___ Date: mo/day/yr

Name: *[Contractor Name]*
Address: *[Contractor Street Address, City/State, ZIP]*
Phone Number: *[Contractor Contact Number]*
Project Manager: *[Contractor Project Manager/POC]*
Project Name:
Job/P.O. No.

Sampler (Signature) (Printed Name)

Laboratory Name: *[Name]*
Address:*[Street Address, City, State, Zip]*
Phone: *[Lab POC/Sample Receiving]*
Fax: *[Lab]*
Contact: *[Lab Project Manager]*

								Requested Parameters															
Laboratory No.	Site ID	Field Sample #	Site Type	Depth	Date	Time	Matrix															No. of Containers	OBSERVATIONS, COMMENTS SPECIAL INSTRUCTIONS

Relinquished by Signature Printed Name Company	Date Time	Received by Signature Printed Name Company	Date Time
Relinquished by Signature Printed Name Company	Date Time	Received by Signature Printed Name Company	Date Time

Total Number of Containers(this page):
Notes: Total:

Methods:

Matrices:

Total Number of Coolers:
Shipment Method:
Airbill No(s).:

Contractor Location
Street Address
City/State/Zip
Phone Number

White: Laboratory *Yellow: Field Project Manager*

Figure 6-5. Example of Chain of Custody Form

6.4.4 Receipt of Sample Forms

The contracted laboratory documents the receipt of environmental samples by accepting custody of the samples from the approved shipping company. This receipt is documented under the received by block on the COC. In addition, the contracted laboratory documents the condition of the environmental samples upon receipt as outlined in Section 7.0. Sample receipt(s), including received COC, sample cooler receipt form, and sample login information, is transmitted to the project manager.

6.5 DOCUMENTATION PROCEDURES

The tracking procedure used to document all samples collected during the AOC-specific investigations is listed below.

1. Collect and place the samples into laboratory sample containers as defined in Section 5.0.

2. Complete the sample container label information as defined in Section 6.4.1.

3. Place the sample containers into an ice-filled cooler as specified by the sample method.

4. Complete sample documentation information in the field logbook as defined in Section 6.1.

5. Complete the project and sampling information sections of the COC form(s) for all samples to be transported in a single cooler, as defined in Section 6.4.3.

6. Complete the airbill for the cooler to be shipped (if necessary).

7. Perform a completeness and accuracy check of the COC form(s).

8. Complete the sample relinquishment section of the COC form(s), as defined in Section 6.4.3, and place the form(s) into the cooler.

9. Place the COC seals on the exterior of the cooler as defined in Section 6.4.3.

10. Pack and ship the cooler to the laboratory as defined in Section 7.0.

11. Laboratory receives the cooler, inspects the contents, and records the sample receipt information of the contained COC form(s) and cooler receipt form(s) as defined in Sections 6.4.4 and 7.0. Each cooler must have a separate cooler receipt form.

12. Transmit the original COC form(s) with the final analytical results from the laboratory.

6.6 CORRECTIONS TO DOCUMENTATION

All original information and data in field logbooks, on sample labels, on COC forms, and on any other project-related documentation are recorded in black waterproof ink and in a completely legible manner. Errors in any document are corrected by crossing out the error and entering the correct information or data. Any error discovered in a document is corrected in the field by the individual responsible for the entry. Erroneous information or data are corrected in a manner that will not obliterate the original entry, and all corrections are initialed and dated by the individual responsible for the entry.

6.7 MONTHLY REPORTS

Monthly reports will be submitted during implementation of field investigations at AOCs as contracts require. The Monthly Reports focus on the progress to date of an AOC-specific investigation and are submitted directly to the U.S. Army Project Manager by the 10th day of the month following the reporting period. Copies of the Monthly Report are subsequently submitted to the Ohio EPA Northeast District Office Site Coordinator. The Monthly Reports will document AOC identification and activities, status, percent complete, data collected to date (excluding analytical results), difficulties encountered, corrective actions, and planned activities.

6.8 SUBMITTAL OF INFORMATION

All information including, but not limited to, sample numbers, collection time and date, borehole and well depths, water level, and water quality measurements will be submitted in electronic format for entry into REIMS per procedures outlined in Section 10.3 of the FWQAPP, Electronic Data Deliverable File Specifications.

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7.0 SAMPLE PACKAGING AND SHIPPING REQUIREMENTS

Sample containers must be packaged according to requirements for preservation in transit to laboratories. Samples requiring cooling are packaged in thermally insulated rigid-body coolers. Samples not requiring cooling (i.e., geotechnical soil samples) are packaged in heavy cardboard shipping boxes. Environmental, QA, and QC samples collected during the project are shipped within their hold time to the laboratory. During the time period between collection and shipment, all samples are stored in ice-filled coolers or refrigerators and maintained in a secure area. Sample packaging, labeling, and shipping are conducted in accordance with applicable DOT (49 *CFR*)/IATA dangerous goods specifications and completed in accordance with instructions defined in Appendix F of the *Requirements for the Preparation of Sampling and Analysis Plans* (USACE 2001b). Packaging and shipping procedures for environmental samples collected during the AOC-specific investigations are as follows:

- Identify all sample containers with sample labels placed onto each container. Clearly label all samples with waterproof ink.

- Verify that sample containers are the appropriate type and volume and are properly preserved.

- Match sample containers with the information on the COC.

- Clean the exterior of all sample containers, if necessary.

- Ensure all bottles are properly sealed with lids tightened. If unsure about lid integrity, tape bottles, except those containing samples designated for volatile organic analyses, with electrical tape.

- Place all glass sample bottles in bubble wrap sleeves or Styrofoam forms.

- Place each sample bottle into a separate plastic bag that will then be sealed. For groundwater samples, place each vial for an individual sample into the same plastic bag. Wrap trip blank containers and place them in the cooler with the volatile organic analyte vials. Squeeze as much air as possible from the sample container bags before sealing.

- Tape the cooler drain plug shut from both the inside and outside before placing the samples into a rigid-body cooler. Line the cooler with a large plastic bag; cushioning packing material is preferred.

- Place all of the sample containers upright in the shipping coolers inside a large plastic bag along with sufficient ice to maintain a temperature of 4°C ±2°C, which will be placed around, among, below, and on top of the sample containers. Include a temperature blank in each cooler.

- Ensure a trip blank is included in each cooler containing environmental samples for organic analysis, beginning when the environmental samples are placed in the cooler for storage and/or shipment.

- Place additional inert packing material into the cooler, if required, to prevent shifting of the sample containers during transport.

- Place all required laboratory paperwork, including the COC form(s), inside a plastic bag and tape it to the inside of the cooler lid.

- To complete the packing process, seal the cooler liner, close the cooler lid, and place two signed/dated custody seals on the cooler – one across the front and one across the side.

- Place arrows on each cooler indicating which end is up.

- Seal rigid-body coolers with strapping tape applied directly to the cooler body. Duct tape may be used around the seam of the cooler if shipping via a commercial carrier.

- Complete the airbill, if required for the shipment, and attach it to the top of the shipping box/cooler, which then will be transferred to the courier or commercial carrier for delivery to the laboratory. Verify the airbill contains accurate information prior to shipment.

- All coolers containing investigation samples will be shipped overnight to the laboratory by Federal Express or a similar courier.

Failure to properly handle, document, or ship the project samples as detailed could jeopardize the usability of the sample results and ultimately the project objectives.

Environmental samples should not be shipped as a hazardous material or a dangerous good unless they are known or expected to present a hazard as specified in one of the nine DOT hazard classes. Using an USEPA method to preserve a water sample does not make the sample a hazardous material (DOT 2003). In addition to standard shipping requirements and packaging and shipping procedures, hazardous samples collected during the AOC-specific investigations require the following:

- Each bagged sample bottle is placed upright into a separate paint-type can, the can filled with vermiculite or a similar packing material, and the lid secured to the can. The lid is sealed with metal clips or with strapping tape.

- Arrows are placed on each can indicating which end is up.

- The outside of each can is labeled with the proper DOT shipping name and identification number for the sample. This information is recorded on a sticker affixed to the can or printed legibly directly on the can.

- The cans containing samples are placed upright in a rigid-body cooler that has had its drain plug taped shut inside and out and has been lined with a large plastic bag. Vermiculite or a similar packing material is placed into the bottom of the cooler.

- All hazardous samples are shipped to the laboratory on ice, which will be contained in double plastic bags placed around, among, and on top of the sample container cans.

- Additional inert packing material is placed around and on top of cans in the cooler to prevent shifting during transport. After this material is added, the plastic liner inside the cooler is taped shut.

- Emergency response information must accompany hazardous materials shipments. This requirement is met by providing the carrier with Material Safety Data Sheets or by entering the Emergency Response Guidebook guide numbers on the shipping paper.

- The following markings are placed on the top of the cooler:

    - Proper shipping name;
    - DOT identification number;
    - Shipper's or consignee's name and address; and
    - "This End Up" legibly written if the shipment contains hazardous liquid materials.

- The following labels are placed on the top of the cooler:

    - Appropriate hazard class label (placed next to the proper shipping name); and
    - "Cargo Aircraft Only," if applicable.

- The airbill, if necessary for the shipment, is completed and attached to the top of the cooler, which then is transferred to the courier for delivery to the laboratory. Restricted-article airbills are used for the shipment, and the "Shipper Declaration for Dangerous Goods" section of the airbill is properly completed.

The contracted laboratory and USACE QA laboratory will document the condition of the environmental samples upon receipt at the laboratory. This is commonly completed on a "Condition Upon Receipt" form. The Condition Upon Receipt form or cooler receipt checklist will be provided to the Contractor Laboratory QA/QC Manager within 24 hr of sample receipt and should be included as part of the final laboratory deliverable. Both the contractor and USACE QA laboratories are responsible for the final disposition of environmental samples, including proper handling and disposal.

The contracted analytical laboratory name and address and laboratory point of contact to be used for each project will be identified in the investigation-specific addenda to this FWFSP. If QA samples are collected as part of an investigation, the addenda for that AOC-specific investigation will also identify the name, address, and point of contact for the USACE QA laboratory to be used for the investigation.

8.0 INVESTIGATION-DERIVED WASTE

IDW includes all materials generated during an investigation that cannot be effectively reused, recycled, or decontaminated in the field. IDW consists of materials that could potentially pose a risk to human health and the environment (e.g., sampling and decontamination wastes) as well as materials that have little potential to pose risk to human health and the environment (e.g., sanitary solid wastes). Two types of IDW are generated during the implementation of environmental field activities: indigenous and non-indigenous. Indigenous IDW potentially generated during environmental activities includes soil and bedrock drill cuttings; residual soil samples; soil and buried waste materials from trenching; residual sludge and sediment samples; and groundwater from well point installation, drilling fluids, monitoring well development, and purging. Non-indigenous IDW potentially generated includes decontamination rinse fluids, spent test kit materials, and compactable and miscellaneous trash (e.g., disposable personal protective equipment (PPE) or investigation-related equipment). Procedures used to manage IDW are described below. This FWFSP addresses generic waste collection, characterization, storage, and disposal procedures to be used when implementing environmental investigations at RVAAP; however, to ensure proper handling of IDW, it is necessary to address project-specific waste management practices in each Investigation-specific SAP Addendum tiered under this FWSAP. In all instances, best management practices should be implemented to effectively minimize the quantity of IDW generated.

All wastes generated during environmental investigations at RVAAP must be managed in accordance with federal and state of Ohio requirements, this FWFSP, investigation-specific addenda, and Ohio EPA correspondence (Ohio EPA 1997). All hazardous wastes generated during environmental investigations at RVAAP must be managed in accordance with federal and state of Ohio large-quantity generator requirements as discussed below. All hazardous waste activities must comply with RVAAP's *Installation Hazardous Waste Management Plan* (BRACO 2009). All waste disposal, other than sanitary refuse, will be coordinated with the RVAAP Operating Contractor and the RVAAP Facility Manager.

8.1 INVESTIGATION-DERIVED WASTE COLLECTION AND CONTAINERIZATION

All indigenous solid IDW (soil and rock cuttings) generated from borehole installations >3.0 m (10 ft) in depth should be collected and segregated by borehole. Additionally, all unsaturated soil should be segregated from saturated soil within each borehole. The segregation of unsaturated and saturated soil is necessary only in boreholes drilled below the water table for completion as monitoring wells because all boreholes drilled for soil characterization are expected to be terminated at or above the water table. All indigenous solid IDW (soil and sediment) from borehole installations <3.0 m (10 ft) will be collected and segregated by the AOC from which it was generated. Segregation by AOC from shallow boreholes/sediment sampling stations is necessary due to the small volume of soil and sediment expected to be generated from individual locations. Decision to segregate IDW per project, sample location, or AOC will be addressed in each investigation-specific addendum to this FWFSP. If generator knowledge indicates that a waste may be hazardous, it will be segregated from non-hazardous waste regardless of the volume generated. The segregation of unsaturated from saturated soil in shallow boreholes <3.0 m (10 ft) and sediment sampling stations is not anticipated because none of the shallow boreholes encountered at the water table and sediment sampling stations will yield either totally saturated or unsaturated solid IDW. All indigenous solid IDW will be contained in labeled, DOT-approved, open-top 55-gal drums and sealed with bung-top lids. All indigenous solid IDW (soil and waste material) generated from trenching operations will be segregated by trench location and staged temporarily on plastic sheeting (minimum 6-mil thickness) at the trenching site until the trench is completed. The temporary staging of trench IDW will be in a manner protective of human health and the environment. All potentially hazardous solid IDW recovered from a trench will be segregated from potentially non-hazardous IDW and will be contained immediately in labeled, DOT-approved, open-top 55-gal drums equipped with plastic drum liners and sealed with bung-top lids. Potentially hazardous solid IDW from trenching will be identified in the field by visual inspection of the soil and waste materials (e.g., heavy discoloration, oil saturated), the types of waste materials unearthed (e.g., drum containers, paint or aerosol cans, munitions wastes), and screening using field instruments (e.g., organic vapor analyzer). All non-hazardous solid (soil and buried material) IDW will be returned immediately to the trench upon completion in the order that the material was excavated.

All liquid indigenous (groundwater) IDW generated from well point and monitoring well installation, development, and purging will be segregated by AOC. All liquid indigenous IDW will be collected either in labeled, DOT-approved, new 55-gal closed-top drums or in labeled polyethylene storage tanks.

All solid non-indigenous (e.g., expendable sampling equipment, PPE, and trash) IDW will be segregated as non-contaminated and potentially contaminated material. Potentially contaminated and non-contaminated solid non-indigenous IDW will be identified in the field based on visual inspection (e.g., soiled versus non-soiled), usage of the waste material (e.g., outer sampling gloves versus glove liners), and field screening of the material using available field instrumentation (e.g., organic vapor analyzer). All non-contaminated non-indigenous IDW will be contained in trash bags with potentially contaminated non-indigenous IDW being additionally contained in labeled, DOT-approved, open-top 55-gal drums equipped with plastic drum liners and sealed with bung-top lids. All liquid non-indigenous (decontamination rinse water) IDW will be segregated by waste stream (e.g., soap and water/water rinses from alcohol rinses [e.g., methanol or isopropanol] and acid rinses [e.g., hydrochloric or nitric acid]) and contained in either labeled, DOT-approved, 55-gal closed-top drums or in approved polyethylene storage containers. All known potentially hazardous liquid non-indigenous IDW streams, such as methanol, hydrochloric acid rinses, and acetone waste from field laboratories, will be contained separately in labeled, DOT-approved closed-top drums. Listed hazardous waste streams (i.e., methanol) must be disposed of as hazardous waste and will not be combined or diluted with non-hazardous waste streams.

As an alternative to off-site disposal following field activities, temporary storage of non-hazardous soil may be permitted on-site with prior approval from Ohio EPA. Storage of soil within its AOC of origin represents a lower-cost option for non-hazardous waste disposal compared to containerization and off-site disposal. Such storage requires soil materials known to be non-hazardous (i.e., chemical analyses already complete) to be placed on polyethylene sheeting inside the AOC where it originated. The soil pile must be stabilized and its boundary marked with flagging or other visible labels. The final disposition of any such soil will take place after site-specific cleanup levels are established. If contaminant concentrations in the soil are below cleanup levels, the soil may be spread and seeded (using RVAAP-approved seed mixes) or used for fill at the AOC after remediation. If the contaminant concentrations are generally higher than cleanup levels, the soil will be removed with any soil excavated during the cleanup.

The method(s) used to containerize each waste stream during each investigation will be identified in the investigation-specific SAP addenda based on the appropriate waste containment option, as defined above, to meet the investigation-specific criteria.

8.2 WASTE CONTAINER LABELING

All containers, including empty ones, must be properly labeled. All waste storage containers (drums and polytanks) will be labeled immediately before and continuously during their use to ensure proper management of the contained wastes. All labels will be weather-resistant, commercially available labels. Two labels will be affixed and located on opposite sides on the upper one-third of each storage container. Labels will be legibly completed using indelible ink. The drum number will be legibly recorded directly on a clean dry drum surface on the top and upper one-third of each storage container using an indelible paint marker. Additional label information may be recorded directly on a clean dry drum surface.

An example of the waste storage container label is shown in Figure 8-1. The following procedure will be used for waste container labeling:

- Place each label on a smooth part of the container and do not affix it across drum bungs, seams, ridges, or dents.

- Upon use of a container, replace the empty label with a drum label filled out with the information listed below.

- When sampling each container per the procedures outlined in Section 8.4, affix an appropriate pending analysis label to the container.

- When classifying the IDW based on analytical results, affix the appropriate hazardous or non-hazardous label to the drum.

- Record the following information on each label:

    - Contractor-assigned container number;
    - Contents;

  - Source of waste;
  - Source location (if applicable);
  - Project name and AOC identification;
  - Physical characteristic of the waste;
  - Generation date(s);
  - Address of waste generation;
  - Satellite or 90-day accumulation container; and
  - Contact information for a contractor contact and the RVAAP Environmental Manager.

- Record all information on container labels with indelible ink (permanent marker or paint pen) and record necessary information in a field logbook or on an appropriate field form.

- Protect all container labels so that damage or degradation of the recorded information is prevented.

DRUM NUMBER: 2010-LL1sb-489

CONTENTS Unsaturated Soil Cuttings, 75% Full

SOURCE OF WASTE: LL1 Sewers Investigation

SOURCE LOCATION: Soil Boring LL1sb-489

GENERATION DATE(S) 04/07/10-04/08/10

ACCUMULATION CONTAINER TYPE: Satellite

ADDRESS: 8451 State Route 5, Ravenna OH 44266

CONTACT: First Last (Company) (555)-555-5555
First Last (RVAAP) (330)-555-5555
COMMENTS________________________________

Figure 8-1. Example of Waste Storage Container Label

8.3 INVESTIGATION-DERIVED WASTE FIELD STAGING

Subject to the review and approval of RVAAP staff before the start of a project, each Contractor Field Operations Manager will designate a field staging area (FSA) for indigenous IDW from each project. These FSAs are satellite accumulation areas only; no 90-day hazardous waste will be stored in an FSA. If a centralized decontamination area is utilized (outside of an AOC) to support the investigation at multiple AOCs, an FSA will also be established and/or co-located with the decontamination facility to store non-indigenous liquid and solid IDW resulting from decontamination activities. All indigenous (solid and liquid) IDW will be stored at the point of generation within the AOC or in the FSA until the IDW is characterized for disposal in accordance with Section 8.4. After IDW characterization, the wastes will be disposed of according to Section 8.5 or moved to the appropriate FSA and stored pending disposal.

All non-indigenous (decontamination rinse and expendable material) IDW will be stored in the appropriate (AOC or central decontamination area) FSA until it is characterized for disposal in accordance with Section 8.4. After characterization of the non-indigenous IDW, the wastes will be disposed of according to Section 8.5 or moved to the appropriate FSA and stored pending disposal. All non-contaminated, non-indigenous IDW will be staged in a sanitary trash container (dumpster) pending disposal.

Each FSA will be visibly marked and all waste containers (drums and polyethylene tanks) will be placed on top of plastic sheeting or pallets and covered. Because of the large number of vacant buildings at many of the AOCs at RVAAP, FSAs will be established, where possible, based on availability and approval of the facility and adjacent to or inside designated, currently unused buildings to protect the waste containers from the weather and to safeguard the integrity of the stored wastes over time. All IDW will be segregated by location and type (e.g., soil and rock cuttings, decontamination water, alcohol and acid decontamination rinses, well development and purge water) so that it can be identified with a given location or operation. All waste containers will be stored in a manner to accommodate inspection and sampling, if necessary, and to facilitate safe handling of the containers. All labels will be oriented so they are facing out in a consistent direction to facilitate easy inspection. If RCRA wastes are suspected at an AOC, they will be identified in the investigation-specific SAP addenda. All RCRA hazardous wastes will be managed in accordance with the appropriate technical requirements establish in OAC, Chapter 3745-55, Management of Hazardous Waste (40 *CFR* 264, Subparts I [containers] and J [tanks]).

Hazardous and non-hazardous IDW staged and stored at RVAAP is subject to the requirements of RVAAP's Installation Hazardous Waste Management Plan (BRACO 2009). All contractors conducting environmental investigations at AOCs must comply with the following minimum requirements of that plan:

- No 90-day hazardous waste storage areas will be permitted within an AOC. Hazardous waste will be stored at a centralized 90-day storage area designated by the RVAAP Environmental Coordinator.

- Satellite accumulation areas may be used for hazardous waste storage, but all state and federal management rules must be followed (40 *CFR* 262.34 [c] [1]). No more than 55-gal of hazardous waste or 1 qt of acutely hazardous waste can be stored in a satellite accumulation area. Hazardous waste satellite accumulation areas must be near the point of hazardous waste generation. An inventory and a location map of the waste must be given to RVAAP staff as soon as waste is generated; this information must be updated on a daily basis if changes occur.

- Any hazardous waste containers in a satellite accumulation area must be moved to the designated 90-day storage area within 72 hr of the decision to dispose of them.

- All contractor waste, including environmental waste pending sampling, pending analysis waste, hazardous waste, and non-hazardous waste will be inspected and inventoried weekly. Documentation of the inspection will be recorded on the RVAAP weekly non-hazardous and hazardous waste inventory sheet (Figure 8-2). This inventory sheet will be submitted weekly to the RVAAP Environmental Coordinator as long as the waste is stored on-site. Hazardous waste must be inventoried every 7 days, at a minimum, and maintain compliance with federal regulations (40 *CFR* 260-265). Inventory and inspection must include, at a minimum:
    - Inventory of number of containers;
    - Inspection of container(s) conditions (no bulging, or rusting);
    - Inspection of labels (all present, correctly labeled, not faded);
    - Date and time of inspection; and
    - Inspectors name and signature.

- Both hazardous and non-hazardous waste (except for municipal waste) must be manifested.

- Hazardous waste containers must be closed and tightened according to manufacturer's specifications using a calibrated torque wrench (49 *CFR* 173.22).

- All contractors must obtain an RVAAP tracking number from the RVAAP Operating Contractor when shipping waste; this number must be written on the top of the front page of the manifest.

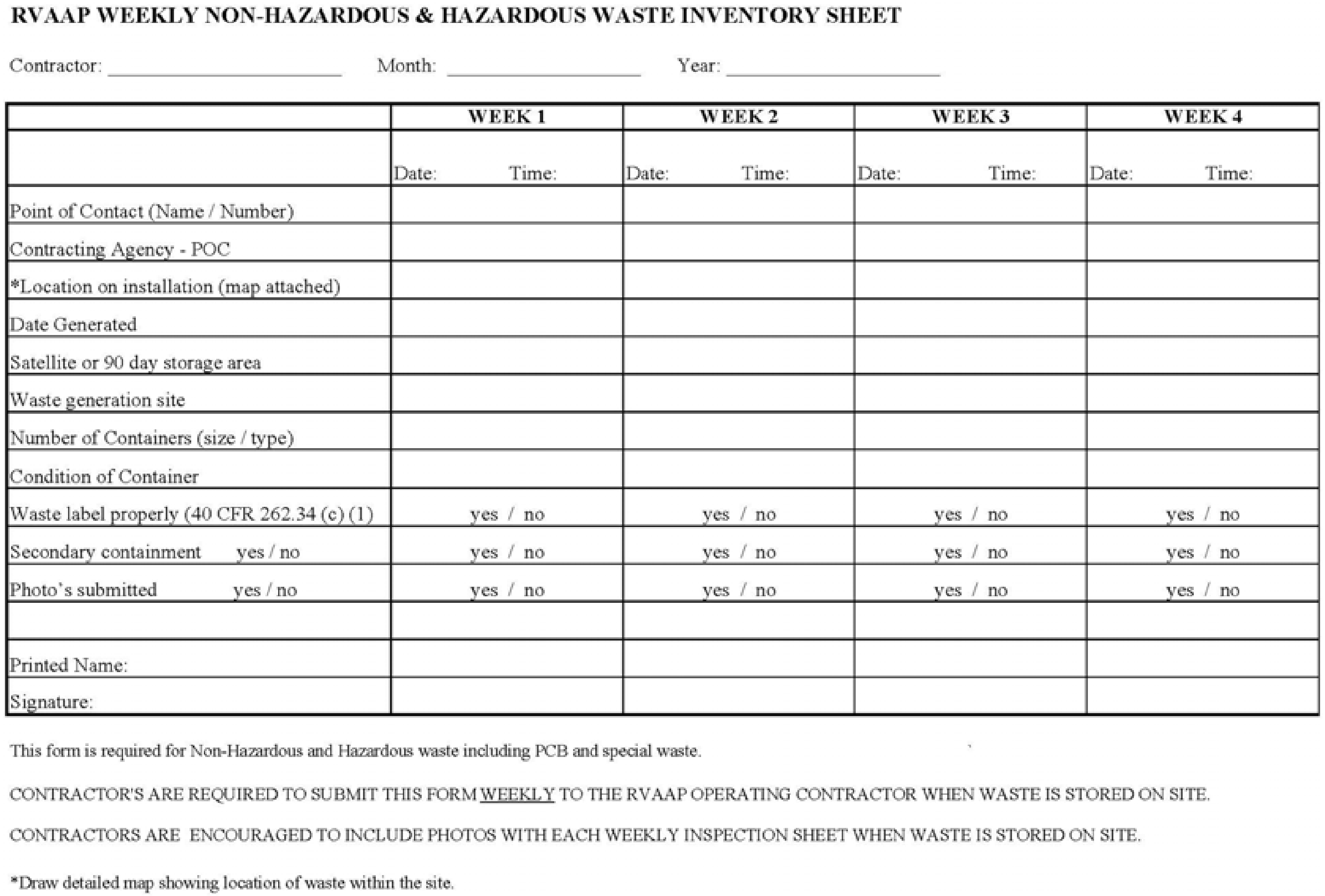
- The source of the waste (project name, activity, area within the AOC) and the weight must be written on the manifest.

- The contractor must give the state's copy of the manifest to the RVAAP Operating Contractor, who will submit it on behalf of the facility.

- All non-hazardous containerized waste not transported off-post within 30 days following project completion must be consolidated at an RVAAP-approved storage area near Post 1. Any non-hazardous liquid waste will require secondary containment at this time.

- All liquid hazardous waste must have secondary containment.

- All contractors must confirm that the disposal facility has received the hazardous and non-hazardous waste shipments within the required time frames. This will be accomplished by contacting the RVAAP Operating Contractor to verify that the disposal facility signed and returned a copy of the manifest to RVAAP. If the copy has not been returned within 35 days of the pickup date, the contractor must immediately notify the RVAAP Environmental Coordinator and begin corrective actions.



RVAAP WEEKLY NON-HAZARDOUS & HAZARDOUS WASTE INVENTORY SHEET

Contractor: ______________________ Month: __________________ Year: ____________________

	WEEK 1	WEEK 2	WEEK 3	WEEK 4
	Date: Time:	Date: Time:	Date: Time:	Date: Time:
Point of Contact (Name / Number)				
Contracting Agency - POC				
*Location on installation (map attached)				
Date Generated				
Satellite or 90 day storage area				
Waste generation site				
Number of Containers (size / type)				
Condition of Container				
Waste label properly (40 CFR 262.34 (c) (1)	yes / no	yes / no	yes / no	yes / no
Secondary containment yes / no	yes / no	yes / no	yes / no	yes / no
Photo's submitted yes / no	yes / no	yes / no	yes / no	yes / no
Printed Name:				
Signature:				

This form is required for Non-Hazardous and Hazardous waste including PCB and special waste.

CONTRACTOR'S ARE REQUIRED TO SUBMIT THIS FORM WEEKLY TO THE RVAAP OPERATING CONTRACTOR WHEN WASTE IS STORED ON SITE.

CONTRACTORS ARE ENCOURAGED TO INCLUDE PHOTOS WITH EACH WEEKLY INSPECTION SHEET WHEN WASTE IS STORED ON SITE.

*Draw detailed map showing location of waste within the site.

Figure 8-2. Weekly Waste Inventory and Inspection Sheet

8.4 INVESTIGATION-DERIVED WASTE CHARACTERIZATION AND CLASSIFICATION FOR DISPOSAL

All indigenous IDW (e.g., soil, rock cuttings, and groundwater) will be characterized for disposal based on analytical results from environmental samples or from direct analysis of composite IDW samples. All IDW must be analyzed for Toxicity Characteristic Leaching Procedure (TCLP) VOCs, TCLP SVOCs, TCLP metals, TCLP herbicides, TCLP pesticides, total sulfide, total cyanide, corrosivity (pH), and flashpoint for proper disposal. Other analyses may be added based on generator knowledge. When indigenous IDW will be segregated by sample station for boreholes >3.0 m (10 ft) in depth, trenches, and monitoring wells, the results of environmental samples collected from each sampling station can be used to determine the chemical composition of the wastes generated from that station and used to characterize the waste for disposal. In boreholes where it is necessary to segregate unsaturated and saturated solid indigenous (soil and rock cuttings) IDW (i.e., boreholes drilled below the water table for completion as monitoring wells), the results from environmental soil samples will be used to characterize the unsaturated soil and rock cuttings and samples of saturated soil or rock from each borehole will be used to characterize the saturated soil and rock cuttings. Where it is necessary to segregate solid indigenous (soil) IDW by AOC or project (i.e., boreholes <3.0 m [10 ft] in depth), the results of environmental soil samples from all boreholes where wastes are commingled will be used to characterize the waste in each container.

Indigenous and non-indigenous IDW not considered hazardous under RCRA but containing PCBs or asbestos may be regulated by the Toxic Substances Control Act (TSCA). In general, PCB concentrations of 50 ppm or greater and asbestos equal to or greater than 1% by weight must be managed in accordance with TSCA requirements in 40 *CFR* 761. Media that come into contact with regulated PCBs must be stored and disposed of as regulated PCB-containing material.

Non-indigenous IDW, except for PPE and expendable sampling equipment, will be characterized for disposal based on composite samples collected from segregated waste stream storage containers. Composite waste samples will be submitted for laboratory analysis to characterize each waste stream for disposal. Procedures for composite waste sampling are presented in Sections 8.4.1 and 8.4.2. PPE and expendable sampling equipment will be visually inspected and screened for contaminants on-site using available field screening instruments after each use to determine if residual levels of contamination exist that may exceed contaminant action levels. PPE and expendable sampling equipment will be segregated by sampling stations as clean or potentially contaminated trash based on the results of field screening and visual inspection. Potentially contaminated PPE and expendable sampling equipment will be containerized in accordance with Section 8.1 and characterized based on the results of environmental samples collected from the sample station with which the wastes are associated.

Analytical results from the subcontracted laboratory (approximately 30 days after submission of sample delivery groups) will be reviewed to determine if any potentially hazardous wastes exist. This review includes a comparison of the analytical results against the TCLP criteria for liquids and a 20-fold TCLP dilution factor for soil. Table 8-1 presents the maximum concentration of contaminants for toxicity characterization of hazardous wastes as specified in 40 *CFR* 261.24. Table 8-2 presents the maximum concentrations for non-TCLP analytes for hazardous waste determination. Based on the results of analytical data, IDW will be categorized and labeled as either hazardous or non-hazardous. After all analytical results have been received for each investigation and prior to the disposal of any waste, an IDW Characterization and Disposal Plan will be prepared and submitted to RVAAP, USACE, and Ohio EPA. The IDW Characterization and Disposal Plan will present an inventory of all stored IDW, document the analytical results and IDW characterization, and make recommendations for the disposal of all IDW based on facility-wide applicable or relevant and appropriate requirements (Ohio EPA regulatory criteria, RCRA, TSCA, and Safe Drinking Water Act) and contaminant risk-based action levels. The recommendations for IDW disposal presented in the IDW Characterization and Disposal Plan will be submitted to the U.S. Army, the Ohio EPA Division of Emergency and Remedial Response, and the Ohio EPA Division of Solid and Infectious Waste Management and, upon approval, implemented.

8.4.1 Solid Investigation-Derived Waste Composite Sampling Procedure

Solid IDW may be characterized on the basis of analytical results from correlative environmental samples; however, if it is necessary to characterize solid IDW by composite sampling, a specific procedure will be used.

Composite sampling of solid IDW (soil and rock cuttings) for disposal characterization will be performed using a composite grab sampling technique. The equipment used in solid IDW sampling will consist of small-diameter hand augers or soil push probes, stainless steel bowls, and mixing instruments (e.g., knives and spoons) decontaminated following the procedure presented in Section 5.5.2.8. The handling, storage, and shipment of IDW composite grab samples will follow the procedures for soil samples described in Section 6.0. Composite grab sample collection will be performed as follows:

1. Collect discrete grab samples using clean, decontaminated, or disposable equipment such as small-diameter hand augers or soil push probes from each segregated IDW waste container. Each discrete grab sample should be collected in an identical fashion (frequency and volume).

    a. For volatile organic characterization, grab samples of equal proportions will be transferred directly from each IDW waste container to the sample container with minimum head space for laboratory analysis.

    b. For all analyses other than VOCs, individual grab samples will be transferred into a sample bowl for homogenizing.

2. Homogenize individual grab samples using a sampling bowl and mixing instrument by stirring and turning over the sample until the mixture is adequately homogenized. The mixture is then divided by half, and equal portions from each half will be used to fill sample containers.

3. Assemble the sample containers that contain the homogenized grab samples that will make up a specific composite sample.

4. Remove an aliquot of sample from each container to be sampled and place it in a decontaminated stainless steel mixing bowl. Each aliquot amount is to be as identical as possible to facilitate representativeness.

5. Homogenize the aliquots as described in Step 2.

6. Remove sample amounts from the homogenized composite sample and place them into the proper containers for shipment to the laboratory.

Table 8-1. Maximum Concentration of Contaminants for Toxicity Characteristic (40 *CFR* 261.24)

USEPA Hazardous Waste Number	Contaminant	CAS Number	Regulatory Level (mg/L)
D004	Arsenic	7440-38-2	5.0
D005	Barium	7440-39-3	100.0
D018	Benzene	71-43-9	0.5
D006	Cadmium	7440-43-2	1.0
D019	Carbon Tetrachloride	56-23-5	0.5
D020	Chlordane	57-74-9	0.03
D021	Chlorobenzene	108-90-7	100.0
D022	Chloroform	67-66-3	6.0
D007	Chromium	7440-47-3	5.0
D023	o-Cresol	95-48-7	200.0[a]
D024	m-Cresol 65794-96-9	108-39-4	200.0[a]
D025	p-Cresol	106-44-5	200.0[a]
D026	Cresol	--	200.0[a]
D016	2,4-D	94-75-7	10.0
D027	1,4-Dichlorobenzene	106-46-7	7.5
D028	1,2-Dichloroethane	107-06-2	0.5
D029	1,1-Dichloroethene	75-35-4	0.7
D030	2,4-Dinitrotoluene	121-14-2	0.13[b]
D012	Endrin	72-20-8	0.02
D031	Heptachlor (and its epoxide)	76-44-8/1024-57-3	0.008
D032	Hexachlorobenzene	118-74-1	0.13[b]
D033	Hexachlorobutadiene	87-68-3	0.5
D034	Hexachloroethane	67-72-1	3.0
D008	Lead	7439-92-1	5.0
D013	Lindane	58-89-9	0.4
D009	Mercury	7439-97-6	0.2
D014	Methoxychlor	72-43-5	10.0
D035	Methyl ethyl ketone (2-Butanone)	78-93-3	200.0
D036	Nitrobenzene	98-95-3	2.0
D037	Pentachlorophenol	87-86-5	100.0
D038	Pyridine	110-86-1	5.0[b]

Table 8-1. Concentration of Contaminants for Toxicity Characteristic (40 *CFR* 261.24) (continued)

USEPA Hazardous Waste Number	Contaminant	CAS Number	Regulatory Level (mg/L)
D010	Selenium	7782-49-2	1.0
D011	Silver	7440-22-4	5.0
D039	Tetrachloroethene	127-18-4	0.7
D015	Toxaphene	8001-35-2	0.5
D040	Trichloroethene	79-01-6	0.5
D041	2,4,5-Trichlorophenol	95-95-4	400.0
D042	2,4,6-Trichlorophenol	88-06-2	2.0
D017	2,4,5-TP (Silvex)	93-72-1	1.0
D043	Vinyl Chloride	75-01-4	0.2

[a] If o-, m-, and p-Cresol concentrations cannot be differentiated, the total cresol (D026) concentration is used. The regulatory level of total cresol is 200 mg/L.

[b] Quantitation limit is greater than the calculated regulatory level. The quantitation limit, therefore, becomes the regulatory level.

-- No standard exists *CFR = Code of Federal Regulations*

CAS = Chemical Abstracts Service USEPA = United States Environmental Protection Agency

Table 8-2. Maximum Concentration of Hazardous Waste Characterization Analytes (40 *CFR* 261.21-23)

USEPA Hazardous Waste Number	Analyte	CAS Number	Aqueous Reporting Limit	Solid Reporting Limit
D002	pH/Corrosivity	Q183	2 ≤ pH ≤ 12.5	--
D003	Cyanide, total	57-12-5	0.01 mg/L	0.66 mg/kg
D001	Flashpoint	Q376	<140°F	<180°F
D003	Sulfide, total	Q1314	3.0 mg/L	39.5 mg/kg

-- No standard exists
CAS = Chemical Abstracts Service
CFR = Code of Federal Regulations
USEPA = United States Environmental Protection Agency

8.4.2 Liquid Investigation-Derived Waste Composite Sampling Procedure

Sampling of liquid IDW (groundwater and decontamination water) for disposal characterization will be performed using a composite grab sampling technique. The equipment used in liquid IDW sampling will consist of sample containers and disposable or decontaminated sampling equipment (e.g., bailers, pump tubing, and drum thief). The handling, storage, and shipment of IDW samples will follow procedures for water samples described in Section 6.0. Liquid IDW (i.e., groundwater and decontamination rinse water) will be sampled and analyzed separately. Composite grab sample collection will be performed as follows:

1. Correlate the number of grab samples and sample volume required by the laboratory to determine the volume needed to provide equal amounts of aliquot from each grab sample (drum container)

at the recommended sample volume (e.g., five 20-mL aliquots from five discrete grab samples to generate a 100-mL composite sample representing five IDW containers).

2. Using decontaminated or clean disposable equipment, collect discrete grab samples from each drum.

3. Using a clean pipette or equivalent clean measuring device, deliver equal aliquots of the grab samples directly into sample container(s) to be sent to the laboratory.

4. Repeat this process until equal amounts of each aliquot from each grab sample have been collected. Each discrete grab sample should be collected in identical fashion.

5. Seal the sample container and shake well to mix. Prepare the container for shipment to the laboratory.

8.5 INVESTIGATION-DERIVED WASTE DISPOSAL

Table 8-3 identifies the disposal options for all expected waste streams from environmental investigations at RVAAP based on past efforts. All indigenous and non-indigenous wastes generated are subject to disposal protocols outlined in Ohio EPA guidance (Ohio EPA 1997). Waste disposal options recommended in the Contractor's IDW Characterization and Disposal Plan are subject to the approval of the RVAAP Environmental Coordinator, the U.S. Army, and Ohio EPA. The RVAAP Environmental Coordinator, or designee, will sign all waste manifests and other shipping documents and oversee the disposition of all IDW at RVAAP. Transportation of all IDW for storage and/or disposal will be in accordance with applicable state of Ohio and federal regulations. When IDW will be disposed of off-site, using public roads as a means of transportation, the shipment or transportation of IDW may be subject to DOT requirements for containerizing, labeling, and shipping documentation (49 *CFR* 172).

There is no means for disposal of contaminated IDW at RVAAP. All IDW determined to be a hazardous waste will be disposed according to applicable state of Ohio and federal regulations at an approved off-site hazardous waste facility. Non-hazardous, contaminated waste contains contaminants but does not meet the criteria for hazardous waste. This waste will either be stored in the FSA pending remediation of the AOC where it originated or will be disposed off-site. Non-hazardous, non-contaminated waste contains contaminants at concentrations at or below acceptable criteria (i.e., background concentrations) and may be disposed on-site with prior approval from the RVAAP Environmental Coordinator, Ohio EPA, and the U.S. Army.

Any contaminated or potentially contaminated liquid IDW or saturated-soil IDW that is stored in an FSA during winter months will require special management to prevent accidental releases due to freezing. The contractor's foremost responsibility is to manage IDW so that, if possible, disposal can be completed before freezing conditions arise. If disposal cannot be executed before the onset of such conditions, or if long-term storage of liquids is anticipated, secondary containment is required.

Secondary containment is the responsibility of the contractor and is subject to the requirements of RCRA.

All non-indigenous solid (expendable sampling equipment and trash) IDW will be disposed of as either sanitary trash or, if determined to be potentially contaminated, stored in an FSA located within the AOC boundary and maintained there in accordance with Section 8.3 until such time that it can be disposed at an approved facility. All expendable sampling equipment determined to be potentially contaminated will be decontaminated according to Section 5.4.2.4 and then disposed of as sanitary trash.

All treatment, storage, and disposal facilities (must be in good standing with environmental regulatory agencies. The RVAAP Environmental Coordinator must be notified in advance of waste disposal as to which disposal facility is to be used. The Environmental Coordinator has the authority to refuse the use of a particular disposal facility based on his/her review of their ability to protect the interests of the U.S. Army.

When IDW will be disposed of off-site, using public roads as a means of transportation, the shipment or transportation of IDW may be subject to DOT requirements for containerizing, labeling, and shipping documentation (49 *CFR* 172).

Table 8-3. IDW Disposal Options for Potential Waste Streams in RVAAP Environmental Investigations

Waste Stream	Non-Hazardous, Non-Contaminated	Non-Hazardous, Contaminated	Hazardous, Contaminated
Solid (soil and rock cuttings)	Spread, seed, and mulch at designated area within the AOC (RVAAP-approved seed mix)	Dispose off-site at permitted waste facility	Dispose off-site at permitted hazardous waste facility
		Store in field staging area until remediation of contaminated media in the AOC	
Liquid (groundwater, decontamination fluids, laboratory reagents, and residues)	Discharge on ground surface at designated area	Dispose off-site at permitted waste facility (most likely scenario for these wastes)	Dispose off-site at permitted hazardous waste facility
		Store in field staging area until remediation of contaminated media in the AOC (requires secondary containment)	
Expendable sampling equipment and trash	Dispose as sanitary trash	Dispose off-site at permitted facility	Dispose off-site at permitted hazardous waste facility

AOC = Area of concern IDW = Investigation-derived waste RVAAP = Ravenna Army Ammunition Plant

9.0 CONTRACTOR CHEMICAL QUALITY CONTROL

The CCQC program to be utilized for the AOC-specific investigations will consist of three phases (preparatory, initial, and follow-up), all of which will be performed by contractors whether or not an U.S. Army representative is present. The CCQC representative responsible for implementing and documenting the CCQC program and definable features of work that will comprise the CCQC program will be identified in the investigation-specific addenda to this FWFSP.

The preparatory phase of the CCQC program will be conducted by the CCQC representative before beginning each definable feature of work. A summary of all activities performed during each preparatory phase meeting will be documented by the CCQC representative in a meeting minutes record. Each preparatory phase meeting will address the following:

- Review of all pertinent sections of this FWFSP and any SAP addenda to ensure that all field personnel are cognizant of the overall project DQOs, specific project activities to be accomplished, and specific sampling and analysis requirements.

- Actual calibration of all instruments to be used for measurement of field parameters using certified calibration standards and gases.

- Physical examination of all materials and equipment required to accomplish the specific project activities.

- Demonstration of equipment decontamination procedures in accordance with this FWFSP and SAP addenda requirements.

- Demonstration of how each sample type is to be collected, containerized, documented, and packaged.

- Demonstration of proper IDW management and documentation.

- Demonstration of the procedure for completing all required information to be recorded on sample custody forms and discussion of the project sample numbering system. Completed examples of a COC form, sample container label, and IDW drum label will be provided to the field personnel for reference.

- Demonstration/discussion of any other activities to be performed as deemed necessary by the CCQC representative.

- Examination of the work area(s) to ascertain if all preliminary work is complete.

- Review of preparatory phase field equipment and support materials checklists. The contents of the field equipment checklist and supporting materials checklist will be presented in the investigation-specific addenda to this FWFSP. An example of the QA table that will be used to match up primary and QC samples is presented in Figure 9-1.

In addition to the activities noted above, the CCQC representative will ensure that the USACE QA laboratory has been contacted to schedule receipt and analysis of the U.S. Army QA samples. This will be accomplished by review of the telephone log used to document the laboratory contact.

The initial phase of the CCQC program will be conducted by the CCQC representative and will include the following:

- Oversight of drilling, monitoring well installation construction and development, and/or sampling activities and review of this work to ensure compliance with delivery order requirements;

- Inspection of individual sample labels and COC forms for accuracy, completeness, and consistency;

- Inspection of sample packaging and shipping activities;

- Observation, verification, and documentation of initial and ongoing field instrument calibration;

- Inspection of field logbooks and other field records/sketches to ensure that all pertinent data are recorded in accordance with delivery order requirements; and

- Inspection of the QA sample match-up table (Figure 9-1) to ensure that all samples collected during each day are documented properly.

The follow-up phase of the CCQC program will be conducted by the CCQC representative and will involve performing the various activities noted for the initial phase on a daily basis until completion of the particular definable feature of work.

		Contractor Laboratory				Government Laboratory				Required Laboratory analyses					
Sample Locations	Sample Type	Sample Number	Associated QA Duplicate Number	Associated QC Rinsate Number	Associated QC Trip Blank Number	Sample Number	Associated QA Duplicate Number	Associated QC Rinsate Number	Associated QC Trip Blank Number	VOCs	SVOCs	RCRA Metals	TPH, Oil, and Grease	Ignitability, Corrosively, RCRA Metals	TCLP, VOAs, TCLP Metals

Figure 9-1. Example of QA Table to be Used for RVAAP AOC-Specific Investigations

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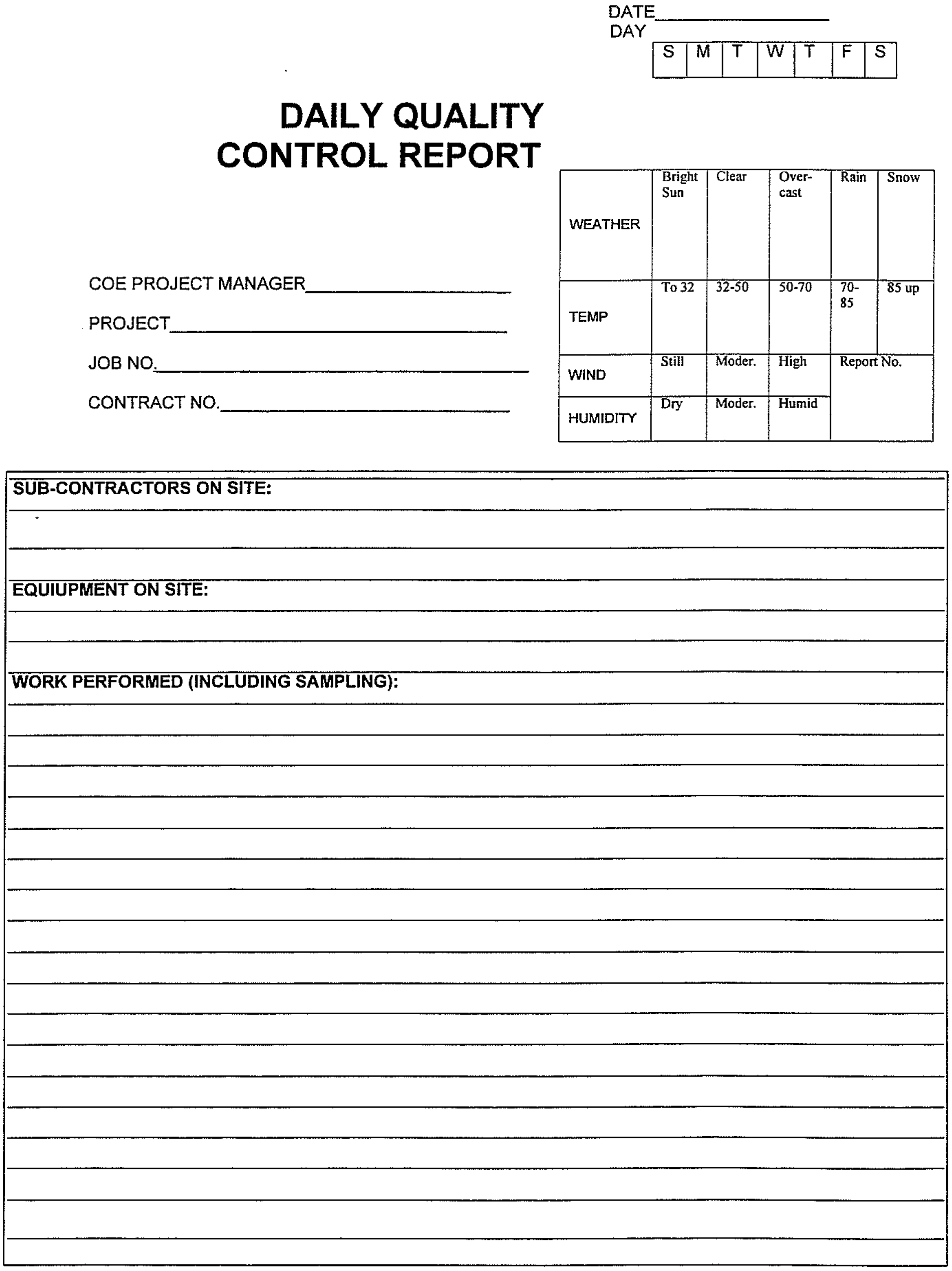
10.0 DAILY CHEMICAL QUALITY CONTROL REPORTS

During the field activities preformed for the AOC-specific investigations, Daily Chemical Quality Control Reports (DCQCRs) are prepared, signed, and dated by the CCQC representative. An example of the DCQCR format is illustrated in Figure 10-1. These reports are submitted to the U.S. Army Project Manager on a weekly basis. The contents of each DCQCR include a summary of activities performed at the AOC, weather information at the time of sampling, results of measurements made with field instruments, results of CCQC activities performed including field instrument calibrations, departures from the approved FWFSP and/or investigation-specific FSP addenda, problems encountered during field activities, and any instructions received from government personnel. Any deviations that may affect the project DQOs will be immediately conveyed to the U.S. Army Project Manager. The following will be attached to each DCQCR submittal, as appropriate:

- The QA sample table that matches up primary and QC samples collected (Figure 10-1);
- A summary of field-generated analytical results;
- Any other project-related forms utilized; and
- A copy of the CCQC preparatory phase meeting minutes (unless bound in a logbook).

A copy of the COC form(s) is sent to the Contractor Laboratory Coordinator weekly.



DATE________________

DAY

S	M	T	W	T	F	S

DAILY QUALITY CONTROL REPORT

COE PROJECT MANAGER________________

PROJECT________________________

JOB NO.__________________________

CONTRACT NO.____________________

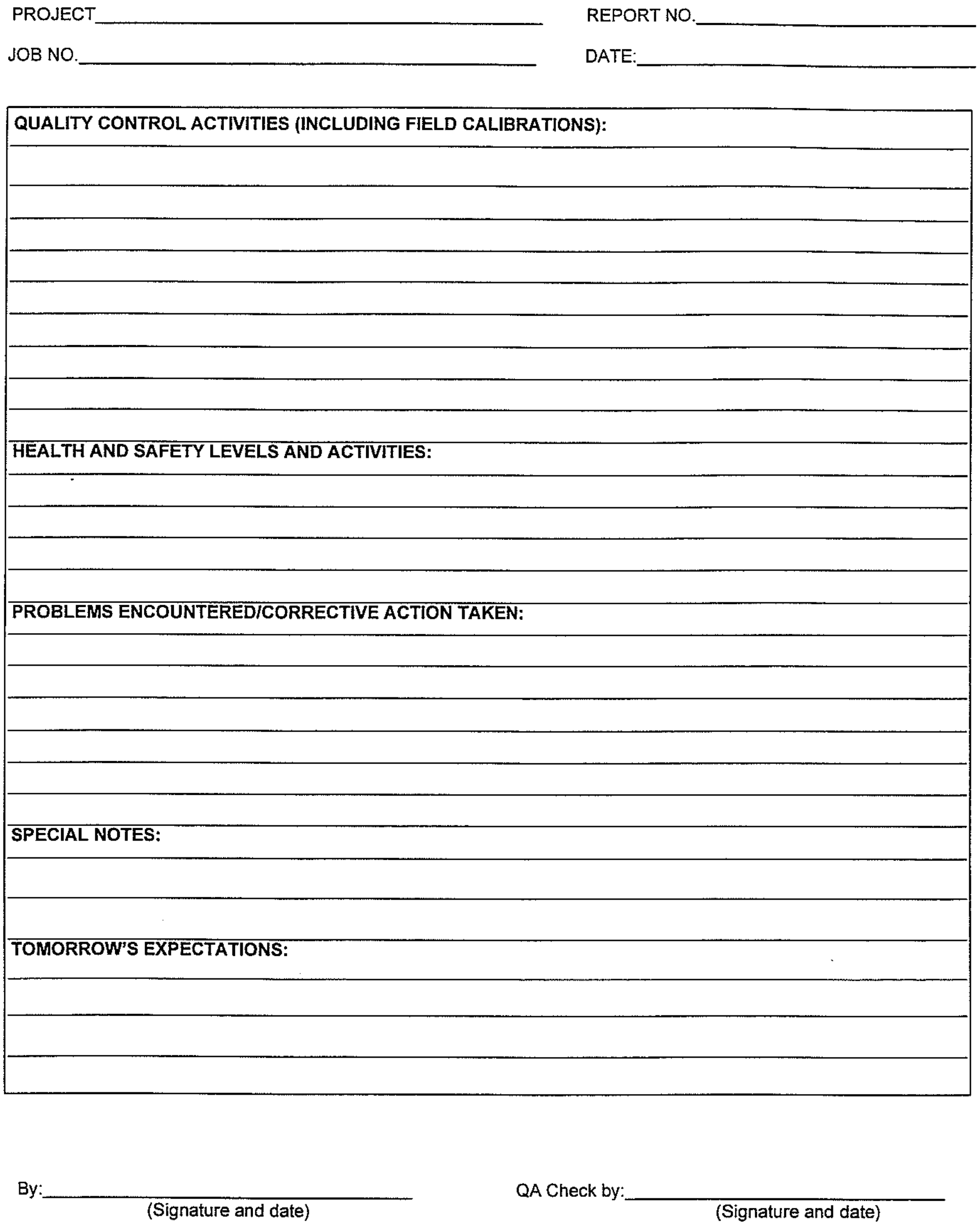
WEATHER	Bright Sun	Clear	Over-cast	Rain	Snow
TEMP	To 32	32-50	50-70	70-85	85 up
WIND	Still	Moder.	High	Report No.	
HUMIDITY	Dry	Moder.	Humid		

SUB-CONTRACTORS ON SITE:

EQUIUPMENT ON SITE:

WORK PERFORMED (INCLUDING SAMPLING):

Figure 10-1. Example of DCQCR to be Used for RVAAP AOC-Specific Investigations



PROJECT________________ REPORT NO.__________

JOB NO.________________ DATE:__________

QUALITY CONTROL ACTIVITIES (INCLUDING FIELD CALIBRATIONS):

HEALTH AND SAFETY LEVELS AND ACTIVITIES:

PROBLEMS ENCOUNTERED/CORRECTIVE ACTION TAKEN:

SPECIAL NOTES:

TOMORROW'S EXPECTATIONS:

By:________________
(Signature and date)

QA Check by:________________
(Signature and date)

Figure 10-1. Example of DCQCR to be Used for RVAAP AOC-Specific Investigations (continued)

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11.0 FIELD VARIANCES AND CORRECTIVE ACTIONS

11.1 FIELD VARIANCE SYSTEM

Variances from the operating procedures and approved investigation-specific addenda will be documented on a field change request (FCR) form (Figure 11-1) or an NCR form (Figure 11-2) where appropriate. If, during the investigation, changes necessary to meet the objectives of the investigation-specific addenda are identified, the Field Operations Manager will contact the U.S. Army Project Manager and Ohio EPA to initiate the FCR and obtain proper approval for recommended changes.

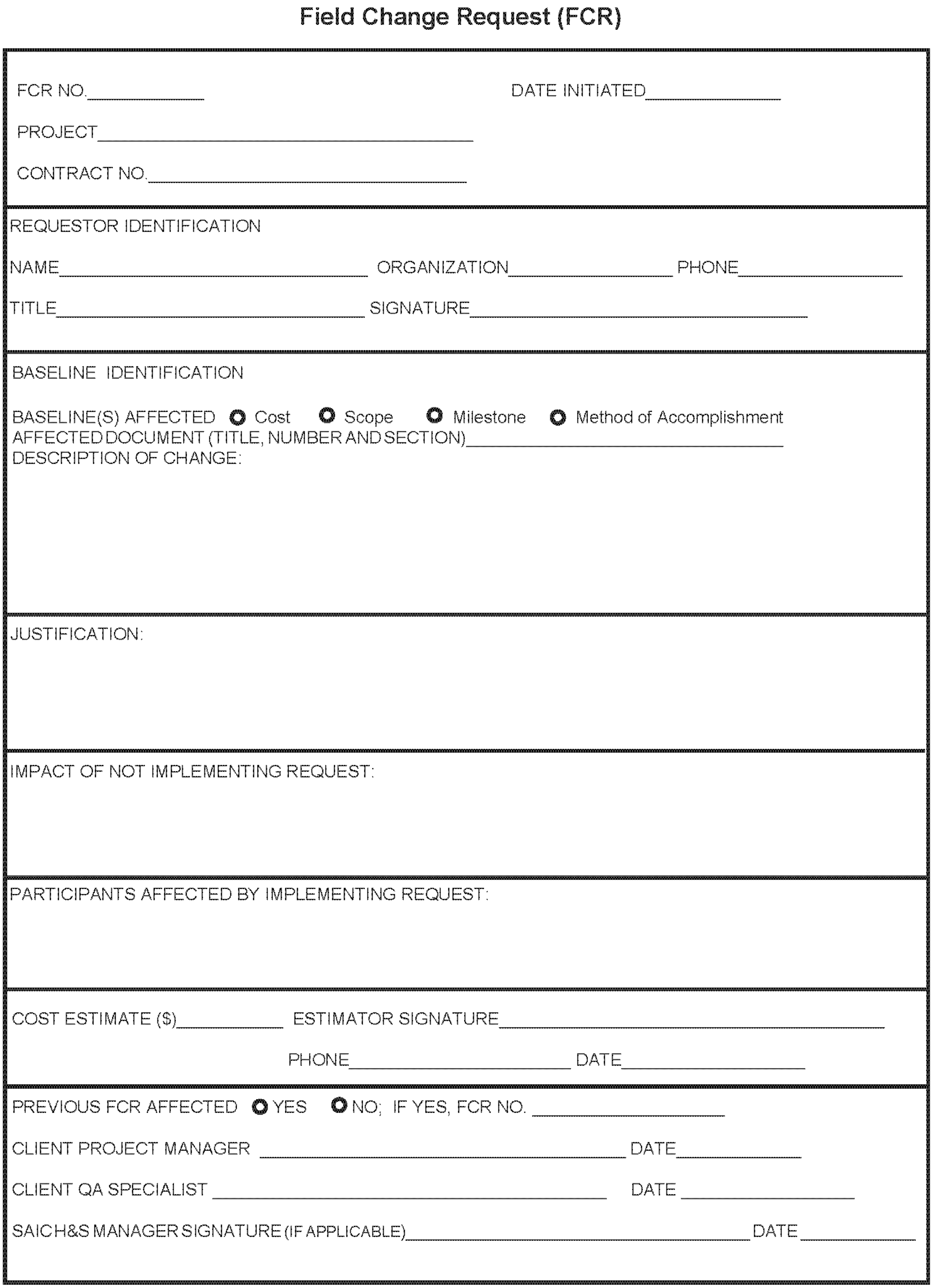
11.2 SAMPLE COLLECTION AND FIELD MEASUREMENTS

Corrective actions will be implemented in the event that a discrepancy is discovered by field personnel, laboratory personnel, and/or during a field or desk audit. The initial responsibility for monitoring the quality of field activities and measurements lies with the field personnel. These personnel are responsible for following QA procedures; the CCQC representative is responsible for verifying these procedures are being followed. This verification requires that the CCQC representative assess the correctness of the field methods and the ability of the field team to meet the QA objectives and to make a subjective assessment of the impact that a procedure has on the field objective and resulting data quality.

If a field problem occurs that might jeopardize the integrity of the project, cause a QA objective not to be met, or affect data quality, the first action taken will be an assessment of the severity of the problem by the CCQC representative. If the problem is determined to be minor, the CCQC representative will initiate an appropriate corrective action, which will be recorded in the field logbook. If the problem is determined to be significant or subject to reoccurrence, the CQC representative will initiate an NCR that will be submitted to the Contractor QA/QC Officer. An example of the NCR is illustrated in Figure 11-2. The Contractor QA/QC Officer will then propose and implement an appropriate corrective action as documented on the NCR.

The Contractor QA/QC Officer is responsible for ensuring that corrective actions for nonconformances are initiated by:

- Evaluating all reported nonconformances;
- Controlling additional work on nonconforming items;
- Determining disposition or action to be taken;
- Maintaining a log of nonconformances;
- Reviewing NCRs and corrective actions taken; and
- Ensuring that NCRs are included in the project evidence file.



Field Change Request (FCR)

FCR NO.____________ DATE INITIATED______________

PROJECT____

CONTRACT NO.__________________________________

REQUESTOR IDENTIFICATION

NAME________________________________ ORGANIZATION_________________ PHONE_________________

TITLE________________________________ SIGNATURE____________________________________

BASELINE IDENTIFICATION

BASELINE(S) AFFECTED ○ Cost ○ Scope ○ Milestone ○ Method of Accomplishment

AFFECTED DOCUMENT (TITLE, NUMBER AND SECTION)_________________________________

DESCRIPTION OF CHANGE:

JUSTIFICATION:

IMPACT OF NOT IMPLEMENTING REQUEST:

PARTICIPANTS AFFECTED BY IMPLEMENTING REQUEST:

COST ESTIMATE ($)___________ ESTIMATOR SIGNATURE____

PHONE_______________________ DATE___________________

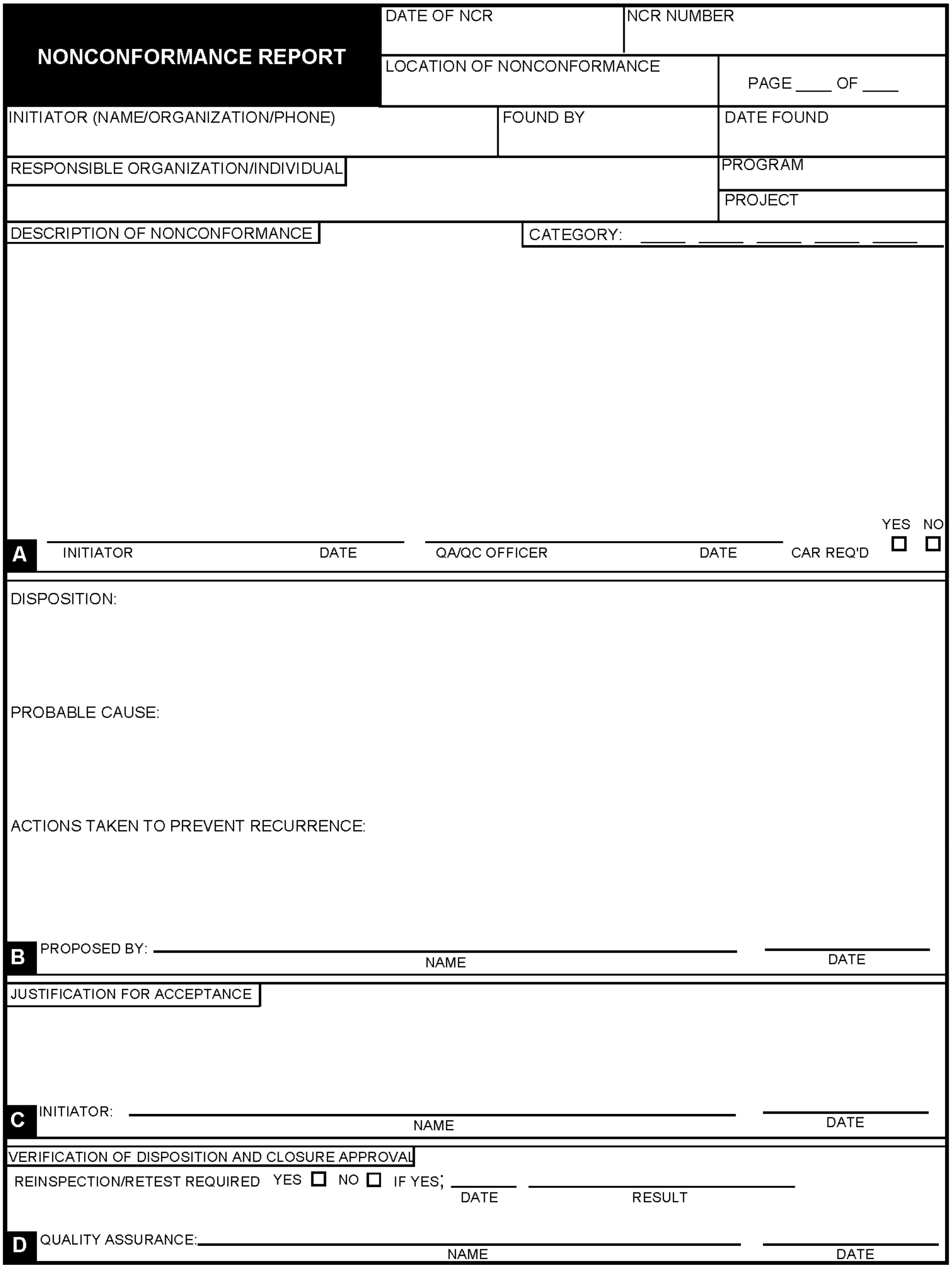
PREVIOUS FCR AFFECTED ○ YES ○ NO; IF YES, FCR NO. ____________________

CLIENT PROJECT MANAGER _______________________________________ DATE_____________

CLIENT QA SPECIALIST ____ DATE __________________

SAIC H&S MANAGER SIGNATURE (IF APPLICABLE)____________________________________ DATE____________

Figure 11-1. Example of FCR to be Used for RVAAP AOC-Specific Investigations



NONCONFORMANCE REPORT

DATE OF NCR

NCR NUMBER

LOCATION OF NONCONFORMANCE

PAGE ____ OF ____

INITIATOR (NAME/ORGANIZATION/PHONE)

FOUND BY

DATE FOUND

RESPONSIBLE ORGANIZATION/INDIVIDUAL

PROGRAM

PROJECT

DESCRIPTION OF NONCONFORMANCE

CATEGORY: _____ _____ _____ _____ _____

A

INITIATOR ____ DATE ____ QA/QC OFFICER ____ DATE ____ CAR REQ'D YES ☐ NO ☐

DISPOSITION:

PROBABLE CAUSE:

ACTIONS TAKEN TO PREVENT RECURRENCE:

B

PROPOSED BY: ____ NAME ____ DATE

JUSTIFICATION FOR ACCEPTANCE

C

INITIATOR: ____ NAME ____ DATE

VERIFICATION OF DISPOSITION AND CLOSURE APPROVAL

REINSPECTION/RETEST REQUIRED YES ☐ NO ☐ IF YES; ____ DATE ____ RESULT

D

QUALITY ASSURANCE: ____ NAME ____ DATE

Figure 11-2. Example of NCR to be Used for RVAAP AOC-Specific Investigations

If appropriate, the Contractor CQC representative or QA/QC Officer will ensure that no additional work that depends on the nonconforming activity is performed until corrective actions are implemented and the nonconforming activity is corrected. Corrective actions for field measurements may include the following:

- Repeat measurement to check errors;
- Check proper instrument adjustments for ambient conditions such as temperature;
- Check battery charge and connections;
- Check instrument calibration and recalibrate as necessary;
- Replace instrument or measurement devices; and
- Stop work (if necessary).

11.3 LABORATORY ANALYSES

In the event that a laboratory problem occurs that might jeopardize the integrity of the project analytical results, cause a QA objective not to be met, or affect data quality, the first action taken will be an assessment of the severity of the problem by the Contractor Laboratory Coordinator. If the problem is determined to be minor, the Contractor Laboratory Coordinator will initiate an appropriate corrective action, which will be recorded in a memorandum submitted to the Contractor Project Manager. The Contractor Project Manager will then relate the corrective action to be implemented to the Contractor CQC representative and/or Contractor QA/QC Officer if the problem is associated with activities being performed in the field. If the problem is determined to be significant, the Contractor Laboratory Coordinator will initiate an NCR which will be submitted to the Contractor QA/QC Officer. Analytical NCRs will be copied to the U.S. Army Project Manager.

Laboratory personnel will be alerted that corrective actions may be necessary if the following apply:

- QC data are outside the warning or acceptable windows for precision and accuracy;

- Blanks contain target analytes above acceptable levels;

- Undesirable trends are detected in spike recoveries or relative percent differences between duplicates;

- Unusual changes in detection limits are encountered;

- Deficiencies are detected during internal or external audits or from the results of performance evaluation samples; and

- Inquiries concerning data quality are received.

12.0 PROJECT SCHEDULE

Because of the generic nature of this FWFSP, the inclusion of a schedule is not practical. Project schedules will be developed for each AOC-specific investigation and included in the investigation-specific addenda.

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Facility-Wide Quality Assurance Project Plan for Environmental Investigations

Revision 0

Ravenna Army Ammunition Plant
Ravenna, Ohio

Contract No. W912QR-08-D-0008
Delivery Order No. 0016

Prepared for:
United States Army Corps of Engineers
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November 11, 2010

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ACRONYMS AND ABBREVIATIONS

A-E	Architect-Engineer
ADR	Automated Data Review
AOC	Area of Concern
ASTM	American Society of Testing and Materials
CAS	Chemical Abstracts Services
CDQAR	Chemical Data Quality Assurance Report
COC	Chain of Custody
CQAR	Chemical Quality Assurance Report
DoD	United States Department of Defense
DL	detection limit
DQO	Data Quality Objective
EDD	Electronic Data Deliverable
ELAP	Environmental Laboratory Accreditation Program
FCR	Field Change Request
FID	Flame Ionization Detector
FWFSP	Facility-wide Field Sampling Plan
FWQAPP	Facility-wide Quality Assurance Project Plan
FWSAP	Facility-wide Sampling and Analysis Plan
GC	Gas Chromatograph
GFAA	Graphite furnace atomic absorption
HPLC	High Pressure Liquid Chromatography
ICP	Inductively Coupled Plasma
IDW	Investigation-Derived Waste
IS	Incremental Sampling
LCS	Laboratory Control Sample
LOD	Level of Detection
LOQ	Level of Quantitation
LOR	Letter of Receipt
M&TE	Material and Testing Equipment
MS	Mass Spectrometer
MRL	Method Reporting Level
NA	Not Applicable
NCR	Nonconformance Report
NEIC	National Enforcement Investigations Center
NIST	National Institute of Standards and Testing
NTU	Nephelometric Turbidity Unit
Ohio EPA	Ohio Environmental Protection Agency
PAHs	Polycyclic Aromatic Hydrocarbons
PCB	Polychlorinated Biphenyl
PID	Photoionization Detector
QA	Quality Assurance
QAPP	Quality Assurance Project Plan

ACRONYMS AND ABBREVIATIONS (CONTINUED)

QC	Quality Control
QSM	Quality Services Manual
RPD	Relative Percent Difference
RSD	Relative Standard Deviation
RVAAP	Ravenna Army Ammunition Plant
SAIC	Science Applications International Corporation
SAP	Sampling and Analysis Plan
SSHO	Site Safety and Health Officer
SM	Standard Method
SOP	Standard Operating Procedure
SVOC	Semi-volatile Organic Compound
TAL	Target Analyte List
TCLP	Toxicity Characteristic Leaching Procedure
TDS	Total Dissolved Solids
TIC	Tentatively identified compound
TSS	Total Suspended Solids
USACE	United States Army Corps of Engineers
USCS	Unified Soil Classification System
USEPA	United States Environmental Protection Agency
VOC	Volatile Organic Compound

1.0 INTRODUCTION

The United States Army Corps of Engineers (USACE) is expected to continue fulfilling the role of laboratory data quality assurance (QA) administrator for all environmental projects at the Ravenna Army Ammunition Plant (RVAAP). USACE and the United States Environmental Protection Agency (USEPA) require that all environmental monitoring and measurement efforts mandated or supported by these organizations participate in a centrally managed QA program.

Any party generating data under this program is responsible for implementing minimum procedures to ensure that the precision, accuracy, completeness, and representativeness of its data are known and documented. To ensure that the responsibility is met uniformly, each party must prepare a written investigation-specific Quality Assurance Project Plan (QAPP) addendum covering each project it is to perform.

This Facility-wide QAPP (FWQAPP) presents the organization, objectives, functional activities, and specific QA and quality control (QC) activities associated with the Facility-wide Field Sampling Plan (FWFSP) for RVAAP in Ravenna, Ohio. This FWQAPP also describes the specific protocols that will be followed for sampling, sample handling and storage, chain of custody, and laboratory analysis.

All QA/QC procedures are in accordance with applicable professional technical standards, USEPA requirements, government regulations and guidelines, and specific project goals and requirements. Science Applications International Corporation (SAIC) prepared this FWQAPP in accordance with USEPA QAPP guidance documents, such as *Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans* (USEPA 1991a), USEPA Region 5's *Model Quality Assurance Project Plan* (USEPA 1991b), *USEPA Requirements for Quality Assurance Project Plans for Environmental Data Operations* (USEPA 1994c), and *Requirements for the Preparation of Sampling and Analysis Plans* (USACE 1994). Concurrence with the United States Department of Defense's (DoD's) *DoD Quality Services Manual (QSM) for Environmental Laboratories* (DoD 2009), Version 4.1, April 2009 or later, and USACE, Louisville District's *Quality Systems Manual Supplement* (USACE 2007) is expected.

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2.0 PROJECT DESCRIPTION

This FWQAPP is part of the Facility-Wide Sampling and Analysis Plan (FWSAP) for RVAAP in Ravenna, Ohio. Investigation-specific addenda will supplement this plan as required when individual area of concern (AOC) investigations are implemented. The FWFSP contains the primary project description and background information and, as such, the information contained in the FWFSP shall be referenced here and not repeated.

2.1 SITE HISTORY/BACKGROUND INFORMATION

This information is contained in Section 2.1 of the FWFSP. Individual tasks at RVAAP will address specific area history and background, as needed, in investigation-specific addenda.

2.2 PAST DATA COLLECTION ACTIVITY/CURRENT STATUS

This information is contained in Section 2.3 of the FWFSP. Individual tasks at RVAAP will address specific areas past and current data collection activities, as needed, in investigation-specific addenda.

2.3 PROJECT OBJECTIVES AND SCOPE

This information is contained in Section 4.0 of the FWFSP. Individual tasks at RVAAP will address unique objectives and scope for specific areas, as needed, in investigation-specific addenda.

2.4 SAMPLE NETWORK DESIGN AND RATIONALE

This information is contained in Section 5.0 of the FWFSP. Individual tasks at RVAAP will present sampling designs and sampling rationales, as required, in investigation-specific addenda.

2.5 PARAMETERS TO BE TESTED AND FREQUENCY

General sample matrix types, analytical parameters, and analytical methods can be found in Section 5.0 of the FWFSP and in Table 2-1 of this FWQAPP. Specific delineation of sample numbers, QA sample frequencies, and field QC sample frequencies will be provided in each investigation-specific SAP addenda.

Samples requiring the “full suite” of parameters will be analyzed for Target Analyte List (TAL) metals, explosives (including nitroglycerin), propellants (nitroguanidine and nitrocellulose), semi-volatile organic compounds (SVOCs), volatile organic compounds (VOCs), pesticides, and polychlorinated biphenyls (PCBs). Typically, 10% of the samples are submitted for full suite analysis while the remaining 90% will have targeted analyses based on the investigation-specific goals. Other analyses, including but not limited to herbicides, perchlorate, cyanide, hexavalent chromium, or polycyclic aromatic hydrocarbons (PAHs), will be performed as needed based on historical information or data quality objectives (DQOs).

2.6 PROJECT SCHEDULE

The project schedule is discussed in Section 12.0 of the FWFSP. Individual task schedules will be developed and defined in investigation-specific FSP addenda.

Table 2-1. Soil, Sediment, Surface Water, and Groundwater Sampling, RVAAP

Parameter	Methods	Field Samples			Field Duplicate Samples[a]	Site Source Water	Sampler Rinsates	Trip Blanks[b]	Total A-E Samples	QA Dups./ Splits	QA Trip Blanks
		Discrete	IS	Total							
Soil/Sediment											
Volatile Organics	SW-846, 8260B/5035										
Semi-volatile Organics	SW-846, 8270C/3540C/ 3541										
Pesticides	SW-846, 8081A/3540C/ 3541										
Herbicides	SW-846, 8151A/3540C/ 3541										
PCBs	SW-846, 8082/3540C/3541										
Explosives	SW-846, 8330B										
Nitroguanidine	SW846, 8330 Mod.										
Nitrocellulose	Colorimetric, Cadmium Reduction										
Polycyclic Aromatic Hydrocarbons	SW846, 8310 or 8270C										
Metals (TAL)	SW-846, 6010B/6020/ 7471A										

Table 2-1. Soil, Sediment, Surface Water, and Groundwater Sampling, RVAAP (continued)

Parameter	Methods	Field Samples			Field Duplicate Samples[a]	Site Source Water	Sampler Rinsates	Trip Blanks[b]	Total A-E Samples	QA Dups./ Splits	QA Trip Blanks
		Discrete	IS	Total							
Hexavalent Chromium	SW-846, 7196A/3060A										
Cyanide	SW-846, 9010B/9012A										
Perchlorate	SW-846, 6860										
Geotechnical Analysis[c]	ASTM Methods										
Surface Water/Groundwater											
Volatile Organics	SW-846, 8260B										
Semi-volatile Organics	SW-846, 8270C/3520C/ 3510C										
Pesticides	SW-846, 8081A/3520C/ 3510C										
Herbicides	SW-846, 8151A/3520C/ 3510C										
PCBs	SW-846, 8082/3520C/3 510C										
Explosives	SW-846, 8330B										
Nitroguanidine	SW846, 8330 Mod.										

Table 2-1. Soil, Sediment, Surface Water, and Groundwater Sampling, RVAAP (continued)

Parameter	Methods	Field Samples			Field Duplicate Samples[a]	Site Source Water	Sampler Rinsates	Trip Blanks[b]	Total A-E Samples	QA Dups./ Splits	QA Trip Blanks
		Discrete	IS	Total							
Nitrocellulose	Colorimetric, Cadmium Reduction										
Polycyclic Aromatic Hydrocarbons	SW846, 8310, or 8270C										
Metals (TAL)	SW-846, 6010B/6020/ 7470A										
Hexavalent Chromium	SW-846, 7196A										
Cyanide	SW-846, 9010B/9012A										
Perchlorate	SW-846, 6860										

[a] Field duplicates should be collected from areas having the highest potential for contamination.

[b] A trip blank is to accompany each cooler shipped with samples for volatile organic analysis in water.

[c] Geotechnical analyses may consist of moisture content (ASTM D2216), grain size (ASTM D422, sieve), Atterberg limits (ASTM D4318), permeability (D5084/D2434), porosity (United States Army Corps of Engineers Engineering Manual 1110-2-1906, Appendix II), bulk density (ASTM D5057), total organic carbon (United States Environmental Protection Agency 415.1, Mod/SW-846 9060A/Walkley-Black), and Unified Soil Classification System classification.

A-E = Architect-Engineer
ASTM = American Society of Testing and Materials
Dups. = Duplicates
IS = Incremental Sampling
PCB = Polychlorinated biphenyl.
QA = Quality assurance
RVAAP = Ravenna Army Ammunition Plant
TAL = Target Analyte List

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3.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

The generic functional project organization and responsibilities are described in Section 3.0 of the FWFSP. Individual task assignments and responsibilities will be delineated in investigation-specific FSP addenda.

Analytical laboratory support for specific investigations will be designated to a single subcontractor based on a competitive bidding process, unless otherwise specified in the scope of work. The selected subcontract laboratory will be accredited in accordance with the DoD Environmental Laboratory Accreditation Program (ELAP). Relevant QA manual, laboratory qualification statements, certifications, and license documentation will be provided upon request to Ohio Environmental Protection Agency (Ohio EPA) and USEPA organizations when the subcontractor has been identified for each individual AOC task.

The Contractor is responsible for coordinating and collecting all samples and analyses. All personnel participating in U.S. Army projects must sign an Ethics and Integrity Agreement.

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4.0 QUALITY ASSURANCE OBJECTIVES FOR MEASUREMENT DATA

The overall QA objective is to develop and implement procedures for field sampling, chain of custody (COC), laboratory analysis, and reporting, which will provide results to be used in risk evaluation and assessment and that are technically and legally defensible. Specific procedures for sampling, COC, laboratory instrument calibration, laboratory analysis, reporting of data, internal QC, audits, preventive maintenance of field equipment, and corrective action are described in other sections of this FWQAPP. This section addresses the specific objectives for analytical accuracy, precision, completeness, representativeness, and comparability.

4.1 DATA QUALITY OBJECTIVES

Data Quality Objectives (DQOs) are qualitative and quantitative statements that specify the quality of data required to support decisions made during investigation activities and are based on the end uses of the data being collected. The primary concern is to develop and implement procedures for field sampling, COC, laboratory analysis, and reporting that will provide results acceptable for submission to USEPA Region 5 and Ohio EPA programs.

An analytical DQO summary generic to the investigations of all AOCs at RVAAP is presented in Table 4-1 for soil and sediment and in Table 4-2 for surface water and groundwater. Laboratories are required to comply with all methods as written; recommendations are considered requirements. Furthermore, analyses will be completed according to the DoD QSM (DoD 2009) and the USACE, Louisville District's QSM Supplement (USACE 2007).

Table 4-1. Investigative DQO Summary, RVAAP – Soil and Sediment

Data Use	Sample Type	Analytical Method	Precision (RPD[a])		Accuracy	Completeness
			Field	Laboratory	Laboratory	
Screening for Sample Site Selection	Discrete	FID/PID Volatile Organics	+/- comparison	NA	NA	95%
Confirmation of Contamination Extent	Discrete	SW-8260B Volatile Organics	<50 RPD	<30 RPD	See QSM, Table G-4	90%
	Discrete or composite	SW-8270C Semi-volatile Organics/PAHs	<50 RPD	<30 RPD	See QSM, Table G-6	90%
		SW-8151A Herbicides	<50 RPD	<30 RPD	See QSM, Table G-14	90%
		SW-8081A Pesticides	<50 RPD	<30 RPD	See QSM, Table G-14	90%
		SW-8082 PCBs	<50 RPD	<30 RPD	See QSM, Table G-16	90%
		SW-8330B Explosives	<50 RPD	<20 RPD	See QSM, Table G-12	90%
		SW-8310 PAHs	<50 RPD	<30 RPD	See QSM, Table G-10	90%
		SW-6010B/ 6020/7000 Metals	<50 RPD	<20 RPD	See QSM, Table G-18	90%
		SW-8330 Mod or Colorimetric Propellants	<50 RPD	<20 RPD	80-120% recovery	90%
		SW-7196A Hexavalent Chromium	<50 RPD	<30 RPD	80-120% recovery	90%
		SW-9010B/9012A Cyanide	<50 RPD	<20 RPD	80-120% recovery	90%
		SW-6860 Perchlorate	<50 RPD	<15 RPD	80-120% recovery	90%
		SW-8015B Petroleum Hydrocarbons (gasoline range)	<30 RPD	<30 RPD	80-120% recovery	90%
		SW-8015B Petroleum Hydrocarbons (diesel range)	<30 RPD	<30 RPD	80-120% recovery	90%
Determination of Geological Regimes	Discrete	ASTM-D2216 Moisture Content	NA	<20 RPD	NA	90%

Table 4-1. Investigative DQO Summary, RVAAP – Soil and Sediment (continued)

Data Use	Sample Type	Analytical Method	Precision (RPD[a])		Accuracy Laboratory	Completeness
Determination of Geological Regimes	Discrete	ASTM-D422 Grain Size	NA	<20 RPD	NA	90%
		ASTM-D4318 Atterberg Limits	NA	<40 RPD	NA	90%
		ASTM-D2434 Permeability	NA	<40 RPD	NA	90%
IDW Characterization	Composite	SW-1311 TCLP Analytes	NA	<40 RPD	75-125% recovery	80%

- Sample numbers and quality control sample numbers are identified in Table 2-1, analytical deliverables are identified in Table 10-1, and analyte sensitivity goals are identified in Tables 4-3 through 4-9 of this Facility-Wide Quality Assurance Project Plan.

[a] RPD values within five times the reporting level comparison are acceptable if the values are plus or minus three times the reporting level.

ASTM = American Society of Testing and Materials
DQO = Data quality objective
FID = Flame ionization detector
IDW = Investigation-derive waste
NA = Not applicable
PAH = Polycyclic aromatic hydrocarbon
PCB = Polychlorinated biphenyl
PID = Photoionization detector
QSM = Quality Services Manual (DoD 2009)
RPD = Relative percent difference
RVAAP = Ravenna Army Ammunition Plant
TCLP = Toxicity Characteristic Leaching Procedure
< = Less than

Table 4-2. Investigative DQO Summary, RVAAP – Surface Water and Groundwater

Data Use	Sample Type	Analytical Method	Precision (RPD[a])		Accuracy Laboratory	Completeness
			Field Duplicates	Laboratory		
Screening for Sample Site Selection	Discrete	FID/PID Volatile Organics	NA	NA	NA	95%
Determination of Basic Water Characteristics	Discrete	USEPA-120.1 Conductivity	<10 RPD	NA	NA	95%
		USEPA-150.1 pH	<10 RPD	NA	NA	95%
		USEPA-170.1 Temperature	<10 RPD	NA	NA	95%
		USEPA-180.1 Turbidity	<10 RPD	NA	NA	95%
		USEPA-360.1 Dissolved Oxygen	<10 RPD	NA	NA	95%
Confirmation of Contamination Extent	Discrete	SW-8260B Volatile Organics	<30 RPD	<30 RPD	See QSM, Table G-5	90%
	Discrete or composite	SW-8270C Semi-volatile Organics	<30 RPD	<30 RPD	See QSM, Table G-7	90%
		SW-8151A Herbicides	<30 RPD	<30 RPD	See QSM, Table G-14	90%
		SW-8081A Pesticides	<30 RPD	<30 RPD	See QSM, Table G-15	90%
		8082 PCBs	<30 RPD	<30 RPD	See QSM, Table G-17	90%
		SW-8330B Explosives	<30 RPD	<20 RPD	See QSM, Table G-13	90%
		SW-8330 Mod or Colorimetric Propellants	<30 RPD	<20 RPD	80-120% recovery	90%
		SW-8310 PAHs	<30 RPD	<30 RPD	See QSM, Table G-11	90%
		SW-6010B/ 6020/7000 Metals	<30 RPD	<20 RPD	See QSM, Table G-19	90%
		SW-7196 Hexavalent Chromium	<30 RPD	<20 RPD	80-120% recovery	90%

Table 4-2. Investigative DQO Summary, RVAAP – Surface Water and Groundwater (continued)

Data Use	Sample Type	Analytical Method	Precision (RPD[a])		Accuracy Laboratory	Completeness
			Field Duplicates	Laboratory		
Confirmation of Contamination Extent	Discrete or composite	SW-9010B/ 9012A Cyanide	<30 RPD	<20 RPD	75-125% recovery	90%
		SW-6860 Perchlorate	<30 RPD	<15 RPD	80-120% recovery	90%
		SW-8015B Petroleum Hydrocarbons (gasoline range)	<30 RPD	<30 RPD	80-120% recovery	90%
		SW-8015B Petroleum Hydrocarbons (diesel range)	<30 RPD	<30 RPD	80-120% recovery	90%
IDW Characterization	Composite	SW-1311 TCLP Analytes	NA	<30 RPD	75-125% recovery	80%

-Sample numbers and quality control sample numbers are identified in Table 2-1, analytical deliverables are identified in Table 10-1, and analyte sensitivity goals are identified in Tables 4-3 through 4-9 of this Facility-Wide Quality Assurance Project Plan.

[a]RPD values within five times the reporting level comparison are acceptable if values are plus or minus three times the reporting level.

DQO = Data quality objective
FID = Flame ionization detector
IDW = Investigation-derive waste
NA = Not applicable
PAH = Polycyclic aromatic hydrocarbon
PCB = Polychlorinated biphenyl
PID = Photoionization detector
QSM = Quality Services Manual (DoD 2009)
RPD = Relative percent difference
RVAAP = Ravenna Army Ammunition Plant
TCLP = Toxicity Characteristic Leaching Procedure
USEPA = United States Environmental Protection Agency
< = Less than

4.2 LEVEL OF QUALITY CONTROL EFFORT

To assess whether QA objectives have been achieved, analyses of specific field and laboratory QC samples are required. These QC samples consist of field blanks, source blanks, trip blanks, field duplicates, laboratory method blanks, laboratory control samples (LCSs), laboratory duplicates, and matrix spike/matrix spike duplicates and will be analyzed to assess the quality of the data resulting from the sampling program.

Field blanks, source blanks, equipment rinsate blanks, trip blanks, and field duplicate (co-located) samples will be submitted for analysis as required by investigation-specific addenda. These samples will provide a means to assess the quality of the data resulting from the field sampling program. Field blank samples are analyzed to determine the potential for contamination of a sample due to contaminant sources (e.g. airborne dust, exhaust fumes) unrelated to the specific sources being investigated. Source blank samples are analyzed to determine the potential for contamination from sampling equipment or for the suitability to use the source water during field activities such as in grout mixtures or to hydrate a boring. Equipment rinsate blanks are used to assess the adequacy of equipment decontamination processes. Trip blanks are used to assess the potential for contamination of samples due to contaminant migration during sample shipment and storage. Criteria and evaluation of blank determinations are provided in the FWSAP and will be based on project reporting levels. Field duplicate samples are analyzed to determine sample heterogeneity and sampling methodology reproducibility.

Laboratory method blanks and LCSs are employed to determine the accuracy and precision of the analytical method implemented by the laboratory. LCS measurements consist of the standard mid-level analyte concentration plus a method reporting level (MRL) low-level concentration. The laboratory will routinely perform and monitor the QC/MRL; however, corrective action will not be required for individual analyte variances. The QC/MRL will be analyzed at the beginning of the analytical sequences as required by the QSM (DoD 2009). Additionally, the laboratory will analyze the QC/MRL sample at the close of the analytical sequence.

Matrix spike samples provide information about the effect of the sample matrix on the measurement methodology. Laboratory sample duplicates and matrix spike duplicates assist in determining the analytical reproducibility and precision of the analysis for the samples of interest.

The general level of the QC effort will be at least one field duplicate for every ten investigative samples. One VOC analysis trip blank consisting of analyte-free water will be included with each shipment of VOC water samples. Source blank samples will be collected from each water source employed. The anticipated number of duplicate samples, field blanks, source water blanks, and equipment rinsate blanks will be specified in each investigation-specific addendum.

Matrix spike/matrix spike duplicate samples must be investigative samples. Soil matrix spike/matrix spike duplicate samples require no extra volume for VOCs or extractable organics. However, aqueous matrix spike/matrix spike duplicate samples must be collected at double the volume for

VOCs and triple the volume for extractable organics. One matrix spike/matrix spike duplicate sample will be designated in the field and collected for at least every 20 investigative samples per sample matrix (e.g., groundwater and soil).

The level of QC effort provided by the laboratory will be equivalent to the level of QC specified in each investigation-specific SAP addenda. The facility-wide goal is to provide a level of QC effort in conformance with the protocols of the DoD QSM (DoD 2009). The level of QC effort for testing and analysis of parameters beyond the scope of the QSM protocols will conform to accepted methods, such as USEPA SW-846 protocols (Update 3, 1998), American Society for Testing and Materials (ASTM) protocols, and National Institute for Occupational Safety and Health protocols.

The QC effort for in-field measurements, including conductivity, pH, organic vapors, dissolved oxygen, will include daily calibration of the instrument using traceable standards and documented instrument manufacturer procedures. Field instruments and their method of calibration are discussed in the FWFSP and will be further identified in investigation-specific FSP addenda.

4.3 ACCURACY, PRECISION, AND SENSITIVITY OF ANALYSIS

The fundamental QA objectives for accuracy, precision, and sensitivity of laboratory analytical data are the QC acceptance criteria of the analytical protocols. The accuracy and precision required for the specified analytical parameters are incorporated in Tables 4-1 and 4-2 and are consistent with the analytical requirements found in the DoD QSM. The sensitivities required for the possible analyses conducted at RVAAP are identified in Tables 4-3 through 4-9 as project reporting levels. The investigation-specific QAPP addendum should list laboratory-specific reporting limits for review and approval prior to the onset of field sampling. In addition, should lower reporting limits than those in Tables 4-3 through 4-9 be required, alternative methods (e.g., Table 4-7, Method 8095 for explosives in soil) may be specified in the investigation-specific Sampling and Analysis Plan (SAP) addendum.

Accuracy and precision goals for field measurements of pH, conductivity, turbidity, dissolved oxygen, and temperature are listed in Table 4-2.

Analytical accuracy is expressed as the percent recovery of an analyte that has been added to a blank sample or environmental sample at a known concentration before analysis. Accuracy will be determined in the laboratory with matrix spike, LCS, and/or blank spike analyses. The percent recoveries for specific target analytes will be calculated and used as an indication of the accuracy of the analyses performed.

Precision will be determined with spike analyses conducted on duplicate pairs of environmental samples (matrix spike/matrix spike duplicate) or comparison of positive duplicate pair responses. The relative percent difference (RPD) between the two results will be calculated and used as an indication of the precision of the analyses performed.

Sample collection precision will be assessed through the analyses of field duplicates. Precision will be reported as the RPD for two measurements.

Table 4-3. Project Reporting Levels for VOCs in Soil and Water Using SW-846 Methods 8260B/5030 and 8260B/5035 (GC/MS)

Compound	CAS Number	Project Reporting Levels[a]	
		Water (µg/L)	Soil/Sediment (µg/kg)
1,1,1-Trichloroethane	71-55-6	1	5
1,1,2,2-Tetrachloroethane	79-34-5	1	5
1,1,2-Trichloroethane	79-00-5	1	5
1,1-Dichloroethane	75-34-3	1	5
1,1-Dichloroethene	75-35-4	1	5
1,2-Dibromoethane	106-93-4	1	5
1,2-Dichloroethane	107-06-2	1	5
1,2-Dichloroethene (total)	540-59-0	1	5
1,2-Dichloropropane	78-87-5	1	5
2-Butanone	78-93-3	10	20
2-Hexanone	591-78-6	10	20
4-Methyl-2-pentanone	108-10-1	10	20
Acetone	67-64-1	10	20
Benzene	71-43-2	1	5
Bromochloromethane	74-97-5	1	5
Bromodichloromethane	75-27-4	1	5
Bromoform	75-25-2	1	5
Bromomethane	74-83-9	1	5
Carbon Disulfide	75-15-0	1	5
Carbon Tetrachloride	56-23-5	1	5
Chlorobenzene	108-90-7	1	5
Chloroethane	75-00-3	1	5
Chloroform	67-66-3	1	5
Chloromethane	74-87-3	1	5
cis-1,3-Dichloropropene	10061-01-5	1	5
Dibromochloromethane	124-48-1	1	5
Ethyl benzene	100-41-4	1	5
Methylene Chloride	75-09-2	1	5
Styrene	100-42-5	1	5
Tetrachloroethene	127-18-4	1	5
Toluene	108-88-3	1	5
trans-1,3-dichloropropene	10061-02-6	1	5
Trichloroethene	79-01-6	1	5
Vinyl Chloride	75-01-4	1	5
Xylenes (total)	1330-20-7	2	10

[a] Specific quantitation limits are highly matrix dependent; project reporting levels listed here are goals and may not always be achievable.
CAS = Chemical Abstracts Service
GC = Gas chromatograph
MS = Mass spectrometer
VOC = Volatile organic compound

Table 4-4. Project Reporting Levels for SVOCs in Soil and Water Using SW-846 Methods 8270C/3510C or 3520C and 8270C/3540C, 3541, or 3550B (GC/MS)

Compound	CAS Number	Project Reporting Levels[a]	
		Water (µg/L)	Soil/Sediment (µg/kg)
1,2,4-Trichlorobenzene	120-82-1	10	330
1,2-Dichlorobenzene	95-50-1	10	330
1,3-Dichlorobenzene	541-73-1	10	330
1,4-Dichlorobenzene	106-46-7	1.0	330
2,4,5-Trichlorophenol	95-95-4	25	800
2,4,6-Trichlorophenol	88-06-2	5.0	330
2,4-Dichlorophenol	120-83-2	10	330
2,4-Dimethylphenol	105-67-9	10	330
2,4-Dinitrophenol	51-28-5	25	800
2,4-Dinitrotoluene	121-14-2	10	330
2,6-Dinitrotoluene	606-20-2	10	330
2-Chloronaphthalene	91-58-7	10	330
2-Chlorophenol	95-57-8	10	330
2-Methylnaphthalene	91-57-6	10	330
2-Methylphenol	95-48-7	10	330
2-Nitroaniline	88-74-4	25	800
2-Nitrophenol	88-75-5	10	330
3 & 4-Methylphenol	108-39-4/106-44-5	10	330
3,3'-Dichlorobenzidine	91-94-1	5.0	330
3-Nitroaniline	99-09-2	25	800
4,6-Dinitro-2-methylphenol	534-52-1	25	800
4-Bromophenylphenyl ether	101-55-3	10	330
4-Chloro-3-methylphenol	59-50-7	10	330
4-Chloroaniline	106-47-8	10	330
4-Chlorophenylphenyl ether	7005-72-3	10	330
4-Nitroaniline	100-01-6	25	800
4-Nitrophenol	100-02-7	25	800
Acenaphthene	83-32-9	10	50
Acenaphthylene	208-96-8	10	50
Anthracene	120-12-7	10	50
Benz(*a*)anthracene	56-55-3	0.20	50
Benzo(*a*)pyrene	50-32-8	0.20	50
Benzo(*b*)fluoranthene	205-99-2	0.20	50
Benzo(*ghi*)perylene	191-24-2	10	50
Benzo(*k*)fluoranthene	207-08-9	0.20	50
Benzoic Acid	65-85-0	25	800
Benzyl Alcohol	100-51-6	10	330
Bis(2-chloroisopropyl)ether	108-60-1	10	330
Bis(2-chloroethoxy)methane	111-91-1	10	330
Bis(2-chloroethyl)ether	111-44-4	1.0	330

Table 4-4. Project Reporting Levels for SVOCs in Soil and Water Using SW-846 Methods 8270C/3510C or 3520C and 8270C/3540C, 3541, or 3550B (GC/MS) (continued)

Compound	CAS Number	Project Reporting Levels[a]	
		Water (μg/L)	Soil/Sediment (μg/kg)
Butylbenzylphthalate	85-68-7	10	330
Carbazole	86-74-8	10	50
Chrysene	218-01-9	10	50
Di-n-butylphthalate	84-74-2	10	330
Di-n-octylphthlalate	117-84-0	10	330
Dibenz(*a*,*h*)anthrancene	53-70-3	0.20	50
Dibenzofuran	132-64-9	10	330
Diethylphthalate	84-66-2	10	330
Dimethylphthalate	31-11-3	10	330
Fluoranthene	206-44-0	10	50
Fluorene	86-73-7	10	50
Hexachlorobenzene	118-74-1	0.20	330
Hexachlorobutadiene	87-68-3	1.0	330
Hexachlorocyclopentadiene	77-47-4	10	330
Hexachloroethane	67-72-1	10	330
Indeno(1,2,3-*cd*)pyrene	193-39-5	0.20	50
Isophorone	78-59-1	10	330
n-Nitroso-di-n-propylamine	621-64-7	10	330
n-Nitroso-diphenylamine	86-30-6	10	330
Naphthalene	91-20-3	10	50
Nitrobenzene	98-95-3	10	330
Pentachlorophenol	87-86-5	5.0	800
Phenanthrene	85-01-8	10	50
Phenol	108-95-2	10	330
Pyrene	129-00-0	10	50

-The primary solid sample preparation procedure will be Method 3540C or 3541, Soxhlet Extraction. However, when it is demonstrated these methods cannot be employed effectively for specific matrices, analytical laboratories may obtain permission to utilize the ultrasonic extraction method, 3550B.

[a] Specific quantitation limits are highly matrix dependent; project reporting levels listed here are goals and may not always be achievable.

CAS = Chemical Abstracts Service
GC = Gas chromatograph
MS = Mass spectrometer
SVOC = Semi-volatile organic compound

Table 4-5. Project Reporting Levels for Pesticides and PCB Compounds in Soil and Water Using SW-846 Methods 8081A and 8082A (GC)

Compound	CAS Number	Project Reporting Levels[a] Water (µg/L)	Project Reporting Levels[a] Soil/Sediment (µg/kg)
Method 8081A			
Alpha-BHC	319-84-6	0.03	1.7
Beta-BHC	319-85-7	0.05	1.7
Delta-BHC	319-86-8	0.05	1.7
Gamma-BHC (Lindane)	58-89-9	0.05	1.7
Heptachlor	76-44-8	0.03	1.7
Aldrin	309-00-2	0.03	1.7
Heptachlor Epoxide	1024-57-3	0.03	1.7
Endosulfan I	959-98-8	0.05	1.7
Dieldrin	60-57-1	0.0.03	1.7
4,4'-DDE	72-55-9	0.05	1.7
Endrin	72-20-8	0.05	1.7
Endosulfan II	33213-65-9	0.05	1.7
4,4'-DDD	72-54-8	0.05	1.7
Endosulfan Sulfate	1031-07-8	0.05	1.7
4,4'-DDT	50-29-3	0.05	1.7
Methoxychlor	72-43-5	0.10	17
Endrin Ketone	53494-70-5	0.05	1.7
Endrin Aldehyde	7421-93-4	0.05	1.7
alpha-Chlordane	5103-71-9	0.05	1.7
gamma-Chlordane	5103-74-2	0.05	1.7
Toxaphene	8001-35-2	2.0	170
Method 8082A			
Aroclor-1016	12674-11-2	0.2	33
Aroclor-1221	11104-28-2	0.2	33
Aroclor-1232	11141-16-5	0.2	33
Aroclor-1242	53469-21-9	0.2	33
Aroclor-1248	12672-29-6	0.2	33
Aroclor-1254	11097-69-1	0.2	33
Aroclor-1260	11096-82-5	0.2	33

-The primary solid sample preparation procedure will be Method 3540C or 3541, Soxhlet Extraction. However, when it is demonstrated these methods cannot be employed effectively for specific matrices, analytical laboratories may obtain permission to utilize the Ultrasonic Extraction Method 3550B.

[a] Specific quantitation limits are highly matrix dependent; project reporting levels listed here are goals and may not always be achievable

CAS = Chemical Abstracts Service

GC = Gas chromatograph

PCB = Polychlorinated biphenyl

Table 4-6. Project Reporting Levels for PAHs in Soil and Water Using SW-846 Methods 8310 (HPLC)

Compound	CAS Number	Project Reporting Levels[a]	
		Water (μg/L)	Soil/Sediment (μg/kg)
Acenaphthene	83-32-9	5	150
Acenaphthylene	208-96-8	5	150
Anthracene	120-12-7	2	60
Benz(*a*)anthracene	56-55-3	0.1	3
Benzo(*a*)pyrene	50-32-8	0.1	3
Benzo(*b*)fluoranthene	205-99-2	0.1	3
Benzo(*k*)fluoranthene	207-08-9	0.1	3
Benzo(*ghi*)perylene	191-24-2	0.5	15
Chrysene	218-01-9	0.5	15
Dibenz(*a,h*)anthrancene	53-70-3	0.1	3
Fluoranthene	206-44-0	0.5	15
Fluorene	86-73-7	0.5	15
Indeno(1,2,3-*cd*)pyrene	193-39-5	0.1	3
Naphthalene	91-20-3	5	150
Phenanthrene	85-01-8	2	60
Pyrene	129-00-0	0.5	15

[a] Specific quantitation limits are highly matrix dependent; project reporting levels listed here are goals and may not always be achievable. All "J" values less than laboratory reporting limits will be reported and evaluated.

CAS = Chemical Abstracts Service

HPLC = High pressure liquid chromatography

PAH = Polycyclic aromatic hydrocarbon

Table 4-7. Project Reporting Levels for Explosives (Nitroaromatics) in Soil and Water Using SW-846 Method 8330B

		Project Reporting Levels[a]	
Compound	CAS Number	Water (μg/L)	Soil/Sediment (mg/kg)
2-Amino-4,6-dinitrotoluene	35572-78-2	0.2	0.25
4-Amino-2,6-dinitrotoluene	19406-51-0	0.2	0.25
1,3-Dinitrobenzene	99-65-0	0.2	0.25
2,4-Dinitrotoluene	121-14-2	0.1	0.25
2,6-Dinitrotoluene	606-20-2	0.1	0.25
HMX	2691-41-0	0.5	1.0
Nitrobenzene	98-95-3	0.2	0.25
2-Nitrotoluene	88-72-2	0.2	0.25
3-Nitrotoluene	99-08-1	0.2	0.25
4-Nitrotoluene	99-99-0	0.2	0.25
RDX	121-82-4	0.5	1.0
Tetryl	479-45-8	0.2	1.0
1,3,5-Trinitrobenzene	99-35-4	0.2	0.25
2,4,6-Trinitrotoluene	118-96-7	0.2	0.25
PETN	78-11-5	3	3
Nitroglycerin	55-63-0	3	3
Nitroguanidine (8330 modified)	556-88-7	20	0.25
Perchlorate (6860)	7601-90-3	0.1	0.05
Nitrocellulose (colorimetric, cadmium reduction)	9004-70-0	500	5

[a] Specific quantitation limits are highly matrix dependent; project reporting levels listed here are goals and may not always be achievable. All "J" values less than laboratory reporting limits will be reported and evaluated.

CAS = Chemical Abstracts Service

USEPA = United States Environmental Protection Agency

Table 4-8. Project Reporting Levels for Metals in Soil and Water Using SW-846 Methods 6010B, 6020, or 7000 Series

Compound	CAS Number	Project Reporting Levels[a]	
		Water (μg/L)	Soil/Sediment (mg/kg)
Aluminum	7429-90-5	50	10
Antimony	7440-36-0	2	0.5
Arsenic	7440-38-2	5	0.5
Barium	7440-39-3	10	1
Beryllium	7440-41-7	1	0.1
Cadmium	7440-43-9	0.5	0.1
Calcium	7440-70-2	100	10
Chromium	7440-47-3	5	0.5
Cobalt	7440-48-4	5	0.5
Copper	7440-50-8	5	0.5
Iron	7439-89-6	100	10
Lead	7439-92-1	3	0.3
Magnesium	7439-95-4	100	10
Manganese	7439-96-5	10	1
Mercury	7439-97-6	0.2	0.1
Nickel	7440-02-0	10	1
Potassium	7440-09-7	200	20
Selenium	7782-49-2	5	0.5
Silver	7440-22-4	5	0.5
Sodium	7440-22-4	200	20
Thallium	7440-28-0	1	0.2
Vanadium	7440-62-2	10	1
Zinc	7440-66-6	10	1

[a] Specific quantitation limits are highly matrix dependent; project reporting levels listed here are goals and may not always be achievable.

CAS = Chemical Abstracts Service

Table 4-9. Project Reporting Levels for Miscellaneous Parameters in Soil and Water Using USEPA Water and Wastewater Methods, SW846 Methods, or ASTM Methods

Compound	CAS Number	Project Reporting Levels[a] Water (mg/L)	Project Reporting Levels[a] Soil/Sediment (mg/kg)
Bicarbonate Alkalinity (SM 2320B)	--	5.0	--
Carbonate Alkalinity (SM 2320B)	--	5.0	--
Ammonia-N (SM 4500 NH3-E)	--	2.0	--
Chloride (300.0)	--	1.0	--
Bromide (300.0)	--	0.5	--
Fluoride (300.0)	--	1.0	--
Nitrate-N (300.0)	--	0.1	--
Nitrite-N (300.0)	--	0.1	--
Ortho-phosphate (300.0)	--	0.5	--
Phosphorous (total) (365.1 or SM 4500 P-E)	--	0.1	--
Sulfate (300.0)	--	1.0	--
Sulfide (SM 4500 S2-E)	--	1.0	--
Cyanide, total (9010B/9012A)	--	0.01	0.5
Hexavalent Chromium (7196A)	--	0.02	1.0
Total Dissolved Solids (SM 2540C or 160.1)	--	10	--
Total Suspended Solids (SM 2540D or 160.2)	--	4.0	--
Settleable Solids (SM 2540F or 160.5)	--	0.1 mL/L/hr	--
pH (SM 4500 H-B or 150.1)	--	--	--
Conductivity (120.1)	--	--	--
Temperature (170.1)	--	--	--
Turbidity (180.1)	--	0.1 NTU	--
Dissolved Oxygen (360.1)	--	0.2	--
Biological Oxygen Demand (SM 5210B)	--	2.0	--
Chemical Oxygen Demand (USEPA 410.4 or SM 5220D)	--	20	--
Oil and Grease (USEPA 1664A)	--	5	10
Total Organic Carbon (SM 5310 Cor SW-846 9060A)	--	1.0	10
Total Petroleum Hydrocarbons (USEPA 1664A (SGT))	--	10	10
Total Phenols (420.1)	--	0.04	1.0
Moisture Content (ASTM D2216)	--	--	NA
Grain Size (ASTM D422)	--	--	NA
Atterberg Limits (ASTM D4318)	--	--	NA

Table 4-9. Project Reporting Levels for Miscellaneous Parameters in Soil and Water Using USEPA Water and Wastewater Methods, SW846 Methods, or ASTM Methods (continued)

Compound	CAS Number	Project Reporting Levels[a]	
		Water (mg/L)	Soil/Sediment (mg/kg)
Bicarbonate Alkalinity (SM 2320B)	--	5.0	--
USCS Classification (ASTM D2487)	--	--	NA
Permeability (ASTM D2434)	--	--	NA

[a] Specific quantitation limits are highly matrix dependent; project reporting levels listed here are goals and may not always be achievable.
ASTM = American Society for Texting and Materials
CAS = Chemical Abstracts Service
SM = Standard methods for the examination of water and wastewater
USEPA = United States Environmental Protection Agency
NA = Not applicable
NTU = Nephelometric turbidity unit
USCS = Unified Soil Classification System

4.4 COMPLETENESS, REPRESENTATIVENESS, AND COMPARABILITY

Completeness is a measure of the amount of valid data obtained from a measurement system compared to the amount expected to be obtained under ideal conditions. The contracted laboratories will provide data meeting QC acceptance criteria for all samples tested. Overall project completeness goals are identified in Tables 4-1 and 4-2.

Representativeness expresses the degree to which data accurately and precisely represents a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition. Representativeness is a qualitative parameter that depends upon the proper design of the sampling program and proper laboratory protocol. The sampling network was designed to provide data representative of site conditions. During development of this FWQAAP, site history, past waste disposal practices, existing analytical data, physical setting and processes, and constraints inherent to the investigation of all AOCs at RVAAP were considered. The sampling design rationale will be discussed in detail in the investigation-specific SAP addenda for each specific AOC investigation.

Representativeness will be satisfied by ensuring that the FWSAP and its addenda are followed, proper sampling techniques are used, proper analytical procedures are followed, and sample holding times are not exceeded. Representativeness will be determined by assessing the combined aspects of the QA program, QC measures, and data evaluations.

Comparability expresses the confidence with which one data set can be compared to another. The extent to which existing and planned analytical data will be comparable depends upon the similarity of sampling and analytical methods. The procedures used to obtain the planned analytical data are expected to provide comparable data. These new analytical data, however, may not be directly comparable to existing data because of differences in procedures and QA objectives.

5.0 SAMPLING PROCEDURES

Sampling procedures are described in the FWFSP and investigation-specific addenda. Investigations performed at RVAAP are anticipated to produce surface soil, subsurface soil, sediment, surface water, groundwater, and investigation-derived waste samples for analysis. Additional samples will be collected to complete field QC and QA laboratory split sample analyses. Field duplicate and QA laboratory split sample requirements will be documented in investigation-specific addendum but will typically occur at a frequency of 10%. RVAAP full-suite analysis will typically occur at a frequency of 10%. Specific sample numbers (including anticipated parameters and methods) will be incorporated into tables similar to Table 2-1. Investigation samples may require VOC, SVOC, pesticide, PCB, TAL metal, explosive, or miscellaneous analyte determinations as represented in Tables 2-1, 4-1, and 4-2.

Tables 5-1 and 5-2 summarize sample container, preservation, and holding time requirements for soil/sediment and water matrices, respectively, associated with investigations at RVAAP. The specific number of containers required for each AOC investigation will be included in each investigation-specific QAPP addenda. Additional sample volumes will be provided, when necessary, for the express purpose of performing associated laboratory QC (e.g., laboratory duplicates, matrix spike/matrix spike duplicates). These QC samples will be designated in the field and identified for the laboratory on the respective COCs. Field duplicate samples will be labeled and numbered in manner that does not allow the analytical facility to compare information with primary sample data.

Table 5-1. Container Requirements for Soil and Sediment Samples at RVAAP

Analyte Group	Container	Minimum Sample Size	Preservative	Holding Time
VOCs	Two 2-oz glass jars with septum cap (no headspace) or Encore® or equivalent	20 g	Cool, 4°C	14 days
SVOCs	One 16-oz glass jar with Teflon®-lined cap	60 g	Cool, 4°C	14 days (extraction) 40 days (analysis)
Pesticide Compounds	Include in SVOC container	60 g	Cool, 4°C	14 days (extraction) 40 days (analysis)
PCBs	Include in SVOC container	60 g	Cool, 4°C	14 days (extraction) 40 days (analysis)
Herbicides	Include in SVOC container	60 g	Cool, 4°C	14 days (extraction) 40 days (analysis)
PAH Compounds	Include in SVOC container	60 g	Cool, 4°C	14 days (extraction) 40 days (analysis)
Explosive Compounds	One 4-oz glass jar with Teflon®-lined cap	60 g	Cool, 4°C	14 days (extraction) 40 days (analysis)
Propellant Compounds	One 4-oz glass jar with Teflon®-lined cap	60 g	Cool, 4°C	14 days (extraction) 40 days (analysis)
Petroleum Hydrocarbons (gasoline range)	Two 2-oz glass jars with septum cap	20 g	Cool, 4°C	14 days
Petroleum Hydrocarbons (diesel range)	One 4-oz glass jar with Teflon®-lined cap	60 g	Cool, 4°C	14 days (extraction) 40 days (analysis)
Metals	Include in SVOC container	50 g	Cool, 4°C	180 days; Hg at 28 days
Hexavalent Chromium	Include in SVOC container	10 g	Cool, 4°C	28 days
Cyanide	Include in SVOC container	25 g	Cool, 4°C	14 days
Perchlorate	Include in SVOC container	10 g	Cool, 4°C	28 days
Incremental Sampling Method (ISM) Samples for multiple analyses	One or more 16-oz glass jar with Teflon®-lined cap, depending on the number of increments to be sampled.	Varies per analyses to be requested.	Cool, 4°C	Varies per analyses to be requested.

Note: When all fractions are being collected and shipped to the same analytical facility, one 16-oz jar should cover all requirements. If analytical groups are sent to separate facilities, then individual containers will be required.

Hg = Mercury
PAH = Polycyclic aromatic hydrocarbon
PCB = Polychlorinated biphenyl
RVAAP = Ravenna Army Ammunition Plant
SVOC = Semi-volatile organic compound
VOC = Volatile organic compound

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Table 5-2. Container Requirements for Water Samples at RVAAP

Analyte Group	Container	Minimum Sample Size	Preservative	Holding Time
VOCs	Three 40-mL glass vials with Teflon®-lined septum (no headspace)	80 mL	HCl to pH <2 Cool, 4°C	14 days
SVOCs	Two 1-L amber glass bottles with Teflon®-lined lid	1,000 mL	Cool, 4°C	7 days (extraction) 40 days (analysis)
Pesticide Compounds	Two 1-L amber glass bottles with Teflon®-lined lid	1,000 mL	Cool, 4°C	7 days (extraction) 40 days (analysis)
PCBs	Two 1-L amber glass bottles with Teflon®-lined lid	1,000 mL	Cool, 4°C	7 days (extraction) 40 days (analysis)
Herbicides	Two 1-L amber glass bottles with Teflon®-lined lid	1,000 mL	Cool, 4°C	7 days (extraction) 40 days (analysis)
PAH Compounds	Two 1-L amber glass bottles with Teflon®-lined lid	1,000 mL	Cool, 4°C	7 days (extraction) 40 days (analysis)
Explosive Compounds	One 1-L amber glass bottle with Teflon®-lined lid	1,000 mL	Cool, 4°C	7 days (extraction) 40 days (analysis)
Propellant Compounds	One 1-L amber glass bottle with Teflon®-lined lid	1,000 mL	Cool, 4°C	7 days (extraction) 40 days (analysis)
Petroleum Hydrocarbons (gasoline range)	Two 40-mL glass vials with Teflon®-lined septum (no headspace)	80 mL	Cool, 4°C	14 days
Petroleum Hydrocarbons (diesel range)	Two 1-L amber glass bottles with septum lid	1,000 mL	Cool, 4°C	7 days (extraction) 40 days (analysis)
Metals	One 1-L polybottle	500 mL	HNO_3 to pH <2 Cool, 4°C	180 days; Hg at 28 days
Hexavalent Chromium	One 250-mL polybottle	200 mL	Cool, 4°C	24 hr
Cyanide	500-mL polybottle	500 mL	NaOH to pH >12 Cool, 4°C	14 days

Table 5-2. Container Requirements for Water Samples at RVAAP (continued)

Analyte Group	Container	Minimum Sample Size	Preservative	Holding Time
Perchlorate	One 125-mL polybottle with headspace	100 mL	Filter with 2-micron Teflon® filter, Cool, 4°C	28 days
Anions (Br, Cl, F, SO_4)	250-mL polybottle	250 mL	Cool, 4°C	28 days
Nitrate-Nitrite (reported as combined value)	250-mL polybottle	100 mL	H_2SO_4 to pH <2 Cool, 4°C	28 days
Nitrate-Nitrite (reported as separate values)	250-mL polybottle	100 mL	Cool, 4°C	48 hr
TSS/TDS	500-mL polybottle	100 mL	Cool, 4°C	28 days

Br = Bromine
Cl = Chlorine
F = Fluorine
SO_4 = Sulfate
H_2SO_4 = Sulfuric acid
HCl = Hydrochloride
Hg = Mercury
HNO_3 = Nitric acid
NaOH = Sodium hydroxide
PAH = Polycyclic aromatic hydrocarbon
PCB = Polychlorinated biphenyl
RVAAP = Ravenna Army Ammunition Plant
SVOC = Semi-volatile organic compound
TDS = Total dissolved solids
TSS = Total suspended solids
VOC = Volatile organic compound

6.0 SAMPLE CUSTODY

It is the U.S. Army's policy, and will be the intent of all investigations, to follow USEPA policy regarding sample custody and COC protocols as described in *National Enforcement Investigations Center (NEIC) Policies and Procedures* (USEPA 1978). This custody is in three parts: sample collection, laboratory analysis, and final evidence files. Final evidence files, including originals of laboratory reports and electronic files, are maintained under document control in a secure area. A sample or evidence file is under your custody when it is:

- In your possession;
- In your view, after being in your possession;
- In your possession and you place them in a secured location; or
- In a designated secure area.

6.1 FIELD CHAIN-OF-CUSTODY PROCEDURES

The sample packaging and shipment procedures summarized below will ensure that samples will arrive at the laboratory with the COC intact. The protocol for specific sample numbering using case numbers and traffic report numbers (if applicable) and other sample designations is included in Section 6.0 of the FWFSP.

6.1.1 Field Procedures

The field sampler is responsible for the care and custody of the samples until they are transferred or properly dispatched. As few people as possible should handle the samples. Each sample container will be labeled with a sample number, date and time of collection, sampler, and sampling location. Sample labels are to be completed for each sample using indelible ink, unless prohibited by weather conditions (e.g., a logbook notation would explain that a pencil was used to fill out the sample label due to the non-functionality of ballpoint pens in freezing weather). The Contractor Project Manager, in conjunction with the U.S. Army, will review all field activities to determine whether proper custody procedures were followed during the fieldwork and to decide if additional samples are required.

6.1.2 Field Logbooks/Documentation

The field logbook will provide a means of recording data collection activities performed. Entries will be described in as much detail as possible so that persons going to the AOC could reconstruct a particular situation without reliance on memory. Field logbooks will be bound field survey books or notebooks. Logbooks will be assigned to field personnel but stored in the document control center when not in use. Each logbook will be identified by a project-specific document number. The title page of each logbook will contain the name of the person to whom the logbook is assigned, the logbook number, the project name, and the project start and end dates.

Logbook entries contain a variety of information. At the beginning of each entry, the date, start time, weather, names of all sampling team members present, level of personal protection being used, and the signature of the person making the entry will be entered. The names of visitors to the AOC, field sampling or investigation team personnel, and the purpose of their visit will also be recorded in the field logbook. Measurements made and samples collected will be recorded. All entries will be made in ink and no erasures will be made. If an incorrect entry is made, the information will be crossed out with a single strike mark and the entry will be initialed and dated.

Samples will be collected following the sampling procedures documented in the FWFSP and its addenda. When a sample is collected or a measurement is made, a detailed description of the location shall be recorded. The equipment used to collect samples will be noted, along with the time of sampling, sample description, depth at which the sample was collected, volume, and number of containers. A sample identification number will be assigned before sample collection. Field duplicate samples, which will receive an entirely separate sample identification number, will be noted under sample description. Equipment employed to make field measurements will be identified along with their calibration dates.

6.1.3 Transfer Of Custody And Shipment Procedures

Samples are accompanied by a properly completed COC form. The sample numbers and locations will be listed on the COC form. When transferring the possession of samples, the individuals relinquishing and receiving will sign, date, and note the time on the record. This record will document the transfer of custody of the samples from the sampler to another person, to a mobile laboratory, to the permanent laboratory, or to/from a secure storage area.

Samples will be properly packaged for shipment and dispatched to the appropriate laboratory for analysis. A separate signed custody record will be enclosed in each sample box or cooler. Shipping containers will be secured with strapping tape and custody seals for shipment to the laboratory. The preferred procedure is use a custody seal attached to the front right and back left of the cooler. The custody seals are covered with clear plastic tape. The cooler is strapped shut with strapping tape in at least two locations. When the samples are sent by common carrier, a bill of lading should be used. Receipts or bills of lading will be retained as part of the permanent documentation. When sent by mail, the package will be registered with return receipt requested. Commercial carriers are not required to sign off on the custody form as long as the custody forms are sealed inside the sample cooler and the custody seals remain intact.

All shipments will be accompanied by the COC record identifying the contents. The original record will accompany the shipment, and copies will be retained by the sampler for return to project management and the project file. Whenever co-located or split samples are collected for comparison analysis by the U.S. Army QA Laboratory or a government agency, a separate COC is prepared for those samples and marked to indicate with whom the samples are being split.

All shipments will comply with applicable United States Department of Transportation regulations for environmental samples.

6.2 LABORATORY CHAIN-OF-CUSTODY PROCEDURES

Custody procedures, along with the holding time and sample preservative requirements for samples, will be described in laboratory QA plans. These documents will identify the laboratory custody procedures for sample receipt and log-in, sample storage, tracking during sample preparation and analysis, and laboratory storage of data.

6.3 FINAL EVIDENCE FILES CUSTODY PROCEDURES

The Contractor is the custodian of the evidence file and will maintain the contents of evidence files for each investigation, including all relevant records, reports, logs, field notebooks, pictures, subcontractor reports, correspondence, laboratory logbooks, and COC forms. Each project evidence file will be stored in a secure, limited-access area and under custody of the Contractor Project Manager.

Analytical laboratories will retain all original raw data information (both hard copy and electronic) in a secure, limited-access area and under custody of the Laboratory Project Manager.

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7.0 CALIBRATION PROCEDURES AND FREQUENCY

This section describes the procedures for maintaining the accuracy of all the instruments and measuring equipment that are used for conducting field tests and laboratory analyses. These instruments and equipment shall be calibrated before each use or on a scheduled, periodic basis according to manufacturer instructions.

7.1 FIELD INSTRUMENTS/EQUIPMENT

Instruments and equipment used to gather, generate, or measure environmental data will be calibrated with sufficient frequency and in such a manner that accuracy and reproducibility of results are consistent with the manufacturer's specifications. All field instruments for this purpose will have unique identifiers, and each instrument will be logged in the Material and Testing Equipment (M&TE) Log Book before use in the field. The Site Safety and Health Officer (SSHO) or his/her designee will be responsible for performing and documenting daily calibration/checkout records for instruments used in the field.

Equipment to be used during field sampling will be examined to certify that it is in operating condition. This will include checking the manufacturer's operating manual and instructions for each instrument to ensure that all maintenance requirements are being observed. Field notes from previous sampling trips will be reviewed so that the notation on any prior equipment problems will not be overlooked and all necessary repairs to equipment will be carried out. Spare parts or duplication of equipment will be available to the sampling effort.

Calibration of field instruments is governed by the specific standard operating procedure (SOP) for the applicable field analysis method and it will be performed at the intervals specified in the SOP. If no SOP is available, then calibration of field instruments will be performed at intervals specified by the manufacturer or more frequently as conditions dictate. Calibration procedures and frequency will be recorded in a field logbook.

Field instruments may consist of a pH meter, thermometer, specific conductivity meter, turbidity meter, flame ionization detector (FID) or photoionization detector (PID) for organic vapor detection, and a combustible gas detection meter capable of determining lower explosive limits, upper explosive limits, and/or oxygen levels. If an internally calibrated field instrument fails to meet calibration/checkout procedures, it will be returned to the manufacturer for service and a back-up instrument will be calibrated and used in its place.

Detailed instructions on the proper calibration and use of each field instrument follow the guidelines established by the manufacturer. The technical procedures for each instrument used on this project include the manufacturer's instructions detailing the proper use and calibration of each instrument. Project personnel responsible for calibrating and operating field instruments will receive training in the proper use of each instrument. Documentation of current training records for all project field personnel will be maintained in the training records database for the project.

7.1.1 pH Meter Calibration

The pH meter will be calibrated according to the manufacturer’s instructions using traceable standard buffer solutions before fieldwork begins. Before use in the field, calibration of the pH meter will be checked against two standard buffer solutions. Calibration procedures, lot numbers of buffer solutions, and other pertinent calibration or checkout information will be recorded in the M&TE Log Book for the project. The calibrations performed, standard used, and sample pH values are to be recorded in the field notebook. Appropriate new batteries will be purchased and kept with the meters to facilitate immediate replacement in the field as necessary.

7.1.2 Temperature Calibration

Temperature measurements are carried out using a thermometer. Mercury thermometers must be inspected before use to ensure that there is no mercury separation. Thermometers should be rechecked in the field before and after each use to see if the readings are logical and the mercury is still intact. Thermometers should be checked biannually for calibration by immersing them in a bath of known temperature until equilibrium is reached. Thermometers should be discarded in an appropriate manner if found to have more than 10% error. The reference thermometer used for bath calibration should be National Institute of Standards and Testing (NIST) traceable. Temperatures will be recorded in the M&TE Log Book, the Sample Log Book, or the Cooler Log Book, as appropriate.

7.1.3 Conductivity Meter Calibration

The conductivity cells of the specific conductivity meter will be cleaned according to manufacturer’s recommendations and specifications and checked against known conductivity standard solutions before each sampling event. The instrument will be checked daily with NIST-traceable standard solutions. If the instrument is more than 10% out of calibration when compared with standard solutions, the instrument will be recalibrated. If this cannot be done in the field, the instrument will be returned to the manufacturer or supplier for recalibration and a back-up instrument will be used in its place. Daily calibration readings and other relevant information will be recorded daily in the M&TE Log Book.

7.1.4 Turbidity Calibration

The turbidity meter will be calibrated each day against a known and traceable standard supplied by the manufacturer prior to use in the field. In the field, the instrument will be checked against the standard and adjusted each time the instrument is turned on. Calibration information will be recorded in the M&TE Log Book; checks made in the field will be recorded in the Sample Log Book.

7.1.5 Organic Vapor Detection

Organic vapor detectors will be checked daily according to the manufacturer's instructions. FIDs will be checked daily by using the internal calibration mechanism. PIDs will be calibrated daily with a gas of known concentration. All daily calibration information will be recorded in the M&TE Log Book.

7.1.6 Combustible Gas And Oxygen Detection

Combustible gas calibration checks should be made daily using the gas recommended by the manufacturer. Calibration of the oxygen system should be checked daily while the combustible gas sensor is being checked. All appropriate calibration check data will be recorded in the M&TE Log Book.

7.1.7 Dissolved Oxygen Calibration

The dissolved oxygen meter will be calibrated against a known standard according to the manufacturer's instructions. Calibration checks will be performed each day prior to use in the field. Calibration information will be recorded daily in the M&TE Log Book.

7.1.8 Geophysical Instruments

Geophysical instruments such as magnetometers, electromagnetic conductivity meters, and ground-penetrating radar equipment will be calibrated per manufacturer's instructions. Calibration procedures and equipment used should also be described in investigation-specific documentation.

7.2 LABORATORY INSTRUMENTS

Calibration of laboratory equipment will be based on approved written procedures. Records of calibration, repairs, or replacement will be filed and maintained by laboratory personnel performing QC activities. These records will be filed at the location where the work is performed and will be subject to QA audit. Procedures and records of calibration will follow direction as stated in the DoD QSM (DoD 2009) and USACE, Louisville District's QSM Supplement (USACE 2007).

In all cases where analyses are conducted according to SW-846 methods, the calibration procedures and frequencies specified in the applicable SW-846 method and the DoD QSM and USACE, Louisville District's QSM Supplement will be followed exactly. For analyses governed by SOPs, refer to the appropriate SOP for the required calibration procedures and frequencies.

Records of calibration will be kept as follows:

- Each instrument will have a record of calibration with an assigned record number.

- Instrument identification numbers, manufacturer, model numbers, date of last calibration, signature of calibrating analyst, and due date for next calibration will be documented. Reports and compensation or correction figures will be maintained with each instrument.

- A written step-wise calibration procedure will be available for each piece of test and measurement equipment.

- Any instrument that is not calibrated to the manufacturer's original specification will display a warning tag to alert the analyst that the device carries only a "Limited Calibration."

7.2.1 Organic Analyses

For all analyses, the laboratory will follow directions provided in the DoD QSM and USACE, Louisville District's QSM Supplement and individual analytical procedures for initial calibration, initial calibration checks, and continuing calibration checks. Before calibration, the instrument(s) used for gas chromatograph/mass spectrometer (GC/MS) analyses are tuned by analysis of p-bromofluorobenzene (BFB) for volatile analyses and decafluorotriphenyl phosphine (DFTPP) for semi-volatile analyses. Once the tuning criteria for these reference compounds are met, the instrument should be initially calibrated using a five-point calibration curve. The instrument tune will be verified each 12 hr of operation.

Calibration standards will be USEPA- or NIST-traceable (when existent) and are spiked with internal standards and surrogate compounds. Calibration and continuing calibration verification of instruments will be performed at approved intervals as specified by the analytical method and the DoD QSM and USACE, Louisville District's QSM Supplement. A second source calibration check will be performed after the initial calibration.

7.2.2 Metals Analysis

For all analyses, the laboratory will follow directions provided in the DoD QSM and USACE, Louisville District's QSM Supplement and individual analytical procedures for initial calibration, initial calibration checks, and continuing calibration checks. Inductively coupled plasma (ICP) emission spectrophotometer and ICP MS instruments are calibrated using a minimum of two calibration standards prepared by dilution of certified stock solutions. One calibration standard will be at the approximate level of quantitation (LOQ) for the metal. Other standards bracket the concentration range of the samples. Calibration standards will contain acids at the same concentration as the digestates. An analysis blank also is prepared.

Two continuing calibration standards (one mid level and one low level), prepared from a different stock solution than that used for preparation of the calibration standards, are analyzed after each ten samples or each 2 hr of continuous operation. The value of the continuing calibration standard concentration must agree within plus or minus 10% of the initial value.

For ICP, linearity near the reporting limit will be verified with a standard prepared at a concentration of two times the reporting limit. This standard must be run at the beginning and end of each sample analysis event.

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8.0 ANALYTICAL PROCEDURES

All samples collected during the investigation activities will be analyzed by DoD ELAP-accredited laboratories. QA samples of groundwater, surface water, and soil will be analyzed by a project-identified QA laboratory. Designated QA laboratory facilities may be arranged through the auspices of Ohio EPA or the USACE, Louisville District office at the time of project-specific coordination efforts. Selected QA laboratories will be logistically and corporately distinct from the primary Contractor's subcontract laboratory facility. Each laboratory supporting this work shall provide statements of qualifications including organizational structure, a QA manual, and SOPs, which will be available upon request or included in the investigation-specific QAPP addenda.

8.1 LABORATORY ANALYSIS

Analytical parameters and project reporting levels are listed in Tables 4-3 through 4-9. SW-846 Update III methods are primarily cited; however, more recent versions may be required in investigation-specific QAPP addenda if warranted by the DQOs.

Principal laboratory facilities will not subcontract or transfer any portion of this work to another facility, unless expressly permitted to do so in writing by the Contractor with the concurrence of Ravenna Program Management.

If contaminant concentrations are high, or for matrices other than normal water and soil, analytical protocols may be inadequate. In these cases, sample analysis may require modifications to defined methodology. Any proposed change to specified analytical methods requires written approval from the Contractor and U.S. Army. All analytical method variations will be identified in investigation-specific QAPP addenda, which will be submitted for regulatory review and approval. All variations from standard SW-846, USEPA, or ASTM methods must be approved by both the U.S. Army and Ohio EPA prior to sample analysis.

These SOPs must be adapted from, and reference, standard USEPA SW-846 methods and thereby specify the following:

- Procedures for sample preparation;

- Instrument start-up and performance check;

- Procedures to establish the detection limit (DL), level of detection (LOD), and LOQ for each parameter;

- Initial and continuing calibration check requirements;

- Specific methods for each sample matrix type; and

- Required analyses and QC requirements.

All VOC, SVOC, pesticide, and PCB results will be expressed in micrograms per liter (µg/L) for water samples and micrograms per kilogram (µg/kg; dry weight) for soil and sediment samples. Metal and explosive results will be expressed in milligrams per liter (mg/L) for water samples and milligrams per kilogram (mg/kg; dry weight) for soil and sediment samples.

All reasonable effort must be made on the part of the laboratory to meet project reporting levels for all analyses. Elevated reporting levels may be reported when reliable sample results cannot be obtained because of a difficult sample matrix. In these cases, the sample must be diluted to reduce the effects of the matrix on the instrument readings. Where practical, the laboratory should report both diluted and undiluted analyses. Attempts to limit elevated reporting levels such as sample cleanup steps should be documented and reported.

In addition, efforts must be made to analyze samples within the first half of the analytical holding time, thus allowing potential repeat analyses to be conducted within analytical holding time windows.

8.2 FIELD SCREENING ANALYTICAL PROTOCOLS

Procedures for field measurements of pH, specific conductivity, and temperature are described in the FWFSP and in Section 7.0 of this document. Tabulation of the methodologies appears in Tables 4-1 and 4-2.

9.0 INTERNAL QUALITY CONTROL CHECKS

9.1 FIELD SAMPLE COLLECTION

Field sampling precision and accuracy assessments will be made by collecting field duplicates and field QC samples in accordance with the procedures described in the FWSAP and at the frequency indicated in the investigation-specific SAP addenda.

9.2 FIELD MEASUREMENT

QC procedures for most field measurements (e.g., pH, conductivity, temperature) are limited to checking the reproducibility of the measurement by obtaining multiple readings on a single sample or standard and by calibrating the instruments. Refer to the FWFSP and investigation-specific addenda for more detail regarding these measurements.

9.3 LABORATORY ANALYSIS

Analytical QC procedures for investigations at RVAAP are specified in the method descriptions; the DoD QSM (DoD 2009); and the USACE, Louisville District's QSM Supplement (USACE 2007). These specifications include the types of QC checks normally required: method blanks, LCSs, matrix spikes, matrix spike duplicates, calibration standards, internal standards, surrogate standards, calibration check standards, and laboratory duplicate analysis. Calibration compounds and concentrations to be used and the method of QC acceptance criteria for these parameters have been identified.

To ensure the production of analytical data of known and documented quality, laboratories associated with the investigations at RVAAP will implement QA program and QC checks.

9.3.1 Sample Preparation

All samples must be prepared according to the requirements of the DoD QSM, applicable SW-846 or USEPA methods, and the laboratory SOPs. Preparations must also include the steps listed below.

9.3.1.1 Incremental Samples

Incremental samples (IS) will be air dried at the laboratory and sieved to less than 2-mm to remove sticks, rocks, and large particles. The sieved soil is then ground to homogenize the sample and to achieve small, uniform size particles. The soil is then sub-sampled using either a rotary riffle splitter or by spreading the soil into a thin layer and collecting 30 increments into a clean, labeled sample container. The laboratory SOP for this procedure should meet the recommendations developed by the Interstate Technology and Regulatory Council working group.

9.3.1.2 Explosives

Soil samples will be prepared and analyzed in accordance with the DoD QSM and SW-846 Method 8330B. Samples will be dried and sieved using a 2-mm sieve. The soil will be sub-sampled for analysis by spreading the soil into a thin layer and collecting 30 increments into a clean, labeled sample container. Samples are not required to be ground using a ring puck mill (SW-846 Method 833B, Section 11.1.4.2.2) unless the samples were collected at a firing range.

9.3.1.3 Metals

Soil and sediment samples will be prepared using SW-846 Method 3050. This method recommends sieving the sample to <2-mm particle size prior to digestion if appropriate and necessary. Sieving should be done when extraneous materials such as rocks and twigs are part of the sample. The state of Hawaii recommends that all soil and sediment samples be sieved and that 10 g be digested instead of 1 g as directed in the method. This approach could diminish the error associated with sample heterogeneity and may be required and documented in investigation-specific QAPP addenda if warranted by the DQOs.

9.3.1.4 Organic Extraction

Liquid samples should be extracted using soxhlet extraction (SW-846 Method 3540C or 3541). Note that laboratories may obtain permission to use the ultrasonic extraction method, USEPA 3550B, if necessary due to sample matrix and performance issues.

9.3.2 Quality Assurance Program

All subcontracted analytical laboratories will have a written QA program providing rules and guidelines to ensure the reliability and validity of work conducted at the laboratory. Compliance with the QA program is coordinated and monitored by the laboratory's QA department, which is independent of the operating departments.

The stated objectives of the laboratory QA program are to:

- Properly receive, preserve, and store all samples;

- Maintain adequate custody records from sample receipt through reporting and archiving of results;

- Use properly trained analysts to analyze all samples by approved methods within holding times;

- Produce defensible data with associated documentation to show that each system was calibrated and is operating within precision and accuracy control limits;

- Accurately calculate, check, report, and archive all data using the Laboratory Information Management System; and

- Document all of the above activities so that all data can be independently validated.

All laboratory procedures are documented in writing as SOPs, which are edited and controlled by the QA department. Internal QC measures for analysis will be conducted with laboratory SOPs and the individual method requirements specified.

External QA shall be provided by the designated Ohio EPA or USACE, Louisville District QA laboratory. The external QA laboratory shall receive QA sample splits as identified in each task-specific set of documentation.

9.3.3 Quality Control Checks

Implementation of QC procedures during sample collection, analysis, and reporting ensures that the data obtained are consistent with its intended use. Both field and laboratory QC checks are performed throughout the work effort to generate data confidence. Analytical QC measures are used to determine if the analytical process is in control and to determine the sample matrix effects on the data being generated.

Specifications include the types of QC required (e.g., duplicates, sample spikes, surrogate spikes, reference samples, controls, and blanks), the frequency for implementing each QC measure, the compounds to be used for sample and surrogate spikes, and the acceptance criteria for this QC.

Laboratories will provide documentation in each data package that both initial and ongoing instrument and analytical QC functions have been met. Any non-conforming analysis will be re-analyzed by the laboratory if sufficient sample volume is available. Sufficient sample volumes will be collected to provide for re-analyses, if required.

9.3.3.1 Analytical Process Quality Control

9.3.3.1.1 Method Blanks

A method blank is a sample of a non-contaminated substance of the matrix of interest (usually distilled/de-ionized water or silica sand) that is then subjected to all of the sample preparation (e.g., digestion, distillation, and extraction) and analytical methodology applied to the samples. The purpose of the method blank is to check for contamination from within the laboratory that might be introduced during sample preparation and analysis that would adversely affect analytical results. One in 20 samples will be method blanks, with fractions rounded to the next whole number.

General analytical sensitivity goals are identified in Tables 4-3 through 4-9 as project reporting levels. Project-specific reporting levels should be determined by the DQOs. In general, the reporting limit should be at least one-half of the action level (e.g., cleanup goal, risk level, or regulatory requirement). The concentration of any target analyte in the blank must not exceed one-half the reporting limit (or the reporting limit for common laboratory contaminants), one-tenth the amount measured in any sample, or one-tenth the regulatory limit (see DoD QSM).

9.3.3.1.2 Laboratory Control Samples

The LCS contains known concentrations of all target analytes to be determined and is carried through the entire preparation and analysis process. Commercially available LCSs or those from USEPA may be used. LCS standards that are prepared in-house must be made from a source independent of that of the calibration standards. In addition to a mid-level LCS, laboratories will include a low-level LCS check at three times the LOD. This QC/MRL check will contain all target analytes and be reported similarly to standard LCS information. The QC/MRL will be analyzed at the beginning of the analytical sequences as required by the QSM (DoD 2009). Additionally, the laboratory will analyze the QC/MRL sample at the close of the analytical sequence.

The primary purpose of the LCS is to establish and monitor the laboratory’s analytical process control. An LCS must be analyzed with each analytical sample batch. LCS information must contain the theoretical concentrations of analytes, measured concentrations, percent recoveries, and RPDs if duplicate LCS samples are analyzed. LCS recoveries are expected to be within the ranges established in the DoD QSM. The number of marginal exceedances should not exceed the number allowed by the QSM.

9.3.3.2 Matrix And Sample-Specific Quality Control

9.3.3.2.1 Laboratory Duplicates

Laboratory duplicates are separate aliquots of a single sample that are prepared and analyzed concurrently at the laboratory. This duplicate sample should not be a method blank, source blank, equipment rinsate, trip blank, or field blank. The primary purpose of the laboratory duplicate is to check the precision of the laboratory analyst, the sample preparation methodology, and the analytical methodology. If there are significant differences between the duplicates, the affected analytical results will be re-examined. One in 20 samples will be a laboratory duplicate, with fractions rounded to the next whole number.

9.3.3.2.2 Surrogate Spikes

A surrogate spike is prepared by adding a pure compound to a sample before extraction. The compound in the surrogate spike should be of a similar type to that being assayed in the sample. The purpose of a surrogate spike is to determine the efficiency of analyte recovery in sample preparation and analysis. The percent of recovery of the surrogate spike is then used to gauge the total accuracy of the analytical method for that sample.

9.3.3.2.3 Matrix Spikes And Matrix Spike Duplicates

A matrix spike is an aliquot of a sample spiked with known quantities of analytes and subjected to the entire analytical procedure. It is used to indicate the appropriateness of the method for the matrix by measuring recovery or accuracy. Accuracy is the nearness of a result or the mean of a set of results to the true or accepted value. A matrix spike duplicate is a second aliquot of the same sample with known quantities of compounds added. The purpose of the matrix spike duplicate, when compared to the matrix spike, is to determine method precision. Precision is the measure of the reproducibility of a set of replicate results among themselves or the agreement among repeat observations made under the same conditions. Matrix spikes and matrix spike duplicates are performed for each preparation batch of up to 20 samples per each matrix.

The matrix spike must contain all analytes being determined in the sample set. In any batch of RVAAP samples, the matrix spike/matrix spike duplicate must be performed on an RVAAP AOC sample. Matrix spike and matrix spike duplicate information must contain the theoretical concentrations of analytes spiked into the sample, concentrations of analytes present in the original sample, measured concentrations determined in the spiked sample, calculated percent recoveries, and RPDs for each matrix spike/matrix spike duplicate pair.

9.3.3.2.4 Method-Specific Quality Control

The laboratory must follow specific quality processes, as defined by the method, such as calibration verification samples, instrument blank analysis, internal standards implementation, tracer analysis, method of standard additions utilization, serial dilution analysis, post-digestion spike analysis, and chemical carrier evaluation.

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10.0 DATA REDUCTION, VALIDATION, AND REPORTING

10.1 DATA REDUCTION

10.1.1 Field Measurements And Sample Collection

Raw data from field measurements and sample collection activities will be recorded in field logbooks. Data to be used in project reports will be reduced and summarized. The methods of data reduction will be documented.

The Contractor Project Manager or his/her designee is responsible for reviewing all field-generated data. This includes verifying that all field descriptive data are recorded properly, that all field instrument calibration requirements have been met, that all field QC data have met frequency and criteria goals, and that field data are entered accurately in all logbooks and worksheets.

10.1.2 Laboratory Services

All samples collected for investigations at RVAAP will be sent to DoD ELAP-accredited laboratories. Data reduction, evaluation, and reporting for samples analyzed by the laboratory will be performed according to specifications outlined in the laboratory's QA plan, this FWQAPP, and any investigation-specific QAPP addenda. Laboratory reports will include documentation verifying analytical holding time compliance.

Laboratories will perform in-house analytical data reduction under the direction of the Laboratory QA Officer. The Laboratory QA Officer is responsible for assessing data quality and informing the Contractor and the U.S. Army of any data considered "unacceptable" or requiring caution on the part of the data user in terms of its reliability. Data will be reduced, evaluated, and reported as described in the laboratory QA plan. Data reduction, review, and reporting by the laboratory will be conducted as follows:

- Raw data are produced by the analyst who has primary responsibility for the correctness and completeness of the data. All data will be generated and reduced following FWQAPP-defined methods and implementing laboratory SOPs.

- Level 1 technical review is completed by the area supervisor or data review specialist. This review evaluates the data for attainment of QC criteria, as outlined in the established methods, and for overall reasonableness. This review ensures all calibration and QC data are in compliance, checks at least 10% of the data calculations, and documents that the data package is complete and ready for reporting and archival.

- Upon acceptance of the raw data by the area supervisor, the report is generated and sent to the Laboratory Project Manager for Level 2 administrative data review. This review ensures consistency and compliance with all laboratory instructions, the laboratory QA plan, the project laboratory statement of work, and the project QAPP.

- The Laboratory Project Manager completes a thorough review of all reports.

- Final reports are generated and signed by the Laboratory Project Manager and QA Officer.

- Data are delivered to the Contractor for data verification and validation.

The data review process identifies any out-of-control data points and data omissions and initiates interactions with the laboratory to correct data deficiencies. Decisions to repeat sample collection and analyses may be made by the Contractor Project Manager based on the extent of the deficiencies and their importance in the overall context of the project. The laboratory will provide flagged data to denote the following: (1) concentrations below project reporting levels, (2) estimated concentrations due to poor spike recovery, (3) concentrations of chemical are also found in the laboratory blank, (4) concentrations exceeding the calibration range, and (5) GC analyses with greater than 25% difference between the primary and confirmation columns.

Laboratories will prepare and retain full analytical and QC documentation for the project. Such retained documentation will be both hard (paper) copy and electronic storage media (e.g., compact disc) as dictated by the analytical methodologies employed. As needed, laboratories will supply hard copies of the retained information.

Laboratories will provide the following information to the Contractor in each analytical data package submitted:

- Cover sheets listing the samples included in the report and narrative comments describing problems encountered in analysis;

- Tabulated results of inorganic and organic compounds identified and quantified; and

- Analytical results for QC sample spikes, sample duplicates, initial and continuous calibration verifications of standards and blanks, standard procedural blanks, LCSs, MRLs and other deliverables as identified in Section 10.3.

10.2 DATA VERIFICATION/VALIDATION

Analytical data for this project will be verified and validated by qualified chemists. Flags signifying the usability of data will be noted and entered into an analytical database. Data discrepancies noted during the verification and validation processes may be recorded as nonconformance reports (NCRs), which are sent to the laboratory for clarification and/or correction. Decisions to repeat sample collection and analyses may be made by the Contractor Project Manager or U.S. Army Project

Manager based on the extent of the deficiencies and their importance in the overall context of the project.

All data generated for investigations will be in the format specified by the Automated Data Review (ADR) User's Manual. The ADR software was developed by Laboratory Data Consultants and is available from USACE or directly from the developers. The ADR format is designed to facilitate data review and evaluation. The electronic dataset will include data flags in accordance with referenced protocols along with additional comments from the data review process. Laboratory data flags will include the following: (1) concentrations below LOQs, (2) estimated concentrations due to poor spike recovery, and (3) concentrations of chemical also found in the laboratory blank. RVAAP investigation datasets will be available for controlled access by the Contractor Project Manager and authorized personnel. Each dataset will be incorporated into investigation reports as required.

10.2.1 Data Verification/Validation Approach

Samples will be analyzed through implementation of "definitive" analytical methods. "Definitive data" will be reported consistent with the deliverables identified in Section 10.3 of this FWQAPP and in Appendix E of the DoD QSM (DoD 2009). This report content is consistent with what is understood as an USEPA Level III deliverable (data forms including laboratory QC and calibration information). DQOs identified in Section 3.0 and method-specified criteria may be verified and validated. Comprehensive analytical information will be retained by the subcontract laboratory.

A systematic process for data verification and/or validation will be performed to ensure the precision and accuracy of the analytical data are adequate for their intended use. The greatest uncertainty in a measurement is often a result of the sampling process and inherent variability in the environmental media rather than the analytical measurement. Therefore, analytical data validation will be performed only to the level necessary to minimize the potential of using false-positive or false-negative results in the decision-making process (i.e., to ensure accurate identification of detected versus non-detected compounds). This approach is consistent with the objectives for the program, with the analytical methods, and for determining contaminants of concern and calculating risk.

These definitive data then will be verified and validated in accordance with the investigation-specific DQO requirements as defined in investigation-specific QAPP addenda. Data may be subjected to some or all of the review process steps presented in Figure 10-1. Primary, field duplicate and QA split samples may be collected for each project. All primary and field duplicate samples will be analyzed at the Contractor's primary laboratory and resultant data will receive primary review (STEP-1) by the analyzing facility. Primary laboratory data will be subjected to data verification (STEP-2) by the Contractor. Ten percent of the primary data may receive comprehensive validation (STEP-3a). This 10% should consist of the samples randomly selected for field duplicate determinations. Data packages (in hard copy or pdf format) selected for validation will be provided by the Contractor to the USACE-contracted third-party validator. Contractors, in conjunction with the regulators, will determine the requirements for third-party validation and document this in their investigation-specific addenda to this FWQAPP. QA split sample analyses will be performed by the QA laboratory designated by either Ohio EPA or USACE, Louisville District. These data will receive primary review by the analyzing facility with subsequent verification and comprehensive validation (STEPS-2 and -3b) by USACE, Louisville District. Validation reports from STEPS-3a and -3b will be combined with QA split sample comparison by USACE, Louisville District into sequentially generated Chemical Quality Assurance Reports (CQARs) (STEP-4). At the end of a project, this information will form the basis for the Chemical Data Quality Assessment Report (CDQAR) produced by USACE, Louisville District (STEP-5).

Verification support staff will conduct a systematic review of all primary data. Automated reviews against the project ADR library will be performed in conjunction with manual review of the data packages for compliance with the established QC criteria based on the following categories:

- Holding times;
- Blanks;
- LCSs;
- Calibration;
- Surrogate recovery (organic methods);
- Internal standards (primarily organic methods);
- Matrix spike/matrix spike duplicate and duplicate results;
- Sample re-analysis;
- Secondary dilutions; and
- Laboratory case narrative.

Validation will be accomplished by comparing the contents of the data packages and QA/QC results to requirements contained in the requested analytical methods. USACE's subcontracted validation support staff will be responsible for these activities. All validation staff will be independent of both the analytical laboratory and the Contractor, and all validation staff must be contracted by USACE, Louisville District. The protocol for analyte data validation can be located in the following documents:

- DoD QSM (DoD 2009);

- USACE, Louisville District's QSM Supplement (USACE 2007);

- *USEPA Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review* (USEPA 2008);

- *USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review* (USEPA 1994b); and

- *USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review* (USEPA 1994a).

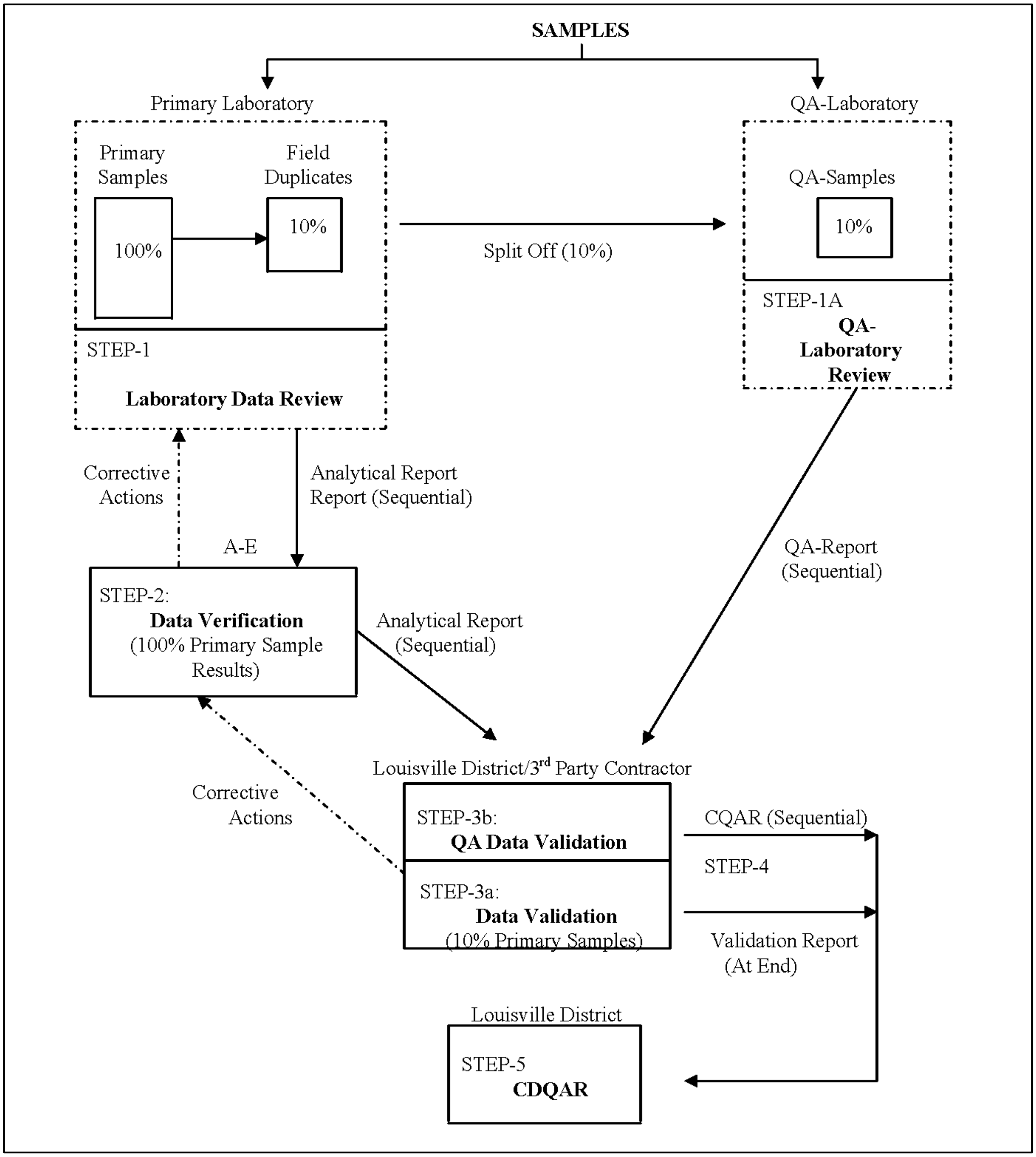

Figure 10-1. Definitive Data Review Process

Consistent with the data quality requirements as defined in the DQOs, all project data and associated QC will be evaluated and qualified as per the outcome of the review.

10.2.2 Primary Analytical Data Verification/Validation Categories

10.2.2.1 Holding Times

Evaluation of holding times ascertains the validity of results based on the length of time from sample collection to sample preparation or sample analysis. Verification of sample preservation must be confirmed and accounted for in the evaluation of sample holding times. The evaluation of holding times is essential to establishing sample integrity and representativeness. Concerns regarding physical, chemical, or biochemical alteration of analyte concentrations can be eliminated or qualified through this evaluation.

10.2.2.2 Calibration

The purpose of initial and continuing calibration verification analyses is to verify the linear dynamic range and stability of instrument response. Relative instrument response is used to quantitate the analyte results. If the relative response factor is outside acceptable limits, then the data quantification is uncertain and requires appropriate qualification.

10.2.2.3 Blanks

The assessment of blank analyses is performed to determine the existence and magnitude of contamination problems. The criteria for evaluation of blanks applies to any blank associated with the samples, including field, trip, equipment, and method blanks. Contamination during sampling or analysis, if not discovered, results in false-positive data.

Blanks will be evaluated against project reporting levels as specified in Tables 4-3 through 4-9. The concentration of any target analyte in the blank should not exceed one-half the reporting limit (or the reporting limit for common laboratory contaminants), one-tenth the amount measured in any sample, or one-tenth the regulatory limit (see the DoD QSM). Field, trip, and equipment rinsate blanks will be evaluated against their project reporting levels. Sample data will be qualified relative to any blank contamination observed.

10.2.2.4 Laboratory Control Samples

The LCS serves as a monitor of the overall performance of the analytical process, including sample preparation, for a given set of samples. Evaluation of this standard provides confidence in, or allows qualification of, results based on a measurement of process control during each sample analysis.

10.2.2.5 Method Reporting Limit Standard

The MRL is used to assess the performance of the measurement system at the lower limits of analysis. Evaluation of this standard provides confidence that low concentrations near the requested reporting limit will be detected and accurately quantified.

10.2.2.6 Surrogate Recovery

System monitoring compounds are added to every sample, blank, LCS, matrix spike, matrix spike duplicate, and standard. Such compounds are used to evaluate extraction, cleanup, and analytical efficiency by measuring recovery on a sample-specific basis. Poor system performance, as indicated by low surrogate recoveries, is one of the most common reasons for data qualification. Evaluation of surrogate recovery is critical to the provision of reliable sample-specific analytical results.

10.2.2.7 Internal Standards

Internal standards are utilized to evaluate and compensate for sample-specific influences on the analyte quantification. These standards are evaluated to determine if data require qualification due to excessive variation in acceptable internal standard quantitative or qualitative performance measures. For example, a decrease or increase in internal standard area counts for organics may reflect a change in sensitivity that can be attributed to the sample matrix. Because quantitative determination of analytes is based on the use of internal standards, evaluation is critical to the provision of reliable analytical results.

10.2.2.8 Matrix Spike, Matrix Spike Duplicate, And Duplicate

Matrix spike, matrix spike duplicate, and duplicate results serve as an indicator of individual sample and matrix type influence over the analytical values. Evaluation of these measures provides confidence that the sample matrix has not impacted results or allows qualification of results based on the percent spike recovery or imprecision indicated by the duplicate comparison.

10.2.2.9 Post-Digestion Spikes

Metal post-digestion spikes are evaluated to establish precision and accuracy of individual analytical determinations. Because of the nature of some elemental analytical techniques and because of the detailed decision tree and analysis scheme required for quantitation of the elements, evaluation of this QC element is critical to ensuring reliable analytical results.

10.2.2.10 Sample Re-Analysis

When instrument performance monitoring standards indicate an analysis is out of control, the laboratory is required to re-analyze the sample. If the re-analysis does not solve the problem (i.e., surrogate compound recoveries are outside the limits for both analyses), then the laboratory is required to submit data from both analyses. An independent review is required to determine which is the appropriate sample result.

10.2.2.11 Secondary Dilutions

When the concentration of any analyte in any sample exceeds the initial calibration range, a new aliquot of that sample must be diluted and re-analyzed. The laboratory is required to report data from both analyses. When this occurs, an independent review of the data is required to determine the appropriate results to be used for that sample. An evaluation of each analyte exceeding the calibration range must be made, including a review of the dilution analysis performed. Results chosen in this situation may be a combination of both the original results (i.e., analytes within the initial calibration range) and the secondary dilution results.

10.2.2.12 Laboratory Case Narratives

Analytical laboratory case narratives are reviewed for specific information concerning the analytical process. This information is used to direct the data validator to potential problems with the data.

10.3 DATA REPORTING

Laboratories will prepare and submit analytical and QC data reports to the Contractor or the U.S. Army (QA split sample data) in compliance with the requirements of this FWQAPP, including data forms listed in Table 10-1, and will be considered a definitive data package. The definitive data package will include a cover sheet, table of contents, case narrative, the analytical results, sample management records, and internal laboratory QA/QC information. The laboratory data package should be organized so that the analytical results are reported on a per-batch basis. A general outline is presented below.

<u>Cover Sheet</u>
- Title of report;
- Name and location of laboratory;
- Name and location of all subcontract laboratories;
- Contract number;
- Client name and address;
- Project name and AOC location;
- Statement of data authenticity with official signatures; and
- Amendments, if applicable.

<u>Table of Contents</u>

<u>Case Narrative</u>

<u>Analytical Results</u>
- Laboratory name and location;
- Project name and ID number;
- Field sample ID number;

- Laboratory sample ID number;
- Matrix;
- Sample description;
- Sample preservation or condition at receipt;
- Date sample collected;
- Date sample received by the laboratory;
- Date sample extracted or prepared;
- Date sample analyzed;
- Analysis time when holding time is <48 hr;
- Analytical method numbers, including preparation numbers;
- Preparation and analytical batch numbers;
- Analyte or parameter;
- MRLs;
- LOQs;
- LODs;
- Analytical results;
- Confirmation data;
- Laboratory-assigned data qualifiers;
- Concentration units;
- Dilution factors;
- Percent moisture or percent solids;
- Chromatograms, as needed;
- Sample aliquot size analyzed; and
- Final extract volume.

Laboratory Reporting Limits

Sample Management Records

QA/QC Information

Table 10-1. Standard Data Deliverables (Hard Copy), RVAAP

Method Requirements	Deliverables
Requirements for all Methods:	
Holding time information and methods requested	Signed chain-of-custody forms
Discussion of laboratory analysis, including any laboratory problems	Case narratives
LCS (run with each batch of samples processed)	Results (control charts when available)
Organics: GC/MS Analysis	
Sample results, including TICs	USEPA Form 1 or equivalent
Surrogate recoveries	USEPA Form 2 or equivalent
Matrix spike/matrix spike duplicate data	USEPA Form 3 or equivalent
Method blank data	USEPA Form 4 or equivalent
GC/MS tune	USEPA Form 5 or equivalent

Table 10-1. Standard Data Deliverables (Hard Copy), RVAAP (continued)

Method Requirements	Deliverables
GC/MS initial calibration data	USEPA Form 6 or equivalent
GC/MS continuing calibration data	USEPA Form 7 or equivalent
GC/MS internal standard area data	USEPA Form 8 or equivalent
Organics: GC Analysis	
Sample results	USEPA Form 1 or equivalent
Surrogate recoveries	USEPA Form 2 or equivalent
Matrix spike/matrix spike duplicate data	USEPA Form 3 or equivalent
Method blank data	USEPA Form 4 or equivalent
Initial calibration data	USEPA Form 6 or equivalent
If calibration factors are used	A form listing each analyte, the concentration of each standard, the relative calibration factor, the mean calibration factor, and the %RSD
Calibration curve if used	Calibration curve and correlation coefficient
Continuing calibration data	USEPA Form 9 or equivalent
Positive identification (second column confirmation)	USEPA Form 10 or equivalent
Metals	
Sample results	USEPA Form 1 or equivalent
Initial and continuing calibration	USEPA Form 2 or equivalent, dates of analyses and calibration curve, and the correlation coefficient factor
Method blank	USEPA Form 3 or equivalent and dates of analyses
ICP interference check sample	USEPA Form 4 or equivalent and dates of analyses
Spike sample recovery	USEPA Form 5A or equivalent
Method Requirements	
Post-digestion spike sample recovery for ICP metals	USEPA Form 5B or equivalent
Post-digestion spike for GFAA	USEPA Form 5B or equivalent
Duplicates	USEPA Form 6 or equivalent
LCS	USEPA Form 7 or equivalent
Standard additions (when implemented)	USEPA Form 8 or equivalent
Holding times	USEPA Form 13 or equivalent
Run log	USEPA Form 14 or equivalent
Wet Chemistry	
Sample results	Report result
Matrix spike recovery	% Recovery
Matrix spike duplicate or duplicate	% Recovery and % RPD
Method blank	Report results
Initial calibration	Calibration curve and correlation coefficient
Continuing calibration check	Recovery and % difference
LCS	LCS result and control criteria

GC = Gas chromatograph
GFAA = Graphite furnace atomic absorption
ICP = Inductively coupled plasma
LCS = Laboratory control standard
MS = Mass spectrometer
RPD = Relative percent difference
RSD = Relative standard deviation
RVAAP = Ravenna Army Ammunition Plant
TIC = Tentatively identified compound
USEPA = United States Environmental Protection Agency

Electronic data deliverables (EDDs) will contain the same information as described for the hard copy deliverables. The contract laboratory will deliver an electronic data deliverable (EDD) that is ADR compatible. The contract laboratory must identify variances to the established library prior to any analysis being performed. No variances to the DoD QSM (DoD 2009) and the USACE, Louisville District’s QSM Supplement (USACE 2007) are anticipated.

The laboratory will be required to confirm sample receipt and log-in information. The laboratory will return a copy of the completed COC and confirmation of the laboratory's analytical log-in to the Contractor within 2 days of sample receipt.

The subcontract analytical laboratory will prepare and retain full analytical and QC documentation. Such retained documentation will include all hard copies and other storage media (e.g., disc storage). As needed, the subcontract analytical laboratory will make available all retained analytical data information.

10.4 DATA QUALITY ASSESSMENT

The Contractor data assessment will be accomplished by the joint efforts of the data validator, the data assessor, and the Contractor Project Manager. Data assessment by data management will be based on the assumption that the sample was properly collected and handled according to the FWFSP and Section 6.0 of this FWQAPP. An evaluation of data accuracy, precision, sensitivity, and completeness, based on criteria in Section 13.0, will be performed by a data assessor and presented in the project report. The QC Summary Report will indicate that data are usable as a quantitative concentration, usable with caution as an estimated concentration, or unusable due to out-of-control QC results.

As part of the ongoing data quality assessment, the U.S. Army Chemist will compile information and provide CQARs and, at the conclusion of the project, assemble a CDQAR if required.

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11.0 PERFORMANCE AND SYSTEM AUDITS

Performance and system audits of both field and laboratory activities will be conducted to verify that sampling and analysis are performed in accordance with the procedures established in the FWFSP and FWQAPP. Audits of field and laboratory activities will include both internal and external audits.

11.1 FIELD AUDITS

Internal audits of field activities (sampling and measurements) will be conducted by the Contractor QA Officer and/or Field Team Leader. The audits will include examination of field sampling records, field instrument operating records, sample collection, handling and packaging in compliance with the established procedures, maintenance of QA procedures, and COC. These audits will occur at the onset of a project to verify that all established procedures are followed (systems audit).

Performance audits will follow to ensure deficiencies have been corrected and to verify QA practices/procedures are being maintained throughout the duration of the project work effort. These audits will involve reviewing field measurement records, instrumentation calibration records, and sample documentation.

External audits may be conducted at the discretion of the U.S. Army, USEPA Region 5, or Ohio EPA.

11.2 LABORATORY AUDITS

DoD ELAP-accrediting bodies conduct on-site audits and approve laboratories that are compliant with the DoD QSM. These independent on-site system audits qualify laboratories to perform U.S. Army environmental analysis. These system audits include examining laboratory documentation of sample receiving, sample log-in, sample storage, COC procedures, sample preparation and analysis, and instrument operating records.

Internal performance and system audits of laboratories also will be conducted by the Laboratory QA Officer as directed in the laboratory QA plan. These system audits will include examination of laboratory documentation of sample receiving, sample log-in, sample storage, COC procedures, sample preparation and analysis, and instrument operating record. Internal performance audits are also conducted on a regular basis. Single-blind performance samples are prepared and submitted with project samples to the laboratory for analysis. The Laboratory QA Officer will evaluate the analytical results of these single-blind performance samples to ensure the laboratory maintains acceptable performance.

Additional audits of laboratories may be planned and budgeted within specific RVAAP task scopes. These project-specific laboratory performance review audits will be conducted by the Contractor at the direction of, and in conjunction with, the U.S. Army, when requested. External audits may be conducted in conjunction with, or at the direction of, USEPA Region 5 or Ohio EPA.

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12.0 PREVENTIVE MAINTENANCE PROCEDURES

12.1 FIELD INSTRUMENTS AND EQUIPMENT

Field equipment for this project may consist of thermometers; pH meters; conductivity meters; turbidity meters; organic vapor detectors (FID or PID); combustible gas detectors capable of measuring the lower explosive limit, upper explosive limit, and/or oxygen levels; and geophysical testing equipment. Specific preventative maintenance procedures to be followed for field equipment are those recommended by the manufacturers. These procedures are included in the technical procedures governing the use of these instruments.

Field instruments will be checked and/or calibrated before they are shipped or carried to the field. Each field instrument will be checked daily against a traceable standard or reference with a known value to ensure that the instrument is in proper calibration. Instruments found to be out of calibration will be recalibrated before use in the field. If the instrument cannot be calibrated, it will be returned to the supplier or manufacturer for recalibration and a back-up instrument will be used in its place. Calibration checks and calibrations will be documented on the Field Meter/Calibration Log Sheets in the M&TE Log Book. Any maintenance conducted on field equipment must be documented in the M&TE Log Book.

Critical spare parts such as tapes, papers, pH probes, electrodes, and batteries will be kept on-site to minimize down time of malfunctioning instruments. Back-up instruments and equipment should be available on-site or within 1-day shipment to avoid delays in the field schedules.

12.2 LABORATORY INSTRUMENTS

As part of their QA/QC program, a routine preventive maintenance program will be conducted by all RVAAP investigation-associated laboratories to minimize the occurrence of instrument failure and other system malfunctions. All laboratory instruments will be maintained in accordance with manufacturers' specifications and the requirements of the specific method employed. This maintenance will be carried out on a regular, scheduled basis and will be documented in the laboratory instrument service logbook for each instrument. Emergency repair or scheduled manufacturer's maintenance will be provided under a repair and maintenance contract with factory representatives.

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13.0 SPECIFIC ROUTINE PROCEDURES TO ASSESS DATA PRECISION, ACCURACY, AND COMPLETENESS

13.1 FIELD MEASUREMENTS DATA

Field data will be assessed by the site QC Officer. The site QC Officer or his/her designee will review the field results for compliance with the established QC criteria that are specified in this FWQAPP and the FWFSP. Accuracy of the field measurements will be assessed using daily instrument calibration, calibration check, and analysis of blanks. Precision will be assessed based on reproducibility by multiple readings of a single sample.

Field data completeness will be calculated using Equations 13-1 and 13-2.

Sample Collection

$$\text{Completeness} = \frac{\text{Number of Sample Points Sampled}}{\text{Number of Sample Points Planned}} \times 100\% \qquad \textbf{(Equation 13-1)}$$

Field Measurements

$$\text{Completeness} = \frac{\text{Number of Valid Field Measurements Made}}{\text{Number of Field Measurements Planned}} \times 100\% \qquad \textbf{(Equation 13-2)}$$

13.2 LABORATORY DATA

Laboratory results will be assessed for compliance with required precision, accuracy, completeness, and sensitivity as follows.

13.2.1 Precision

The precision of the laboratory analytical process will be determined through evaluation of LCS analyses. The standard deviation of these measurements over time will provide confidence that implementation of the analytical protocols was consistent and acceptable. These measurements will establish the precision of the laboratory analytical process.

Investigative sample matrix precision will be assessed by comparing the analytical results between the matrix spike/matrix spike duplicate for organic analysis and the laboratory duplicate analyses for inorganic analysis. The RPD will be calculated for each pair of duplicate analyses using Equation 13-3. This precision measurement will include variables associated with the analytical process, influences related to sample matrix interferences, and sample heterogeneity.

$$\mathrm{RPD} = \frac{|\mathrm{S}-\mathrm{D}|}{\frac{(\mathrm{S}+\mathrm{D})}{2}} \times 100$$ **(Equation 13-3)**

where

S = First sample value (original or matrix spike value),
D = Second sample value (duplicate or matrix spike duplicate value).

13.2.2 Accuracy

The accuracy of the laboratory analytical measurement process will be determined by comparing the percent recovery for the LCS versus its documented true value.

Investigative sample accuracy will be assessed for compliance with the established QC criteria described in Section 3.0 of this FWQAPP using the analytical results of method blanks, reagent/preparation blanks, matrix spike/matrix spike duplicate samples, field QC samples, and bottle blanks. The percent recovery of matrix spike samples will be calculated using Equation 13-4. This accuracy will include variables associated with the analytical process, influences related to sample matrix interferences, and sample heterogeneity.

$$\%R = \frac{A - B}{C} \times 100$$ **(Equation 13-4)**

where

A = The analyte concentration determined experimentally from the spiked sample,
B = The background level determined by a separate analysis of the unspiked sample,
C = The amount of the spike added.

13.2.3 Completeness

Data completeness of laboratory analyses will be assessed for compliance with the amount of data required for decision making. The completeness is calculated using Equation 13-5.

$$\text{Completeness} = \frac{\text{Number of Valid Laboratory Measurements Made}}{\text{Number of Laboratory Measurements Planned}} \times 100\%$$ **(Equation 13-5)**

13.2.4 Sensitivity

Achieving MRLs depends on sample preparation techniques, instrumental sensitivity, and matrix effects. Therefore, it is important to establish actual detection limits for each major matrix under investigation (e.g., water and soil) using a scientifically valid and documented procedure (see the

DoD QSM). The LOD is typically an established analysis of a standard spiked at two to three times the detection limit. The LOQ is the lowest concentration of an analyte that can be determined within the specified limits of precision and bias. LOQ values will be greater than or equal to the LOD and must be less than or equal to the project reporting limits.

LODs and LOQs should be verified at least quarterly. It is also important to monitor instrument sensitivity through calibration blanks and low concentration standards to ensure consistent instrument performance. It is also critical to monitor the analytical method sensitivity through analysis of method blanks, calibration check samples, and LCSs.

13.3 PROJECT COMPLETENESS

Project completeness will be determined by evaluating the planned versus actual data. Consideration will be given for project changes and alterations during implementation. All data not flagged as rejected by the review, verification, validation, or assessment processes will be considered valid. Overall, the project completeness will be assessed relative to media, analyte, and area of investigation.

13.4 REPRESENTATIVENESS/COMPARABILITY

Representativeness expresses the degree to which data accurately reflect the analyte or parameter of interest for the environmental media examined at the AOC. It is a qualitative term most concerned with the proper design of the sampling program. Factors that affect the representativeness of analytical data include appropriate sample population definitions, proper sample collection and preservation techniques, analytical holding times, use of standard analytical methods, and determination of matrix or analyte interferences. Sample collection, preservation, analytical holding time, analytical method application, and matrix interferences will be evaluated by reviewing project documentation and QC analyses.

Comparability, like representativeness, is a qualitative term relative to a project dataset as an individual. Investigations at RVAAP will employ narrowly defined sampling methodologies, AOC audits/surveillances, use of standard sampling devices, uniform training, documentation of sampling, standard analytical protocols/procedures, QC checks with standard control limits, and universally accepted data reporting units to ensure comparability to other datasets. Through proper implementation and documentation of these standard practices, the project will establish confidence that data will be comparable to other project and programmatic information.

Additional input to determine representativeness and comparability may be gained through statistical evaluation of data populations, chemical charge balances, compound evaluations, or dual measurement comparisons (e.g., total versus dissolved water analysis and field versus fixed laboratory analyses).

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14.0 CORRECTIVE ACTIONS

Corrective actions may be required for two major types of problems: analytical/equipment problems and non-compliance with criteria. Analytical and equipment problems may occur during sampling, sample handling, sample preparation, laboratory instrumental analysis, and data review.

Non-compliance with specified criteria and analytical/equipment problems will be documented through a formal corrective action program at the time the problem is identified. The person identifying the problem is responsible for notifying the Contractor Project Manager and the U.S. Army Project Manager. When the problem is analytical in nature, information on these problems will be promptly communicated to the Contractor Analytical Laboratory Coordinator and the U.S. Army Chemist. Implementation of corrective action will be confirmed in writing.

Any nonconformance with the established QC procedures in this FWQAPP or the FWFSP will be identified and corrected in accordance with this FWQAPP. The Contractor Project Manager or his/her designee will issue an NCR for each nonconformance condition.

Corrective actions will be implemented and documented in the field record book. No staff member will initiate corrective action without prior communication of findings through the proper channels. If corrective actions are deemed insufficient, then work may be stopped through a stop-work order issued by the Contractor Project Manager and the U.S. Army Project Manager.

14.1 SAMPLE COLLECTION/FIELD MEASUREMENTS

Technical staff and project personnel will be responsible for reporting all suspected technical and QA nonconformances or suspected deficiencies of any activity or issued document by reporting the situation to the Contractor Project Manager or his/her designee. The Contractor Project Manager or his/her designee will be responsible for assessing the suspected problems in consultation with the Contractor Project QA Manager to make a decision based on the potential for the situation to impact the quality of the data. When it is determined that the situation warrants a reportable nonconformance and corrective action, an NCR will be initiated by the Contractor Project Manager or his/her designee.

The Contractor Project Manager or his/her designee will be responsible for ensuring that corrective actions for nonconformances are initiated by:

- Evaluating all reported nonconformances;
- Controlling additional work on nonconforming items;
- Determining disposition or action to be taken;
- Maintaining a log of nonconformances;
- Reviewing NCRs and corrective actions taken; and
- Ensuring that NCRs are included in the final documentation project files.

If appropriate, the Contractor Project Manager will ensure that no additional work dependent on the nonconforming activity is performed until the corrective actions are completed.

Corrective action for field measurements may include the following:

- Repeating the measurement to check the error;
- Checking for all proper adjustments for ambient conditions such as temperature;
- Checking the batteries;
- Re-calibrating equipment;
- Checking the calibration;
- Modifying the analytical method including documentation and notification (i.e., standard additions);
- Replacing the instrument or measurement devices; and
- Stopping work (if necessary).

The Contractor Project Manager or his/her designee is responsible for all AOC activities. In this role, he/she may, at times, be required to adjust the AOC activities to accommodate site-specific needs. When it becomes necessary to modify a program, the responsible person notifies the Contractor Project Manager of the anticipated change and implements the necessary changes after obtaining the approval of the Contractor Program Manager and the U.S. Army Program Manager. All changes in the program will be documented on the Field Change Request (FCR) that will be signed by the initiators and the Contractor Project Manager. The FCR for each document will be numbered serially as required. The FCR shall be attached to the file copy of the affected document. The Contractor Project Manager must approve the change in writing or verbally before field implementation. If unacceptable, the action taken during the period of deviation will be evaluated to determine the significance of any departure from established program practices and action taken.

The Contractor Project Manager is responsible for controlling, tracking, and implementing the identified changes. Reports on all changes will be distributed to all affected parties, including the U.S. Army Project Manager. The U.S. Army will be notified whenever program changes in the field are made.

14.2 LABORATORY ANALYSES

Each RVAAP investigation laboratory QA plan provides systematic procedures to identify out-of-control situations and corrective actions. Corrective actions shall be implemented to resolve problems and restore malfunctioning analytical systems. Laboratory personnel have received QA training and are aware that corrective actions are necessary when:

- QC data do not meet DoD QSM (DoD 2009) criteria for precision and accuracy;

- Blanks contain target analytes above acceptable levels and must be investigated (see Table 4-3 and Section 10.2.2.2);

- Undesirable trends are detected in spike recoveries or RPDs between duplicates;

- Unusual changes in detection limits are identified;

- Deficiencies are detected by internal audits, external audits, or from performance evaluation samples results; or

- Inquiries concerning data quality are received.

Corrective action procedures are often handled at the bench level by the analyst, who reviews the preparation or extraction procedure for possible errors and checks the instrument calibration, spike and calibration mixes, instrument sensitivity, and so on. If the problem persists or cannot be identified, the matter is referred to the Laboratory Supervisor, Manager, and/or QA Department for further investigation. Once resolved, full documentation of the corrective action procedure is filed with project records and the QA Department, and the information is summarized within case narratives.

Corrective actions may include:

- Re-analyzing the samples if holding time criteria permit;

- Evaluating, eliminating, and re-analyzing blank contaminant sources;

- Modifying the analytical method (i.e., standard additions) with appropriate notification and documentation;

- Re-sampling and analyzing;

- Evaluating and amending sampling procedures; or

- Accepting data and acknowledging the level of uncertainty.

If re-sampling is deemed necessary due to laboratory problems, the Contractor Project Manager will identify the necessary cost recovery approach to implement the additional sampling effort.

The following corrective action procedures will be required:

- Problems noted during sample receipt will be documented in the appropriate laboratory's Letter of Receipt (LOR). The Contractor and U.S. Army will be contacted immediately to determine the problem resolution. All corrective actions will be thoroughly documented.

- When sample extraction/digestion or analytical holding times are not within the method required specifications, the Contractor and U.S. Army will be notified immediately to determine the problem resolution. All corrective actions will be thoroughly documented.

- All initial and continuing calibration sequences that do not meet method requirements will result in a review of the calibration. When appropriate, re-analysis of the standards or re-analysis of the affected samples back to the previous acceptable calibration check is warranted.

- All appropriate measures will be taken to prepare and clean up samples in an attempt to achieve the project reporting limits as stated. When difficulties arise in achieving these limits, the laboratory will notify the Contractor and the U.S. Army to determine the problem resolution. All corrective actions will be thoroughly documented.

- Any dilutions impacting the project reporting limits will be documented in case narratives along with revised reporting limits for those analytes affected. Analytes detected above the detection limit, but below the LOQ, will be reported as estimated values.

- Failure of method-required QC to meet the requirements specified in this FWQAPP shall result in review of all affected data. Resulting corrective actions may encompass those identified earlier. The Contractor and U.S. Army will be notified as soon as possible to discuss possible corrective actions, particularly when unusual or difficult sample matrices are encountered.

- When calculation and reporting errors are noted within any given data package, reports will be re-issued with applicable corrections. Case narratives will clearly state the reasons for reissuance of such reports.

15.0 QUALITY ASSURANCE REPORTS TO MANAGEMENT

All performance and system audits of laboratory and field operations will be reported directly to project management, program management, and USACE in accordance with Section 11.0 of this FWQAPP. In addition to these audit reports, laboratory LORs and analytical case narratives will be required from the laboratory.

The laboratory will provide status reports, as requested, to the Contractor point of contact for analytical activities. These status reports will contain the status of each sample received for the project and may be presented from established laboratory information system electronic databases or spreadsheets. Information to be provided may include the following:

- Project name and contract number;

- Laboratory sample number, project sample identification number, matrix type, and location of samples received during the monthly reporting period;

- Description of, and justification for, alternative methods used or modifications of existing methods (any proposed changes to analytical methods in approved SAPs require written approval from the Contractor and U.S. Army);

- Control charts for all LCS or matrix spike analyses applicable to the project;

- A summary of all out-of-control events during the monthly reporting period, including references to documentation and corrective action reports;

- Changes in laboratory QA personnel and other key technical staff, including resumes of new personnel;

- Changes in business affiliation or status; and

- Changes in the laboratory QA plan, SOPs, or applicable operating licenses.

All COC forms will be compared with samples received by the laboratory, and a LOR will be prepared and sent to the Contractor describing any differences in the COC forms and the sample labels or tags. All deviations, such as broken or otherwise damaged containers, will be identified on the receiving report. This report will be forwarded to the Contractor within 2 days of sample receipt and will include a signed copy of the COC form, itemized project sample numbers, laboratory sample numbers, cooler temperature upon receipt, and itemization of analyses to be performed.

Case narrative statements will accompany analytical results from the laboratory. These reports, in conjunction with evaluation of field QC and any significant problems/corrective actions, will form the basis for the project data quality assessment. Final project reports will contain QA sections summarizing the data quality information collected during the project.

16.0 REFERENCES

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