FINAL

FEASIBILITY STUDY

for Fuze and Booster Quarry Landfill/Ponds

(RVAAP-16)

Ravenna Army Ammunition Plant
Ravenna, Ohio

July 2006

US Army Corps of Engineers®
Louisville District

Contract No. GS-10F-0076J
Delivery Order No. W912QR-05-F-0033

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From Science to Solutions™

Prepared for:
U.S. Army Corps of Engineers
Louisville, Kentucky

Prepared by:
Science Applications International Corporation
8866 Commons Boulevard, Suite 201
Twinsburg, Ohio 44087

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LIST OF ACRONYMS

AGO	Adjutant General of Ohio
ALM	adult lead model
AMSL	above mean sea level
AOC	Area of Concern
ARAR	Applicable and Relevant or Appropriate Requirements
AT123D	Analytical Transient 1-, 2-, 3-Dimensional
BGS	below ground surface
BRAC	Base Realignment and Closure
C&DD	Construction & Demolition Debris
CAMU	Corrective Action Management Unit
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	*Code of Federal Regulations*
CMCOC	contaminant migration chemical of concern
CMCOPC	contaminant migration chemical of potential concern
COC	constituent of concern
COEC	constituent of ecological concern
COI	chemical of interest
COPC	constituent of potential concern
COPEC	constituent of potential ecological concern
cPAH	carcinogenic polycyclic hydrocarbon
CSF	cancer slope factor
CTT	closed, transferring, and transferred
DCE	dichloroethylene
DDE	dichlorodiphenyldichloroethylene
DERR	Division of Emergency and Remedial Response
DFFO	Director's Final Findings and Orders
DNT	dinitrotoluene
DoD	U. S. Department of Defense
DOT	U. S. Department of Transportation
DQO	data quality objective
DQSR	Data Quality Summary Report
EPC	exposure point concentration
ERA	ecological risk assessment
ESA	Endangered Species Act
ESV	ecological screening value
EU	exposure unit
FBQ	Fuze and Booster Quarry Landfill/Ponds
FRTR	Federal Remediation Technologies Roundtable
FS	Feasibility Study
FSCOC	feasibility study constituent of concern
FWHHRAM	Facility Wide Human Health Risk Assessor's Manual

LIST OF ACRONYMS (CONTINUED)

GAF	gastrointestinal absorption factor
GRA	general response actions
GSA	U. S. General Services Administration
HHRA	human health risk assessment
HI	hazard index
HQ	hazard quotient
IDW	Investigation Derived Waste
IEUBK	Integrated Exposure Uptake Biokinetic
ILCR	incremental lifetime cancer risk
IRP	Installation Restoration Program
LDR	land disposal requirement
MCL	maximum contaminant level
MDC	maximum detected concentration
MEC	munitions and explosives of concern
MMRP	Military Munitions Response Program
MNA	monitored natural attenuation
MS	matrix spike
MSD	matrix spike duplicate
MTR	minimum technical requirement
NCP	National Contingency Plan
NEPA	National Environmental Policy Act
NGB	National Guard Bureau
NPDES	National Pollutant Discharge Elimination System
O&M	operation and maintenance
OAC	Ohio Administrative Code
OHARNG	Ohio Army National Guard
Ohio EPA	Ohio Environmental Protection Agency
PAH	polycyclic aromatic hydrocarbon
PBC	Performance Based Contract
PBT	persistent, bioaccumulative, and toxic
PCB	polychlorinated biphenyl
POL	petroleum, oil, and lubricant
POTW	publicly owned treatment works
PPE	personal protective equipment
PWS	Performance Work Statement
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
RAB	Restoration Advisory Board
RAGS	Risk Assessment Guidance for Superfund

LIST OF ACRONYMS (CONTINUED)

RAO	Remedial Action Objective
RBC	risk-based concentration
RCRA	Resource Conservation and Recovery Act
RD	Remedial Design
RDX	hexahydro-1,3,5-trinitro-1,3,5-triazine
RfC	reference concentration
RfD	reference dose
RGO	remedial goal option
RI	Remedial Investigation
ROD	Record of Decision
RRSE	Relative Risk Site Evaluation
RTLS	Ravenna Training and Logistics Site
RVAAP	Ravenna Army Ammunition Plant
S/S	Stabilization/solidification
SAIC	Science Applications International Corporation
SMDP	Scientific Management Decision Point
SERA	Screening Ecological Risk Assessment
SESOIL	Seasonal Soil Compartment Model
SRC	site-related contaminant
SVE	soil vapor extraction
SVOC	semivolatile organic compound
TBC	to be considered
TCE	trichloroethene
TCLP	toxicity characteristic leaching procedure
TEF	toxicity equivalent factor
TERP	Transportation and Emergency Response Plan
THI	target hazard index
TNT	Trinitrotoluene
TR	target risk
TU	temporary unit
UCL	upper confidence limit
UHC	underlying hazardous constituent
USACE	U. S. Army Corps of Engineers
USACHPPM	U. S. Army Center for Health Promotion and Prevention
USEPA	U. S. Environmental Protection Agency
USGS	U. S. Geological Society
UTS	universal treatment standards
UV	ultraviolet
VOC	volatile organic compound
WQC	water quality criteria

1.0 INTRODUCTION

Science Applications International Corporation (SAIC) has been contracted by the U. S. Army Corps of Engineers (USACE), Louisville District to provide environmental services to achieve remedy for (or cleanup of) soils and dry sediments at the six high priority areas of concern (AOCs) at the Ravenna Army Ammunition Plant (RVAAP) in Ravenna, Ohio by September 30, 2007:

- RVAAP-01 Ramsdell Quarry Landfill;
- RVAAP-02 Erie Burning Grounds;
- RVAAP-04 Open Demolition Area #2;
- RVAAP-12 Load Line 12;
- RVAAP-16 Fuze and Booster Quarry Landfill/Ponds (FBQ); and
- RVAAP-49 Central Burn Pits.

This work is being performed under a firm fixed price basis in accordance with U. S. General Services Administration (GSA) Environmental Advisory Services Contract GS-10-F-0076J under a Performance Based Contract (PBC) as specified in the Performance Work Statement (PWS) issued by the US Army on February 10, 2005 (USACE 2005e). In addition, planning and performance of all elements of this work will be in accordance with the requirements of the Director's Final Findings and Orders (DFFO) dated June 10, 2004 [Ohio Environmental Protection Agency (Ohio EPA) 2004].

1.1 PURPOSE

This Feasibility Study (FS) evaluates remediation alternatives to achieve remedy for soils and dry sediments at FBQ. Remediation of impacts to aqueous media (groundwater, surface water, and wet sediment) are not included under the scope of this FS but will be addressed under future decisions. The following steps summarize the process supporting development and implementation of remedies for soil at the six high priority AOCs:

1. Complete Remedial Investigation (RI) Reports;
2. Complete FS and Reports;
3. Prepare Proposed Plan(s);
4. Prepare Record of Decision(s) (ROD);
5. Prepare Remedial Design (RD) Work Plans;
6. Implement the RD Work Plans; and
7. Prepare Remedial Action Completion Reports.

The FBQ RI phase is complete with the submittal of the supplemental investigation results included in this FS. The RI phase of work indicates evidence of impacts that requires further evaluation in an FS. This report documents the FS (Item 2 listed above) for soil and dry sediment media at FBQ in compliance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980.

This FS evaluates a range of remedial actions to reduce risks to the environment and human health at FBQ in accordance with remedial action objectives (RAOs) and to obtain remedy for (or cleanup of) soils and dry sediments. The remedial activities include no action, limited action, and removal of soils/dry sediments. RAOs are developed in the FS to protect receptors from impacted environmental media and constituents of concern (COCs) identified in the RI. Alternatives for remediation of impacted soils/dry sediments are presented and evaluated. Applicable and relevant or appropriate requirements (ARARs) also are identified.

Depending on the outcome of the evaluation in this FS, a preferred alternative will be submitted for public review and comment in a Proposed Plan. Public comments will be considered in the final selection of a remedy, which will be documented in a ROD. Responses to public comments will be addressed in the responsiveness summary of the ROD.

1.2 SCOPE

This FS evaluates necessary CERCLA remediation requirements for chemical contamination in soils/dry sediments to achieve remedy at FBQ. In addition, residual soils are evaluated to demonstrate that the evaluated remedy is protective of groundwater with respect to the anticipated future land use. Remediation of aqueous media (i.e., groundwater, surface water, and wet sediments) is not included in the scope of this FS. However, a preliminary evaluation of options to address impacts to aqueous media (i.e., groundwater, surface water, and wet sediments) is included in this FS. Remedies for soils/dry sediments also incorporate the necessary engineering controls during implementation to ensure protectiveness of surface water during implementation.

In addition, removal actions specifically addressing munitions and explosives of concern (MEC) issues or the potential environmental impact from MEC removal are not included in the scope of this FS. In 2001, the U. S. Department of Defense (DoD) established the Military Munitions Response Program (MMRP) to manage the environmental, health, and safety issues presented by MEC as a result of historical activities at a site. An inventory of the closed, transferring, and transferred (CTT) ranges or AOCs at RVAAP completed in November 2003 identified 19 MMRP AOCs at RVAAP that are known or suspected to contain MEC, including FBQ.

Ohio Army National Guard (OHARNG) has established future land uses for FBQ based on anticipated training mission and utilization of the Ravenna Training and Logistics Site (RTLS) (USACE 2005b). These anticipated future land uses, in conjunction with the evaluation of residential land use and associated receptors, form the basis for identifying and evaluating remedial alternatives in this FS.

This FS contains an evaluation of a trespasser scenario in addition to the anticipated current/future receptors identified in the RVAAP Facility-Wide Human Health Risk Assessor's Manual (FWHHRAM) (USACE 2004) [i.e., National Guard Trainee, National Guard Dust/Fire Control Worker, Security Guard/Maintenance Worker, Hunter/Trapper/Fisher, and Resident Subsistence Farmer (adult and child)]. An Adult and Juvenile Trespasser scenario was evaluated to supplement the baseline human health risk assessment (HHRA) detailed in the RI Report (USACE 2005b) per the FWHHRAM Amendment #1

(USACE 2005c) to provide risk managers with information to support determination of the need for continued security at the facility.

1.3 REPORT ORGANIZATION

The organization of this report is based on the U. S. Environmental Protection Agency (USEPA) guidance and includes ten major chapters. This report presents the findings of the FS for FBQ and is organized as follows:

- Chapter 2: Background Information;
- Chapter 3: RAOs;
- Chapter 4: ARARs;
- Chapter 5: Technology Types and Process Options;
- Chapter 6: Development of Remedial Alternatives;
- Chapter 7: Analysis of Remedial Alternatives;
- Chapter 8: Agency Coordination and Public Involvement;
- Chapter 9: Conclusions; and
- Chapter 10: References.

Chapter 2 summarizes facility and AOC background information. Chapter 3 outlines the development of RAOs for the constituents and media of concern. Chapter 4 presents the ARARs. Chapter 5 reviews the identification and screening of technology types and process options considered for possible use in remediation. Chapter 6 develops the proposed remedial alternatives, which are analyzed in detail in Chapter 7. Chapter 8 summarizes partnering and public involvement activities. Chapter 9 presents conclusions. References are found in Chapter 10, followed by the appendices. The appendices provide information supporting the evaluations presented in the body of this FS:

- Appendix 2A: Characterization of evaluation of trespasser (Adult and Juvenile) exposure scenario;
- Appendix 2B: Presentation/evaluation of supplemental Phase II RI sampling results for FBQ;
- Appendix 3A: Contaminant fate and transport assessment;
- Appendix 3B: Volume estimates of impacted soils;
- Appendix 5: Initial screening of technologies for aqueous media; and
- Appendix 7: Detailed cost estimates.

The FS also summarizes the results of the Supplemental Phase II RI implemented in November 2005. The supplemental investigation completes delineation of extent at FBQ and presents and incorporates these results into the assessment of FBQ.

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2.0 BACKGROUND INFORMATION

2.1 FACILITY-WIDE BACKGROUND INFORMATION

2.1.1 General Facility Description

When the RVAAP Installation Restoration Program (IRP) began in 1989, the RVAAP was identified as a 21,419-acre installation. The property boundary was resurveyed by OHARNG over a 2-year period (2002 and 2003) and the actual total acreage of the property was found to be 21,683.289 acres. As of February 2006, a total of 20,403 acres of the former 21,683-acre RVAAP have been transferred to the National Guard Bureau (NGB) and subsequently licensed to OHARNG for use as a military training site. The current RVAAP consists of 1,280 acres scattered throughout the OHARNG RTLS.

The RTLS is in northeastern Ohio within Portage and Trumbull Counties, approximately 4.8 km (3 miles) east northeast of the city of Ravenna and approximately 1.6 km (1 mile) northwest of the city of Newton Falls. The RVAAP portions of the property are solely located within Portage County. The RTLS/RVAAP is a parcel of property approximately 17.7 km (11 miles) long and 5.6 km (3.5 miles) wide bounded by State Route 5, the Michael J. Kirwan Reservoir, and the CSX System Railroad on the south; Garret, McCormick, and Berry roads on the west; the Norfolk Southern Railroad on the north; and State Route 534 on the east (see Figures 2-1 and 2-2). The RTLS is surrounded by several communities: Windham on the north; Garrettsville 9.6 km (6 miles) to the northwest; Newton Falls 1.6 km (1 mile) to the southeast; Charlestown to the southwest; and Wayland 4.8 km (3 miles) to the south.

When the RVAAP was operational, the RTLS 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 and, therefore, 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 RTLS 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 into large-caliber shells and bombs. The operations on the load lines produced explosive dust, spills, and vapors that collected on the floors and walls of each building. Periodically, the floors and walls were cleaned with water and steam. The liquid, containing 2,4,6-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 its use as a weapons demilitarization facility.

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 sites 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, waste oils, and sanitary waste. Other types of AOCs present at RVAAP include landfills, an aircraft fuel tank testing facility, and various general industrial support and maintenance facilities.

2.1.2 Demography and Land Use

RVAAP consists of 8,775 ha (21,683 acres) and is located in northeastern Ohio, approximately 37 km (23 miles) east-northeast of Akron and 48.3 km (30 miles) west-northwest of Youngstown. RVAAP occupies east-central Portage County and southwestern Trumbull County. U. S. Census Bureau population estimates for 2001 indicate that the populations of Portage and Trumbull counties are 152,743 and 223,982, respectively. Population centers closest to RVAAP are Ravenna, with a population of 12,100, and Newton Falls, with a population of 4,866.

The RVAAP facility is located in a rural area and is not close to any major industrial or developed areas. Approximately 55% of Portage County, in which the majority of RVAAP is located, consists of either woodland or farmland acreage. The closest major recreational area, the Michael J. Kirwan Reservoir (also known as West Branch Reservoir), is located adjacent to the western half of RVAAP south of State Route 5.

RVAAP is operated by the Base Realignment and Closure (BRAC) Division. The BRAC Division controls environmental AOCs at RVAAP. NGB controls non-AOC areas and has licensed these areas to OHARNG for training purposes. Training and related activities at RTLS include field operations and bivouac training, convoy training, equipment maintenance, and storage of heavy equipment. As environmental AOCs are investigated and addressed or remediated, if needed, transfer of these AOCs from the BRAC Division to NGB is conducted.

OHARNG has prepared a comprehensive Environmental Assessment and an Integrated Natural Resources Management Plan to address future use of RTLS property (OHARNG 2001). The perimeter of RVAAP is currently fenced and is patrolled intermittently by the facility caretaker contractor. Access to RVAAP is strictly controlled and any contractors, consultants, or visitors who wish to gain access to the facility must follow procedures established by RVAAP and the facility caretaker contractor.

2.1.3 RVAAP Physiographic Setting

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

2.2 FUZE AND BOOSTER QUARRY LANDFILL/PONDS

2.2.1 FBQ History

FBQ is located in the south-central part of RVAAP (Figure 2-2). FBQ operated from 1945 until 1993, and is approximately 45 acres in size. The western part of the AOC contains eleven small, shallow settling basins, and an abandoned rock quarry is located in the eastern portion. The AOC was expanded in 1998 to include two debris piles and three shallow settling ponds. Reportedly, the quarry was used for open burning and as a landfill before 1976. The debris resulting from these operations were reportedly removed during construction of the three settling ponds (quarry ponds). These settling ponds, 20-30 ft deep and separated by earthen berms, were constructed in 1976 to receive spent brine regenerate and sand filtration backwash water discharge from one of the RVAAP water plants. The discharge was regulated under a National Pollutant Discharge Elimination System (NPDES) permit and continued until 1993.

No training exercises are currently conducted within FBQ. Surveying, sampling, and other security, safety, or natural resources management activities are conducted after personnel have been properly briefed on potential hazards/sensitive areas. Projected use of surface water at FBQ (i.e., quarry ponds) includes dust suppression, fire control, fishing, trapping, and waterfowl hunting. FBQ may contain MEC and contains environmentally sensitive areas (i.e., wetlands).

2.2.2 FBQ Surface Features

FBQ is characterized by relatively flat-lying to gently sloping topography on a weathered sandstone bedrock surface. Elevations vary from 335 m at the eastern side to 353 m (1,088-1,160 ft) above mean sea level (AMSL) on the western side (Figure 2-3). Structural features include gravel access roads, two debris piles, three man-made ponds (quarry ponds) and eleven settling basins. The three large quarry ponds (one pictured in Photograph 2-1) on the eastern part of the AOC, and the eleven smaller, settling basins are located in the western part. Quarrying operations have resulted in the removal of surface soils in the central area and adjacent to the ponds. Relatively undisturbed areas in the north and west remain as hardwood forest. Wetlands are found in the settling basins, shallow areas of the quarry ponds, and around an unnamed tributary to Hinkley Creek. The soils range from well drained soils in the eastern area to poorly drained silty clay loam in the central and west portions. This variation is due to disturbance from past activities.

Photograph 2-1. Conditions of Fuze and Booster Quarry Pond, April 2005

2.2.3 FBQ Investigations

2.2.3.1 <u>Previous Investigation</u>

Two studies have been performed at FBQ:

- Hazardous and Medical Waste Study No. 37-EF-5360-97, Relative Risk Site Evaluation (RRSE), RVAAP, Ravenna, Ohio, 28 October – 1 November 1996, Volume 1 [U. S. Army Center for Health Promotion and Prevention (USACHPPM) 1996]; and

- Phase I/Phase II RI (USACE 2005b).

The RRSE was a limited investigation that sampled surface water and sediment within the Quarry Ponds. The Phase I/Phase II RI focused on surface water and sediment as the media most likely to be contaminated, but also included gathering data to more clearly define the nature and extent of the contamination at the AOC. This data was also used to conduct a quantitative baseline HHRA and ecological risk assessment (ERA).

2.2.3.2 Supplemental Phase II RI Activities at FBQ

Implementation of the supplemental Phase II RI sampling activities was completed in November 2005. This FS presents and incorporates these results into the assessment of FBQ. The primary objective of the Supplemental Phase II RI of FBQ was to conduct surface [0-1 ft below ground surface (BGS)] and subsurface (1-3 ft BGS) soil sampling to define the nature and extent of contamination the AOC and finalize the RI. A summary of the results as well as an assessment of the impacts, if any, on the completed HHRA and ERA is included in Appendix 2B.

2.2.4 Nature and Extent

Nature and extent of contamination, as determined during the Phase I/Phase II RI and the Supplemental Phase II RI, is discussed below. Figure 2-4 shows the sample locations, proposed sample locations, and groundwater monitoring wells at FBQ. Appendix 2B summarizes the findings of the Supplemental Phase II RI.

2.2.4.1 Surface Soil

Nine explosive/propellant compounds were detected at least once in surface soil (0-1 ft BGS) samples collected during the Phase II RI: nitrocellulose; 2,4,6- TNT; nitrobenzene; 2-amino-4,6-dinitrotoulene (DNT); 4-amino-2,6-DNT; 1,3,5-trinitrobenzene; 2,4-DNT; 2,6-DNT; and hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX).

The sample locations with the most detected explosive/propellant compounds are located in the higher elevations northeast of the Quarry Ponds. However, the extent of explosive contamination during the Supplemental Phase II was defined to below reporting limits in soils at FBQ. Only one explosive, nitrobenzene, was detected in the discrete samples. However, all detections of nitrobenzene were below reporting limits. Detections of manganese not previously bounded by Phase I sample locations were bounded in the Supplemental Phase II.

Seventeen inorganics were detected above background in surface soil (0-1 ft BGS) samples collected from FBQ: antimony, arsenic, barium, beryllium, cadmium, chromium, hexavalent chromium, cobalt, copper, lead, mercury, manganese, nickel, selenium, silver, vanadium, and zinc. Generally, the sample locations with the greatest number of detected inorganics above background were located in the higher elevations northeast of the northern-most Quarry Pond. These locations were bound during the Supplemental Phase II RI.

Seven semivolatile organic compounds (SVOCs) were detected in surface soil (0-1 ft BGS): benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthrene, benzo(k)fluoranthrene, and chrysene were detected only at one location, fluoranthene was detected at two locations, and pyrene was detected at one location.

2.2.4.2 Subsurface Soil

Subsurface samples were only collected up to 3 ft BGS. Two explosive/propellant compounds (nitrobenzene and nitrocellulose) were detected at three locations. Thirteen inorganics were detected above background in subsurface soil (1-3 ft BGS) samples collected from FBQ: aluminum, antimony, arsenic, barium, beryllium, cadmium, chromium, hexavalent chromium, lead, mercury, selenium, vanadium, and zinc. The following volatile organic compounds (VOCs) were detected in subsurface soil (1-3 ft BGS) samples collected from FBQ: methylene chloride; carbon disulfide; m,p-xylenes, 1,2-dimethylbenzene, and toluene; and trichloroethene (TCE).

2.2.4.3 Sediment

Eleven explosive/propellant compounds were detected at least once at 29 of the 40 sediment sample locations during the Phase I/II RI at FBQ. Explosive/propellant compounds were detected in every sediment sample collected from the Quarry Ponds, with the exception of one location. Explosive/propellant compounds were detected in almost half of the sediment samples collected from the settling basins. Explosive/propellant compounds were not detected in the sediment samples collected from the unnamed creek in the southwest portion of the AOC, or in the sediment samples collected south of the southern-most Quarry Pond.

Inorganic site-related contaminants (SRCs) were detected in every sediment sample collected. Sediment located in the southwestern-most corner of the AOC, had the highest number of inorganic SRCs detected (15).

Sixteen SVOCs and five VOCs were detected in sediments. No polychlorinated biphenyl (PCB) compounds were detected in the sediment samples. Eleven pesticides were detected in the sediment samples and were retained as SRCs even though they were detected at <5% of the sample locations. Endrin aldehyde was also retained as an SRC even though it was found at only one sample location.

The greatest number of SVOC, VOC, and pesticide SRCs detected in sediment were collected from the Quarry Ponds, and from a drainage channel west of the southern-most Quarry Pond.

2.2.4.4 Surface Water

The following explosives/propellants were detected in surface water samples at FBQ: 2-amino-4,6-DNT and 4-amino-2,6-DNT were detected only once from one of the smaller settling basins. Nitrocellulose was detected at 12 of the 15 stations.

The following inorganics were detected above background in surface water: aluminum, arsenic, barium, beryllium, cadmium, chromium, hexavalent chromium, cobalt, copper, lead, manganese, mercury, nickel, silver, vanadium, and zinc. Overall, the highest concentrations and greatest number of inorganic SRCs above background occurred in surface water collected from the southwestern-most settling basin. The settling basins generally have more inorganic SRCs at higher concentrations than the Quarry Ponds.

The following SVOCs were detected in the surface water samples for the Phase I/II RI: 4-methlphenol, bis(2-ethylhexyl) phthalate, and phenol. The following VOCs were detected in the 15 surface water samples for the Phase I/II RI: 2-butanone, carbon disulfide, methylene chloride, styrene, and toluene. No pesticides or PCBs were detected in the surface water samples.

The surface water sampled from the downgradient settling basins located in the southwest portion of the AOC generally have a greater number of SRC compounds than the surface water sampled from the upgradient Quarry Ponds located to the east. Additional information about the biology and surface water study is available in Section 3.4.2.1.

2.2.4.5 Groundwater

Wells Screened in Unconsolidated Sediments

Explosives/propellants were detected in five of the six monitoring wells screened in the unconsolidated sediments at FBQ. The following explosives/propellants were detected: 2-amino-4,6-DNT; 4-amino-2,6-DNT; and nitrocellulose.

Inorganic SRCs detected above background in all six unconsolidated monitoring wells were barium and manganese. Aluminum and nickel were detected in three monitoring wells; zinc and cobalt were detected in two monitoring wells; and copper and cadmium were detected in one monitoring well.

Caprolactum (three of six samples) and bis(2-ethylhexyl) phthalate (three of six samples) were detected in the monitoring well samples. VOCs [1,1,1-trichloethane; 1,1-dichloroethylene (DCE); acetone; and carbon disulfide] were detected in groundwater samples collected from the unconsolidated sediments.

No pesticides or PCBs were detected in groundwater samples collected from the unconsolidated sediments.

Wells Screened in Sandstone Bedrock

Six explosive/propellant compounds were detected in the monitoring wells screened in bedrock at FBQ (2,4,6-TNT; 2,4-DNT; 2-amino-4,6-DNT; 4-amino-2,6-DNT; nitrobenzene, and nitrocellulose).

Barium and manganese were detected in all six bedrock screened monitoring wells. Zinc was detected in four of the wells, cobalt in three of the wells, nickel in two of the wells, and aluminum and hexavalent chromium in one of the wells.

The SVOCs [caprolactum (six of six samples), bis(2-ethylhexyl) phthalate (six of six samples), benzyl butyl phthalate (two of six samples), and di-n-butyl phthalate (one of six samples)] were detected in the bedrock monitoring well samples. VOCs (acetone and TCE) were detected in groundwater samples collected from bedrock. No pesticides or PCBs were detected in groundwater samples collected from the bedrock.

The monitoring well with the greatest number of SRCs was the upgradient well at the AOC, while the monitoring wells with the lowest number of SRCs were the downgradient wells.

2.2.5 Fate and Transport Analysis

Based on AOC characterization and monitoring data, metals, organics, and explosives-related compounds exist in the surface (0-1 ft BGS) and subsurface (1-3 ft BGS) soil and groundwater at FBQ. Based on AOC characterization data, iron and manganese among the metals; 2,4,6-TNT among the explosives; and TCE among the VOCs were detected in groundwater exceeding their respective maximum contaminant levels (MCLs)/risk-based concentrations (RBCs). Fate and transport modeling indicates that some of the contaminants may leach from contaminated soils into the groundwater beneath the source. Migration of many of the constituents is, however, likely to be attenuated because of moderate to high retardation factors and biodegradation of organic constituents. Conclusions of the leachate and groundwater modeling are as follows.

- 2,4-DNT; 2,6-DNT; nitrobenzene; RDX; methylene chloride; chromium; and selenium were identified as initial contaminant migration chemicals of potential concern (CMCOPCs) for FBQ based on soil screening analysis.

- RDX, chromium, and selenium were identified as final CMCOPCs for this source area based on source loading predicted by the Seasonal Soil Compartment Model (SESOIL) modeling.

- RDX and chromium were identified as contaminant migration chemical of concern (CMCOCs) based on Analytical Transient 1-, 2-, 3-Dimentional (AT123D) modeling.

Because iron, manganese, and 2,4,6-TNT were detected in groundwater exceeding their respective MCLs/RBCs, these constituents were also identified as CMCOCs. A refined assessment of contaminant fate and transport demonstrated that, based on modeled time frames to attain peak leaching concentrations and on actual observed groundwater concentrations, none of the constituents identified as CMCOCs are predicted to reach downgradient receptor locations. Either the predicted peak leaching concentration has already occurred (e.g., 7 years for RDX), chemical concentrations in soil are less than background, or actual groundwater concentrations are less than modeling results, which indicates a higher degree of attenuation than that accounted for by the numerical model, which assumed a constant source of contamination and no degradation of contaminants. A full discussion of contaminant fate and transport is presented in Section 3.5 and Appendix 3A.

2.2.6 Human Health Risk Assessment

The HHRA at FBQ was conducted to evaluate risks and hazards associated with contaminated media at FBQ for one representative receptor (National Guard Trainee) exposed to deep surface soil (0-3 ft BGS), surface water, sediment, and groundwater. In addition to the representative receptor, the other four receptors described in the FWHHRAM [National Guard Dust/Fire Control Worker, Security

Guard/Maintenance Worker, Hunter/Fisher, and Resident Subsistence Farmer (adult and child)] were evaluated for exposure to shallow surface soil (0-1 ft BGS), subsurface soil (1-3 ft BGS) (Resident Subsistence Farmer only), groundwater, sediment, and surface water. The Resident Subsistence Farmer provides a baseline for evaluating this AOC with respect to residential release.

Arsenic and manganese were identified as COCs in deep surface (0-3 ft BGS) soil and sediment for the National Guard Trainee at FBQ; however, the exposure point concentrations (EPCs) for arsenic and manganese in soil are less than surface soil background and the EPCs of these metals in sediment are less than (arsenic in Quarry Ponds) or similar to (arsenic and manganese in the Drainage Ditch) sediment background. Two additional metals (cadmium and hexavalent chromium) were identified as COCs in sediment at the Quarry Ponds for the National Guard Trainee. Calculated risks from these two metals are primarily associated with the very high dust loading factor and inhalation rate assumed for the National Guard Trainee.

Arsenic and bis(2-ethylhexyl)phthalate were identified as COCs in surface water at the settling basins for the National Guard Trainee at FBQ. Arsenic was detected in only one of ten surface water samples. Bis(2-ethylhexyl)phthalate, a comment laboratory contaminant, was detected in nine of ten surface water samples. All nine of these detected concentrations were estimated values and bis(2-ethylhexyl)phthalate was identified in blank samples from this exposure unit.

A summary of the HHRA results is provided in Table 2-1.

Table 2-1. Summary of HHRA Risk Results for Direct Contact at the Fuze and Booster Quarry Ponds

Receptor	Total HI	Total ILCR	COCs	Notes
National Guard Trainee (Representative Receptor)				
Deep Surface Soil	2.2	4.4E-06	As, Mn	HQ>1 for Mn inhalation. ILCR exceeds USEPA *de minimis* risk but below Ohio EPA target risk.
Sediment Ditch Quarry Ponds Settling Basins	 12 0.57 2.4	 7.3E-06 2.0E-05 5.0E-09	 As, Mn As, Cd, Cr+6 Mn	HQ>1 for Mn inhalation at Ditch and Settling Basins. ILCR exceeds USEPA and Ohio EPA target risk at Quarry Ponds (primary risk driver is Cr+6, risk from As and Cd are below Ohio EPA target risk.
Surface Water Ditch Quarry Ponds Settling Basins	 0.96 0.000054 0.24	 -- 8.7E-09 7.3E-06	 -- None As, BEHP	Ditch and Quarry Ponds below USEPA and Ohio EPA target risk values. Settling Basins exceed USEPA *de minimis* risk but below Ohio EPA target risk.
Groundwater Bedrock Unconsolidated	 0.35 0.48	 9.0E-07 --	 None None	Below USEPA and Ohio EPA target risk values.
Security Guard/Maintenance Worker				
Shallow Surface Soil	0.067	5.5E-06	As	Exceeds USEPA *de minimis* risk but below Ohio EPA target risk.

Table 2-1. Summary of HHRA Risk Results for Direct Contact at the Fuze and Booster Quarry Ponds (continued)

Receptor	Total HI	Total ILCR	COCs	Notes
Fire/Dust Suppression Worker				
Shallow Surface Soil	0.0027	2.0E-07	None	Below USEPA and Ohio EPA target risk values for all media.
Sediment				
Ditch	0.0059	4.5E-07	None	
Quarry Ponds	0.0092	4.3E-07	None	
Settling Basins	0.00096	2.4E-08	None	
Surface Water				
Ditch	0.073	--	None	
Quarry Ponds	0.0000073	1.2E-09	None	
Settling Basins	0.020	7.0E-07	None	
Hunter/Trapper/Fisher				
Shallow Surface Soil	0.0017	1.6E-07	None	Below USEPA and Ohio EPA target risk values for all media.
Sediment				
Ditch	NA	NA	NA	
Quarry Ponds	0.0057	3.5E-07	None	
Settling Basins	NA	NA	NA	
Surface Water				
Ditch	NA	NA	NA	
Quarry Ponds	0.0000033	6.5E-10	None	
Settling Basins	NA	NA	NA	
Resident Subsistence Farmer (Adult)				
Shallow Surface Soil	0.22	2.0E-05	As, B(*a*)P	Exceeds USEPA and Ohio EPA target risk. Primary risk driver is arsenic. Risk from B(*a*)P is below Ohio EPA target risk.
Subsurface Soil	0.16	2.4E-05	As	Exceeds USEPA and Ohio EPA target risk.
Sediment				Ditch and Quarry Ponds exceed USEPA and Ohio EPA target risk. Settling Basins exceed USEPA *de minimis* risk but below Ohio EPA target risk.
Ditch	0.49	4.2E-05	As, B(*a*)A, B(*a*)P, B(*b*)F	
Quarry Ponds	0.95	4.0E-05	As, B(*a*)P	
Settling Basins	0.086	1.9E-06	B(*a*)P	
Surface Water				Ditch and Settling Basins exceed USEPA and Ohio EPA target HI and risk. Quarry Ponds are below target HI and risk.
Ditch	1.8	--	Mn	
Quarry Ponds	0.00018	3.4E-08	None	
Settling Basins	0.49	2.1E-05	As, BEHP	
Groundwater				HQ>1 for Mn and TNT. ILCR exceeds USEPA *de minimis* risk but below Ohio EPA target risk for Bedrock Aquifer. No carcinogenic COPCs in Unconsolidated Aquifer.
Bedrock	3.2	9.7E-06	Mn, TNT, DNT, TCE	
Unconsolidated	4.3	--	Mn	
Resident Subsistence Farmer (Child)				
Shallow Surface Soil	1.2	2.3E-05	As	Exceeds USEPA and Ohio EPA target risk.
Subsurface Soil	0.98	2.8E-05	As	Exceeds USEPA and Ohio EPA target risk.
Sediment				Ditch and Quarry Ponds exceed USEPA and Ohio EPA target risk. Settling Basins exceed USEPA *de minimis* risk but below Ohio EPA target risk.
Ditch	2.8	4.3E-05	As, Mn, B(*a*)P	
Quarry Ponds	7.1	4.1E-05	As, Hg, Sb, B(*a*)P	
Settling Basins	0.53	1.1E-06	B(*a*)P	
Surface Water				Ditch and Settling Basins exceed USEPA and Ohio EPA target HI and risk. Quarry Ponds are below target HI and risk.
Ditch	4.2	--	Mn	
Quarry Ponds	0.00062	2.4E-08	None	
Settling Basins	1.2	1.2E-05	As, BEHP	

Table 2-1. Summary of HHRA Risk Results for Direct Contact at the Fuze and Booster Quarry Ponds (continued)

Receptor	Total HI	Total ILCR	COCs	Notes
Groundwater				HQ>1 for Mn and TNT.
Bedrock				ILCR exceeds USEPA *de minimis* risk but below
Unconsolidated	11	6.0E-06	Mn, TNT, DNT, TCE	Ohio EPA target risk for Bedrock Aquifer. No
	15	--	Mn	carcinogenic COPCs in Unconsolidated Aquifer.

Chemical abbreviations:

As = Arsenic.
B(*a*)A= Benz(*a*)anthracene.
B(*b*)F = Benzo(*b*)fluoranthene.
B(*a*)P = Benzo(*a*)pyrene.
BEHP = Bis(2-ethylhexyl)phthalate.
Cd = Cadmium.
Cr+6 = Hexavalent chromium.
DNT = 2,6-Dinitrotoluene.
Hg = Mercury.
Mn = Manganese.
Sb = Antimony.
TCE = Trichloroethylene.
TNT = 2,4,6-Trinitrotoluene.

COC = Constituent of concern.
COPC = Constituent of potential concern.
HI = Hazard index.
ILCR = Incremental lifetime cancer risk.
NA = Not applicable, these exposure units do not support hunting/trapping/fishing.
Ohio EPA = Ohio Environmental Protection Agency.
USEPA = U. S. Environmental Protection Agency.
-- = No carcinogenic COPCs identified in this medium.

Supplemental soil samples were collected from surface (0-1 ft BGS) and subsurface (1-3 ft BGS) soil at FBQ to complete the analysis of nature and extent of contamination. These supplemental data are presented in Appendix 2B and summarized in Sections 2.2.3 and 2.2.4 of this FS. An evaluation of the supplemental soil data shows that these new data do not change the conclusions of the HHRA at FBQ for shallow (0-1 ft BGS) or deep (0-3 ft BGS) surface soil or subsurface (1-3 ft BGS) soil.

2.2.7 Ecological Risk Assessment

FBQ contains sufficient terrestrial and aquatic (soil, sediment, and surface water) habitat to support various classes of ecological receptors. For example, terrestrial habitats at FBQ include woodlots, marshy areas, and open water. Various classes of receptors, such as vegetation, small and large mammals, and birds, have been observed at the AOC. The presence of suitable habitat and observed receptors at the AOC warranted a screening ERA. Thus, Ohio EPA protocol (Level I) was met and Level II was needed.

A Level II screening and ecological risk assessment (SERA) was conducted at FBQ. The SERA process provides an evaluation of the potential for risk to ecological receptors. This evaluation is considered to be conservative for two reasons: (1) maximum detected concentrations (MDCs) are compared to ecological screening values (ESVs) as opposed to EPCs being compared to these values, and (2) the medium-specific ESVs are intended to protect sensitive, multiple receptors, some of which may not be present at FBQ. Chemicals with no ESV are also retained as constituents of potential ecological concern (COPECs). As part of this screen, the chemicals classified as persistent, bioaccumulative, and toxic (PBT) are retained as COPECs. For the Level II Screen, specific receptors are not identified because the ESVs are screening toxicity benchmarks that are intended to protect sensitive, multiple receptors (and thus, are conservative in nature).

A SERA (Level II Screen) was conducted for FBQ and identified multiple COPECs in surface (0-1 ft BGS) and subsurface (1-3 ft BGS) soil (USACE 2005b). Ohio EPA does not require that hazard quotients (HQs) be calculated when comparing the maximum detect concentrations against the ESVs, so HQs were not calculated for the FBQ. Soil COPECs have the potential to pose a hazard to plants and animals.

For the surface soil, 34 total COPECs were identified. Fourteen COPECs were based solely on their MDC exceeding the ESV (Table 2-2). This included 12 metals and two explosives (1,3,5-trinitrobenzene and 2,4,6-TNT). Some of the metals included antimony, arsenic, barium, chromium, iron, and vanadium. In addition, there were nine COPECs based solely on being PBT compounds, which included a pesticide (4,4'-dichlorodiphenyldichloroethylene [DDE]) and eight polycyclic aromatic hydrocarbons (PAHs). Four inorganics (cadmium, lead, mercury, and zinc) were COPECs based on two criteria, including having an MDC exceeding the ESV and being PBT compounds. Seven chemicals were COPECs based on having no ESV, including 4 inorganics, and 3 explosives. Thus, 27 total surface soil COPECs were identified based on either having a MDC exceeding the ESV and/or being PBT compounds (14 + 9 + 4), indicating that surface soil chemicals pose a potential for adverse effects to ecological receptors.

Table 2-2. COPECs in Surface (0-1 ft BGS) and Subsurface (1-3 ft BGS) Soil at FBQ

COPEC	Surface Soil (0-1 ft BGS)	Subsurface Soil (1-3 ft BGS)
COPECs with MDC Greater than ESV		
Aluminum	—	X
Antimony	X	—
Arsenic	X	X
Barium	X	—
Chromium	X	X
Chromium, hexavalent	X	X
Cobalt	X	—
Copper	X	—
Iron	X	X
Manganese	X	—
Nickel	X	—
Selenium	X	X
Vanadium	X	X
1,3,5-Trinitrobenzene	X	—
2,4,6-Trinitrotoluene	X	—
Carbon disulfide	—	X
COPECs with MDC Greater than ESV and are PBTs		
Lead	X	X
Mercury	X	X
Zinc	X	X
COPECs with MDC Less than ESV but are Retained as PBTs		
Cadmium	X	X
4,4′-DDE	X	—
Benzo(a)anthracene	X	—
Benzo(a)pyrene	X	—
Benzo(b)fluoranthene	X	—
Benzo(k)fluoranthene	X	—
Chrysene	X	—

Table 2-2. COPECs in Surface (0-1 ft BGS) and Subsurface (1-3 ft BGS) Soil at FBQ (continued)

COPEC	Surface Soil (0-1 ft BGS)	Subsurface Soil (1-3 ft BGS)
Di-n-butylphthalate	X	—
Fluoranthene	X	—
Pyrene	X	—
COPECs having no ESV		
Calcium	X	—
Magnesium	X	X
Potassium	X	—
Sodium	X	X
2-amino-4,6-dinitrotoluene	X	—
4-amino-2,6-dinitrotoluene	X	—
Nitrocellulose	X	X

BGS = Below ground surface.
COPECs = Constituents of potential ecological concern.
DDE = Dichlorodiphenyldichloroethylene.
ESV = Ecological screening value.
MDC = Maximum detected concentration.
PBT = Persistent, bioaccumulative, and toxic compound (inorganics include cadmium, lead, mercury, and zinc; organics include Log K_{ow} of at least 3.0).
"X" = Chemical is a COPEC due to criterion in this column.
"—" Chemical was not a COPEC at this soil depth.

For the subsurface soil, there were fewer total COPECs (15) and fewer COPECs across the categories compared to surface soil (Table 2-2). Similar to the surface soil, COPECs based solely on the MDC exceeding the ESV were the most prevalent type [eight constituents of potential concern (COPCs), including seven inorganics and one volatile (carbon disulfide)]. The metals included aluminum, arsenic, chromium, iron, and vanadium. There was only one COPEC based solely on being a PBT compound, cadmium. Three inorganics (lead, mercury, and zinc) were COPECs based on two criteria: having a MDC exceeding the ESV and being a PBT compound. Three chemicals were COPECs based on having no ESV, and included 2 inorganics (magnesium and sodium) and nitrocellulose. Thus, 12 total subsurface COPECs were identified based on either having a MDC exceeding the ESV and/or being PBT compounds (8 + 1 + 3), indicating that subsurface soil chemicals pose a potential for adverse effects to ecological receptors.

In summary, both the surface and subsurface soil had multiple COPECs that exceed the ESV and/or are PBT compounds. The surface soil had substantially more COPECs based on MDCs exceeding ESV and based on being PBT compounds than did the subsurface soil (27 COPECs versus 12 COPECs). Inorganics comprised the majority of COPECs at both soil depths. Although some of the COPECs likely overestimate the risk to ecological receptors due to low bioavailability of the chemicals for biological uptake from soil (e.g., aluminum) or low confidence in the ESVs (e.g., iron for plants), the presence of multiple COPECs indicates the potential for adverse effects to ecological receptors from these chemicals in FBQ surface and subsurface soil.

The SERA (Level II screen) also evaluated potential risks and identified COPECs in sediment and surface water for FBQ (USACE 2005b). There were three exposure units: the Quarry Ponds consisting of the three geographically proximate ponds, the Drainage Ditch near the bottom Quarry Pond, and the Settling Basins located about 700 ft west of the Quarry Ponds. The Quarry Ponds are considered the most important ecological resource of the three exposure units because they continuously contain water and, therefore, there is more information provided about that exposure unit.

The following 46 sediment COPECs including 17 inorganics, 6 explosives, 6 pesticides, 15 SVOCs, and 2 VOCs were identified at the Quarry Ponds.

The inorganics were:

Antimony	Chromium	Nickel
Arsenic	Copper	Selenium
Barium	Iron	Silver
Beryllium	Lead	Sodium
Cadmium	Magnesium	Zinc
Calcium	Mercury	

The explosives were:

2,4,6-Trinitrotoluene	HMX
2-amino-4,6-Dinitrotoluene	Nitrocellulose
4-amino-2,6-Dinitrotolune	Nitroglycerin

Other sediment COPECs included the typical pesticides such as 4,4'-DDE and 4,4'-DDE accompanied by the usual PAHs such as anthracene, chrysene, and pyrene. Finally, the VOCs were 2-Butanone and Acetone.

Of the 46 retained COPECs at the Quarry Ponds (starting with 52 detected chemicals of interest), 8 had maximum detectable concentrations that exceeded their ESV and were not PBT compounds (5 inorganics, 1 SVOC, and 2 VOCs), 8 were COPECs solely due to being PBT compounds (all 6 pesticides and 2 SVOCs), and 14 had no ESVs (8 inorganics and 6 explosives). Fifteen of the retained COPECs (cadmium, lead, mercury, zinc, and 11 SVOCs) had maximum detectable concentrations that exceeded the ESV and were also PBT compounds. In addition, carbazole was retained as a COPEC because it is a PBT compound and had no ESV.

For the Drainage Ditch, we started with 51 detected chemicals of interest (COIs) and ended up with 37 COPECs. For the Small Basins, the numbers were also 51 (starting) and 43 (ending).

The following four surface water COPECs including 2 inorganics, 1 explosive, and 1 SVOCs were identified at the Quarry Ponds:

Calcium	Nitrocellulose
Zinc	Bis(2-ethylhexyl)phthalate

Of the four retained COPECs at the Quarry Ponds, two were COPECs solely due to being PBT compounds [zinc and bis(2-ethylhexyl)phthalate], whereas the other two had no Ohio Administrative Code (OAC) water quality criteria (WQC) (calcium and nitrocellulose).

For the Drainage Ditch we started with 16 detected COIs and ended up with 5 COPECs. For the Small Basins, the numbers were 29 (starting) and 10 (ending).

In summary, there were as many as 46 sediment COPECs at the Quarry Ponds and as many as 10 surface water COPECs at the Drainage Ditch and Settling Basins. Most sediment COPECs were organics and surface water COPECs were an equal blend of inorganics and organics. Some COPECs likely overestimate exposure and risk to benthos and aquatic life due to low bioavailability (aluminum and iron), antagonistic effects (PAHs), and other factors. The exceedances of ESVs and assumed low ecological risk in the sediment and surface water have been corroborated by the facility-wide biology and surface water study that showed healthy and functioning aquatic ecosystems in the Quarry Ponds.

Supplemental soil samples were collected from surface (0-1 ft BGS) and subsurface (1-3 ft BGS) soil at FBQ to complete the analysis of nature and extent of contamination. These supplemental data are presented in Appendix 2B and summarized in Section 2.2.3 and 2.2.4 of this FS. Evaluation of the supplemental soil data shows that these new data do not change the conclusions of the SERA at FBQ for surface (0-1 ft BGS) or subsurface (1-3 ft BGS) soil.

2.3 RISK CHARACTERIZATION FOR TRESPASSER (ADULT AND JUVENILE) SCENARIO

The baseline HHRA provided in the RI Report for FBQ evaluates the potential health risks to humans resulting from exposure to contamination at FBQ. The HHRA presented in the Phase I/Phase II FBQ RI Report is based on the methods outlined in the FWHHRAM, which addresses five receptors to be evaluated at RVAAP [National Guard Trainee, National Guard Dust/Fire Control Worker, Security Guard/Maintenance Worker, Hunter/Trapper/Fisher, and Resident Subsistence Farmer (adult and child)].

In addition to the receptors in the FWHHRAM, an Adult and Juvenile Trespasser is evaluated in this FS per the FWHHRAM Amendment #1 (USACE 2005c) to supplement the baseline HHRA provided in the RI Report to provide risk managers with information relating to potential trespasser exposure. This supplemental risk characterization is presented in Appendix 2A and is incorporated into subsequent sections of this FS as appropriate.

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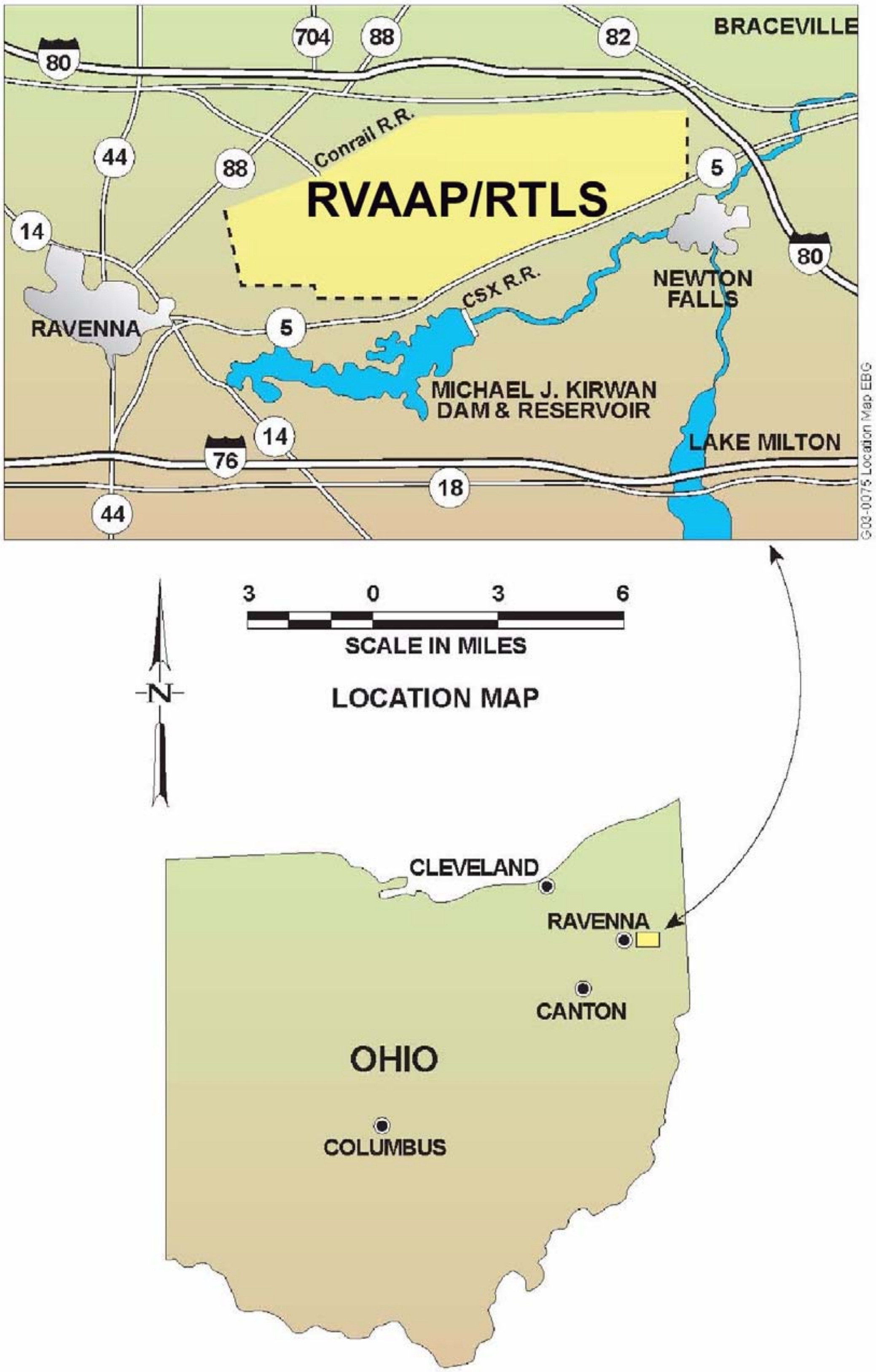

Figure 2-1. General Location and Orientation of RVAAP/RTLS

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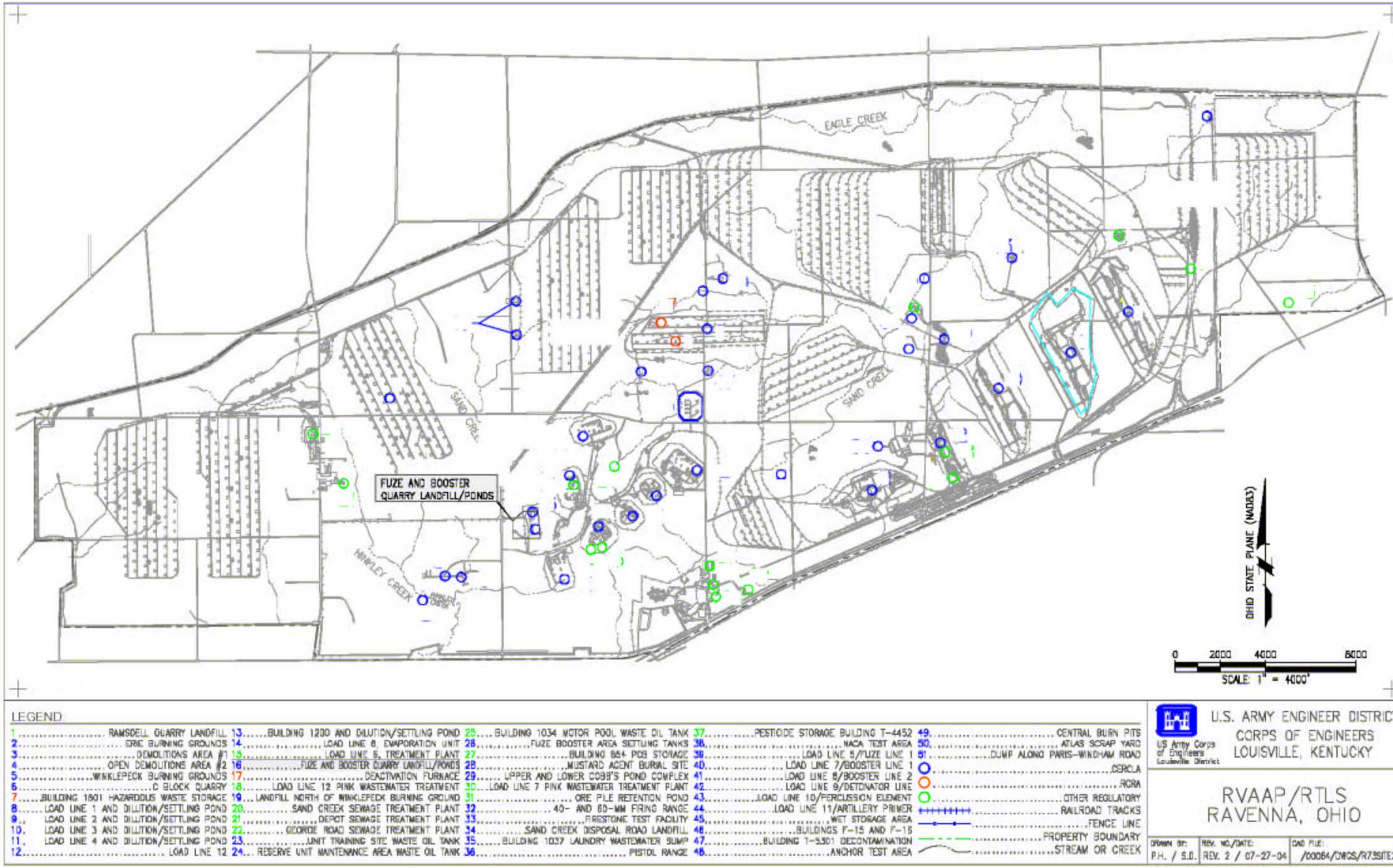

Figure 2-2. RVAAP/RTLS Installation Map

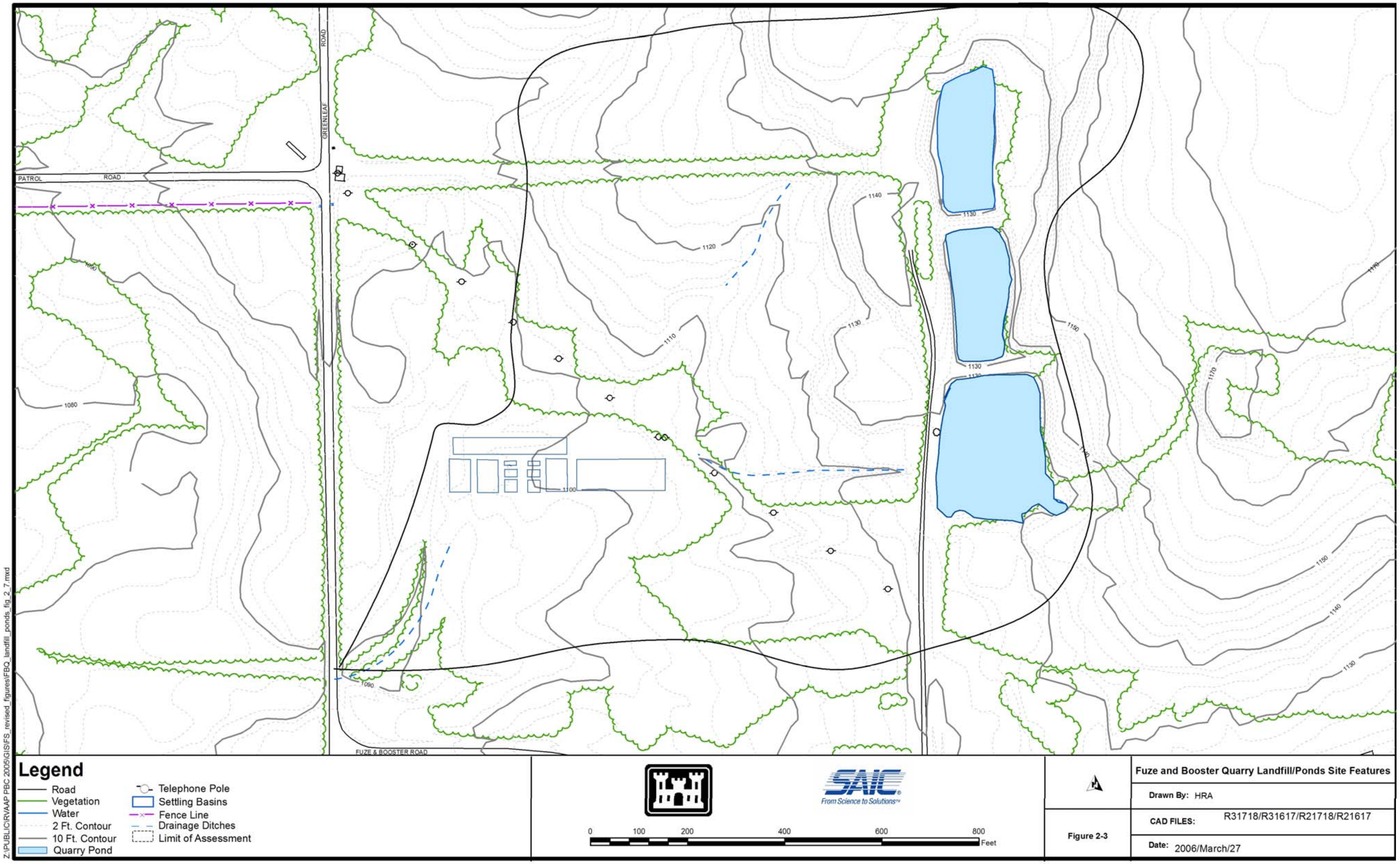

Figure 2-3. Features of FBQ

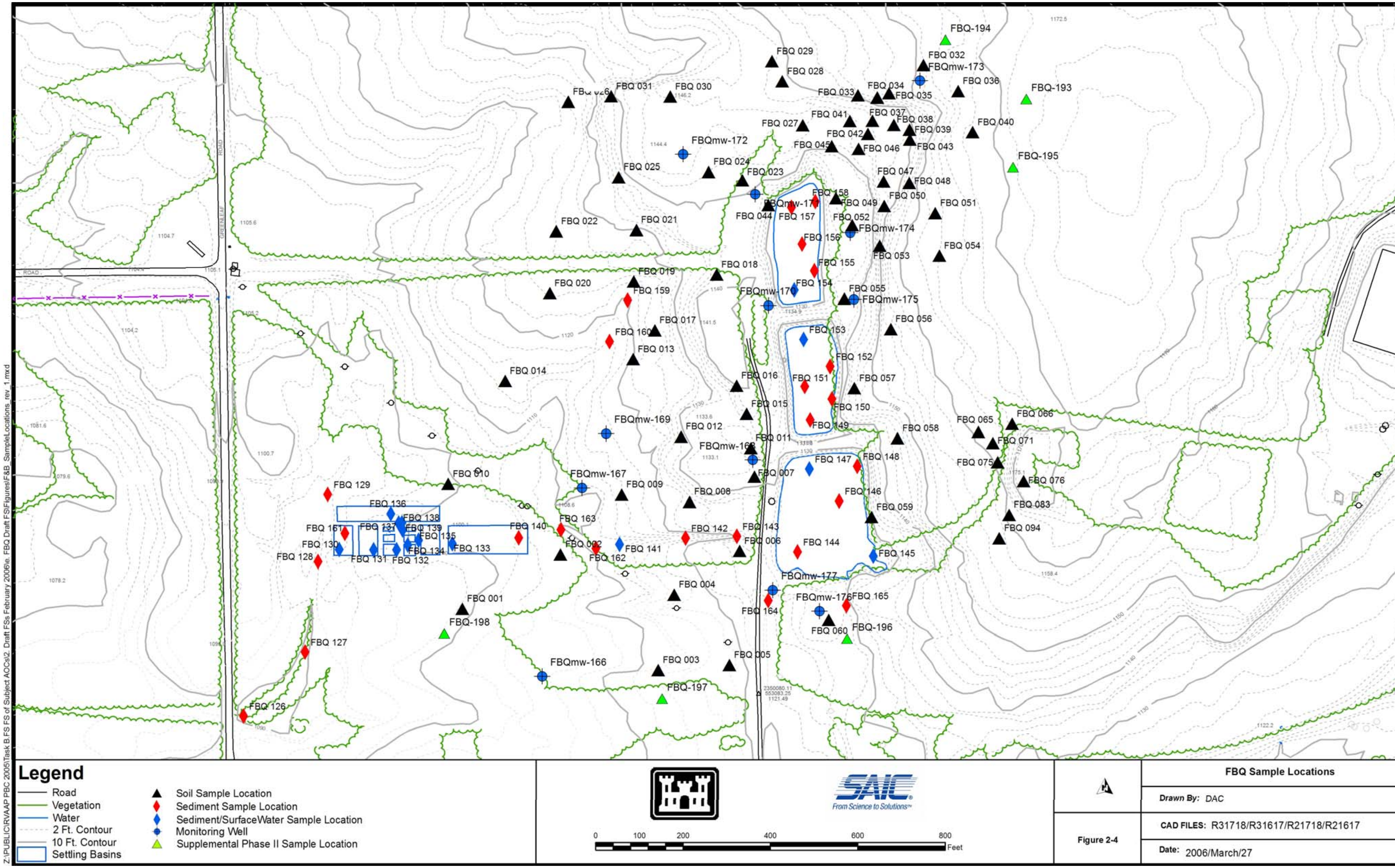

Figure 2-4. Sample Locations and Monitoring Well Locations at FBQ

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3.0 REMEDIAL ACTION OBJECTIVES

This chapter of the FS describes the RAO for FBQ. RAOs specify the requirements that remedial alternatives must fulfill to protect human health and the environment from contaminants and provide the basis for identifying and evaluating remedial alternatives in Chapters 5, 6, and 7. The primary objectives of this chapter are:

1. To present the RAO for FBQ;

2. To identify media-specific preliminary cleanup goals to meet this RAO;

3. To identify areas of soil, sediment, surface water, and groundwater where remediation may be needed to meet the RAO; and

4. To identify the extent of contamination to be used in volume calculations for evaluating removal/treatment alternatives.

The discussion in this chapter is organized as follows:

- The RAO is presented in Section 3.1.

- Anticipated future land use is discussed in Section 3.2.

- Human health preliminary cleanup goals and the identification of COCs requiring further evaluation for remedial alternatives to meet this RAO are presented in Section 3.3.

- Ecological weight-of-evidence for meeting the RAO are presented in Section 3.4.

- An assessment of the potential for impacted soils to affect groundwater at the AOC and at an exposure point downgradient of the AOC is summarized in Section 3.5.

- A summary of the COCs and corresponding preliminary cleanup goals established for each medium from the information presented in Sections 3.1 through 3.4 is presented in Section 3.6.

- The extent and volume of impacted soils/sediments to be addressed by the remedial alternatives evaluated in this FS are summarized in Section 3.7.

3.1 REMEDIAL ACTION OBJECTIVES

RAOs specify the requirements remedial alternatives must fulfill to protect human health and the environment from SRCs at FBQ. To provide this protection, media-specific objectives that identify major contaminants and associated media-specific cleanup goals are developed. These objectives specify COCs, exposure routes and receptors, and acceptable constituent concentrations for long-term protection of receptors. The baseline HHRA conducted for FBQ is summarized in Chapter 2 of this FS and detailed in Chapters 6 and 7 of the Phase I/Phase II RI Report (USACE 2005b).

As discussed in Chapter 2, the HHRA includes baseline risk calculations for a number of receptors for representative and residential land use scenarios. Table 3-1 lists the representative receptor and the residential receptor for FBQ.

Table 3-1. Land Use Scenarios Assessed in the FBQ FS

AOC	Land Use Scenario	Receptor
FBQ	Restricted	National Guard Trainee
	Residential	Resident Subsistence Farmer

AOC = Area of concern.
FBQ = Fuze and Booster and Quarry Landfill/Ponds.

Land use at FBQ may change in time, but the receptors shown in Table 3-1 are the receptors assessed for the purposes of this FS. The representative receptors correspond to active (National Guard Trainee) and restricted (Security Guard/Maintenance Worker, Fire/Dust Suppression Worker) National Guard land uses. The Resident Subsistence Farmer provides a baseline for evaluating whether FBQ may be eligible for residential release; however, FBQ is not currently a candidate for residential release because of the suspected presence of MEC, which will be investigated in the MMRP. Other receptors, in addition to the representative receptor and Resident Subsistence Farmer, are evaluated in the baseline HHRA for FBQ. The representative receptors chosen for FBQ are protective of other activities that may occur under anticipated future land use. In addition to the receptors evaluated in the HHRA, an Adult and Juvenile Trespasser is evaluated in this FS (Appendix 2A).

Cleanup goals are based on the evaluation of both the National Guard Trainee and Resident Subsistence Farmer scenarios. More information can be found in Section 3.3 regarding representative receptors, risk calculations, and preliminary cleanup goals.

The ERA performed for FBQ identifies a variety of ecological receptor populations that could be at risk and identifies the COPECs and constituents of ecological concern (COECs) that could contribute to potential risks from exposure to contaminated media. Ohio EPA guidance (Ohio EPA 2003) allows a decision about remediation to be made at the completion of each level of risk assessment. A decision whether it is necessary to remediate because of potential harm to ecological receptors at FBQ is not included in the RI Report. Section 3.4 provides weight-of-evidence input for that decision. When a human health cleanup goal is chosen, it offers dual protectiveness to human health and ecological resources after any habitat disturbance has been reversed through ecological succession or environmental management.

The necessary CERCLA remediation requirements, with respect to soils and dry sediments, will be performed to achieve remedy at FBQ. Remedy with respect to groundwater, surface water, and wet sediments are not included in the scope of this FS. However, remedy with respect to soils also must be protective of groundwater. The following RAO is developed accordingly for impacted soils and dry sediments at FBQ:

- Prevent National Guard Trainee exposure to contaminants in soils and dry sediments which exceed risk-based cleanup goals to a depth of 4 ft BGS.

At FBQ, preliminary cleanup goals are developed for impacted environmental media including groundwater, surface water, and wet sediments (in addition to soils and dry sediments) to facilitate future considerations with respect to selection of remedies for these media.

3.2 ANTICIPATED FUTURE LAND USE

OHARNG has prepared a comprehensive Environmental Assessment and an Integrated Natural Resources Management Plan to address future use of RTLS property (OHARNG 2001). OHARNG has established future land use for FBQ as Mounted Training, No Digging based on anticipated training mission and utilization of the RTLS (USACE 2004). Future land use is discussed in more detail in Section 3.3.

3.3 IDENTIFICATION OF HUMAN HEALTH PRELIMINARY CLEANUP GOALS FOR FBQ

This section documents the proposed land use and corresponding preliminary cleanup goals to support the remedial alternative selection process for soil remediation at FBQ. Preliminary cleanup goals are the chemical-specific numeric cleanup criteria used to meet the RAO for protection of human health.

The HHRA performed for FBQ is detailed in the RI Report and summarized in Chapter 2 of this FS. The risk assessment included in the RI Report documents a variety of potential human receptor populations [e.g., National Guard Trainee, National Guard Dust/Fire Control Worker, Security Guard/Maintenance Worker, Hunter/Trapper/Fisher, and Resident Subsistence Farmer (adult and child)] that could be at risk, and identifies the COCs that could contribute to potential risks from exposure to contaminated media at FBQ. In addition to the receptors in the HHRA, a Trespasser (Adult and Juvenile) is evaluated in this FS (Appendix 2A). The HHRA also documents the calculation of risk-based remedial goal options (RGOs) for human receptors for all media (i.e., soil, surface water, sediment, and groundwater), all COCs, and all receptor populations evaluated in the RI Report. These risk-based RGOs are referred to as risk-based cleanup goals in this FS.

Chemical-specific preliminary cleanup goals are established for National Guard Trainee and Resident Subsistence Farmer land use from these risk-based cleanup goals, background concentrations, and other information in this section. Preliminary cleanup goals are established for a National Guard Trainee for likely future land use by OHARNG. The preliminary cleanup goals for the National Guard Trainee are protective of other potential receptors with equal or lesser exposure assumptions than the representative receptor and; therefore, serve as surrogates for these other possible receptors (e.g., preliminary cleanup goals for the National Guard Trainee are also protective of a hunter or a security guard). The potential for the National Guard Trainee to be protective of a trespasser to the AOC is also addressed. In addition to the National Guard Trainee, preliminary cleanup goals are established for a Resident Subsistence Farmer (adult and child) to provide a baseline for evaluating whether this AOC may be eligible for unrestricted release; however, FBQ is not currently a candidate for unrestricted release because of the suspected presence of MEC, which will be investigated in the MMRP.

The risk-based cleanup goals were calculated using the methodology presented in the Risk Assessment Guidance for Superfund (RAGS), Part B (USEPA 1991), while incorporating site-specific exposure parameters applicable to the five potential receptors outlined in the FWHHRAM. The process for calculating risk-based cleanup goals was a rearrangement of the cancer risk or non-cancer hazard equations, to solve for the concentration that will produce a specific risk or hazard level instead of calculating risk/hazard from a given concentration. For example, the risk-based cleanup goal for RDX at the cancer risk level of 1E-05 for the National Guard Trainee is the concentration of RDX that produces a risk of 1E-05 when using the exposure parameters specific to the National Guard Trainee receptor and the cancer slope factor (CSF) for RDX. Equations, exposure parameters, and toxicity values (CSFs) and non-cancer reference doses) are provided in the HHRA and were taken from the FWHHRAM (USACE 2004).

The FWHHRAM (USACE 2004) identifies 1E-05 as a target for cumulative incremental lifetime cancer risk (ILCR) [target risk (TR)] for carcinogens and an acceptable target hazard index (THI) of 1 for non-carcinogens consistent with Ohio EPA guidance (Ohio EPA 2004b), with the caveat that exposure to multiple COCs might require these targets to be decreased for chemical-specific risks. The chemical-specific TR and THI are dependent on several factors, including the number of carcinogenic and non-carcinogenic COCs and the target organs and toxic endpoints of these COCs. For example, if numerous (i.e., more than ten) non-carcinogenic COCs with similar toxic endpoints are present, it might be appropriate to select chemical-specific preliminary cleanup goals with a THI of 0.1 to account for exposure to multiple contaminants. AOC-specific TR and THI levels are established in Section 3.3.3.

The risk-based cleanup goals assumed combined exposure through ingestion, inhalation of vapors and fugitive dust, and dermal contact with contaminated media. For chemicals having both a cancer and non-cancer endpoint, risk-based cleanup goals were calculated for both cancer risk and non-cancer hazard at the appropriate TR and THI. The preliminary cleanup goal is selected as the lower of the risk-based cleanup goal for cancer risk and non-cancer hazard and the adult and child receptor (for the Resident Subsistence Farmer), unless the risk-based cleanup goal is below background concentration. If the applicable risk-based cleanup goal concentration is less than background, the background concentration is selected as the preliminary cleanup goal.

The list of human health COCs for evaluation of remedial alternatives are identified for FBQ based on risk management considerations including:

- Comparison of EPC to preliminary cleanup goal concentrations (including background concentrations);

- Comparison of EPC to upgradient concentrations for sediment, surface water, and groundwater;

- Consideration of soil as the primary source of contamination (i.e., if soil concentrations are below background at an AOC, that AOC is not contributing to contamination in other media); and

- Other AOC-specific and receptor-specific considerations.

The remainder of this section provides the following detailed information:

- Land use and potential receptors at FBQ (Section 3.3.1);

- A summary of COCs identified in the HHRA (Section 3.3.2);

- Identification of the appropriate TR level and THI for establishing preliminary cleanup goals based on the number and type of COCs identified in the HHRA (Section 3.3.3);

- Chemical-specific preliminary cleanup goals (Section 3.3.4); and

- Risk management considerations and the identification of COCs to be carried through the evaluation of remedial alternatives (Section 3.3.5).

3.3.1 Land Use and Potential Receptors at FBQ

The intended future land use for FBQ is for National Guard training. Specifically, this area will be used for mounted training. Per the FWHHRAM (USACE 2004), mounted training would permit direct contact with soil and/or water up to 24 hrs/day, 24 days/year on inactive duty training and/or 24 hrs/day, 15 days/year during annual training. All digging is prohibited in this area. Digging and occupying fighting positions, tank defilade positions, tank ditches and battle positions that extend below ground surface are prohibited. Tracked and wheeled operations are permitted only as directed in Section 16 of Adjutant General of Ohio (AGO) Pamphlet (Pam) 210-1. Maneuver damage may occur up to 4 ft BGS. This future use could include the three National Guard receptor types (Trainee, Security Guard/Maintenance Worker, and Fire/Dust Suppression Worker). The National Guard Trainee is exposed to soil through incidental ingestion, dermal contact, and inhalation of vapors and fugitive dust 24 hr/day, 39 days/year for 25 years (for a total of 936 hr/year). The other two National Guard receptors are exposed for shorter periods of time [i.e., 4 hr/day, 15 days/year (60 hr/year) for 25 years for the fire/dust-suppression worker and 1 hr/day, 250 days/year (250 hr/year) for 25 years for the security guard/maintenance worker]. Based on these parameter values, the National Guard Trainee produces the largest risks among the three National Guard receptors, and; therefore, preliminary cleanup goals established for this receptor will also be protective of other National Guard receptors. Based on this intended future land use, preliminary cleanup goals for the National Guard Trainee are presented here as the primary preliminary cleanup goals applicable to FBQ soil.

While the intended future land use for FBQ does not include recreational use, preliminary cleanup goals established for the National Guard Trainee will be protective of a recreational receptor exposed to contaminants in soil during hunting, trapping, and fishing because these recreational activities are assumed to result in exposure only 4.57 hr/day, 7 days/year (32 hr/year) for 30 years.

The intended future land use at FBQ does not include commercial/industrial development. The National Guard Trainee has similarities to a commercial/industrial receptor (e.g., 25-year adult exposure). The total exposure time for an industrial worker (2,000 hr/year) is approximately double that of the National Guard Trainee; however, exposure to airborne contaminants (i.e., fugitive dust) is greater for the National Guard Trainee because of high dust generation by tracked vehicles used in training. Based on this analysis, the National Guard Trainee would produce larger risks than the commercial/industrial receptor when assessing human health risks via inhalation and; therefore, the National Guard Trainee would be protective of the commercial/industrial receptor exposed via the inhalation pathway. However, if commercial/industrial development is proposed in future land use planning, it will be necessary to reevaluate potential receptors. The National Guard Trainee is also protective of a Juvenile Trespasser who is assumed to visit the AOC 2 hr/day, 50 days/year (100 hr/year) for 10 years and an Adult Trespasser who is assumed to visit the AOC 2 hr/day, 75 days/year (150 hr/year) for 30 years (compared to 936 hr/year for 25 years for the National Guard Trainee).

In addition to the representative receptor (National Guard Trainee) described above the Resident Subsistence Farmer (adult and child) provides a baseline for evaluating whether this AOC may be eligible for unrestricted release; however, FBQ is currently not a candidate for unrestricted release as it is being transferred to the OHARNG. The Resident Subsistence Farmer is considered a “worst-case” exposure scenario and is considered to be protective for all other potential land uses.

3.3.2 Constituents of Concern

COCs are defined as constituents with an incremental lifetime cancer risk greater than 1E-06 and/or a hazard index (HI) greater than 1 for a given receptor. COCs were identified in the HHRA for each exposure medium and receptor evaluated.

3.3.2.1 COCs in Soil and Sediment

Two COCs were identified in deep surface soil (0-3 ft BGS) for the National Guard Trainee including one non-carcinogen (manganese) and one carcinogen (arsenic).

No non-carcinogenic COCs were identified for the Resident Subsistence Farmer. Two carcinogenic COCs were identified in shallow surface soil (0-1 ft BGS) for this receptor including one metal (arsenic) and one SVOC [benzo(a)pyrene]. Arsenic was also identified as a subsurface soil (1-3 ft BGS) COC for this receptor.

Sediment at FBQ was evaluated as three exposure units (EUs): Ditch, Settling Basins, and Quarry Ponds. The Quarry Ponds continuously contain water and are not included in the scope of this FS for soil remediation. COCs for sediment for the National Guard Trainee and Resident Subsistence Farmer (adult and child) are summarized for each of the remaining sediment EUs below.

Ditch:

- Two COCs (arsenic and manganese) were identified in sediment for the National Guard Trainee.
- Five COCs [arsenic, manganese, benz(a)anthracene, benzo(a)pyrene, and benzo(b)fluoranthene] were identified in sediment for the Resident Subsistence Farmer at the Ditch.

Settling Basins:

- One COC (manganese) was identified in sediment for the National Guard Trainee.
- One COC [benzo(a)pyrene] was identified in sediment for the Resident Subsistence Farmer at the Settling Basins.

A Trespasser (Adult and Juvenile) is evaluated in Appendix 2A to supplement the representative receptor (National Guard Trainee) and residential land use. No soil or sediment COCs are identified for the Juvenile Trespasser. Arsenic is identified as a shallow surface soil (0-1 ft BGS) COC for the Adult Trespasser. Arsenic and benzo(a)pyrene are identified as COCs in sediment for the Adult Trespasser. The total risk to the Adult Trespasser is below Ohio EPA's level of concern of 1E-05.

3.3.2.2 COCs in Surface Water and Wet Sediment

Surface Water at FBQ was evaluated as three EUs: Ditch, Settling Basins, and Quarry Ponds. The Quarry Ponds continuously contain water; therefore, these ponds are evaluated for both surface water and wet sediment.

COCs for surface water for the National Guard Trainee and Resident Subsistence Farmer (adult and child) are summarized for these three EUs.

Ditch:

- No COCs were identified in surface water for the National Guard Trainee.
- One COC (manganese) was identified in surface water for the Resident Subsistence Farmer at the Ditch.

Settling Basins:

- Two COCs [arsenic and bis(2-ethylhexyl)phthalate] were identified in surface water for the National Guard Trainee.
- Two COCs [arsenic and bis(2-ethylhexyl)phthalate] was identified in surface water for the Resident Subsistence Farmer at the Settling Basins.

Quarry Ponds:

- No COCs were identified in surface water for the National Guard Trainee.

- No COCs were identified in surface water for the Resident Subsistence Farmer at the Quarry Ponds.

COCs for wet sediment for the National Guard Trainee and Resident Subsistence Farmer (adult and child) are summarized for the Quarry Ponds as follows:

- Three COCs (arsenic, cadmium, and hexavalent chromium) were identified in wet sediment for the National Guard Trainee.

- Five COCs [antimony, arsenic, lead, mercury, and benzo(a)pyrene] were identified in wet sediment for the Resident Subsistence Farmer at the Ditch.

No surface water or wet sediment COCs are identified for the Juvenile Trespasser. Arsenic and benzo(a)pyrene are identified as COCs for wet sediment in the Quarry Ponds. Arsenic and bis(2-ethylhexyl)phthalate are identified as COCs for surface water in the Settling basins. The total risk to the Adult Trespasser is below Ohio EPA's level of concern of 1E-05.

3.3.2.3 COCs in Groundwater

No groundwater COCs were identified for the National Guard Trainee at FBQ. Four groundwater COCs (manganese; 2,4,6-TNT; 2,4-DNT; TCE) were identified in the HHRA for the Resident Subsistence Farmer.

3.3.3 Target Risk for Preliminary Cleanup Goals

The FWHHRAM (USACE 2004) identifies a 1E-05 target for cumulative ILCR [target risk (TR)] for carcinogens and an acceptable THI of 1 for non-carcinogens consistent with Ohio EPA guidance, with the caveat that exposure to multiple COCs might require these targets to be decreased. For example, if numerous (i.e., more than 10) non-carcinogenic or carcinogenic COCs with similar toxic endpoints are present, it might be appropriate to select chemical-specific preliminary cleanup goals with a TR of 1E-06 or a THI of 0.1 to account for exposure to multiple contaminants. The TR and THI selected for FBQ are dependent on several factors, including the number of carcinogenic and non-carcinogenic COCs and the target organs and toxic endpoints of these COCs.

A chemical-specific TR of 1E-05 and THI of 1.0 are identified as appropriate for establishing preliminary cleanup goals for soil at FBQ based on the small number of COCs present and the types of COCs (carcinogenic or non-carcinogenic).

The National Guard Trainee is the representative receptor for FBQ. Only two COCs were identified for this receptor: one non-carcinogen (manganese) and one carcinogen (arsenic). Two COCs (both carcinogens) were identified for the residential receptors.

A maximum of two sediment COCs (arsenic and manganese) were identified for the National Guard Trainee (at the Ditch). Arsenic is both a carcinogen and a non-carcinogen but the risk-based cleanup goals are dominated by their carcinogenic effects. Manganese is a non-carcinogen.

A maximum of five sediment COCs were identified for the Resident Subsistence Farmer scenario (at the Ditch): four carcinogens and one non-carcinogen. Of the four carcinogens, one (arsenic) is a class A carcinogen associated with lung tumors; three PAHs [benz(a)anthracene (stomach tumors), benzo(a)pyrene (larynx/stomach tumors), and benzo(b)fluoranthene (tumors)] are class B2 carcinogens that might have some similarities in target organs (mostly stomach or undefined tumors).

Based on these results, a chemical-specific TR of 1E-05 and THI of 1.0 was identified as appropriate for establishing preliminary cleanup goals for both soil and sediment at FBQ.

A maximum of two surface water COCs (both carcinogens) were identified for the National Guard Trainee and Resident Subsistence Farmer scenario (at the Settling Basins). Three wet sediment COCs (all carcinogens) were identified for the National Guard Trainee. Four wet sediment COPCs were identified for the Resident Subsistence Farmer (two non-carcinogens and two carcinogens). Based on these results, a chemical-specific TR of 1E-05 and THI of 1.0 was identified as appropriate for establishing preliminary cleanup goals for both surface water and wet sediment at FBQ.

Five groundwater COCs (two non-carcinogens, two carcinogens, and one COC with both non-carcinogenic and carcinogenic endpoints) were identified for the Resident Subsistence Farmer scenario. Based on these results, a chemical-specific TR of 1E-05 and THI of 1.0 was identified as appropriate for establishing preliminary cleanup goals for groundwater at FBQ.

3.3.4 Preliminary Cleanup Goals

3.3.4.1 Soil and Sediment

Risk-based cleanup goals calculated in the HHRA for COCs in soil and sediment, background concentrations for inorganics, and preliminary cleanup goals are presented for the National Guard Trainee in Tables 3-2 and 3-3, respectively.

Estimated soil EPCs for both arsenic (13 mg/kg) and manganese (630 mg/kg) are less than the preliminary cleanup goals established for these COCs for the National Guard Trainee Scenario.

The estimated sediment EPCs for arsenic and cadmium are less than the preliminary cleanup goals established for these metals for the National Guard Trainee Scenario.

Table 3-2. Soil Preliminary Cleanup Goals for National Guard Trainee Scenario at FBQ[a]

COC	EPC (mg/kg)	Risk-Based Cleanup Goal from HHRA (mg/kg)		Background[b] (mg/kg)	Preliminary Cleanup Goal (mg/kg)
		HI = 1.0	ILCR = 1E-05		
Inorganics					
Arsenic	13	1500	31	15	31
Manganese	630	350	--	1500	1800[c]

[a] Deep (0-3 ft BGS) surface soil is used for National Guard Trainee.
[b] Final facility-wide background values for the Ravenna Army Ammunition Plant from the *Phase II Remedial Investigation Report for the Winklepeck Burning Grounds at the Ravenna Army Ammunition Plant, Ravenna, Ohio* (USACE 1999). Background values for soil are available for two soil depths: surface (0-1 ft BGS) and subsurface (1-12 ft BGS); the minimum value for these two aggregates is reported.
[c]Value is U. S. Environmental Protection Agency Region 9 residential Preliminary Remediation Goal (http://www.epa.gov/region09/waste/ sfund/prg/index.html).
COC = Constituent of concern.
EPC = Exposure point concentration.
HI = Hazard index.
HHRA = Human health risk assessment.
ILCR = Incremental lifetime cancer risk.
-- = Toxic endpoint not evaluated for this COC.

Table 3-3. Sediment Preliminary Cleanup Goals for National Guard Trainee Scenario at FBQ

COC	EPC (mg/kg)			Risk-Based Cleanup Goal from HHRA (mg/kg)		Background[a] (mg/kg)	Preliminary Cleanup Goal (mg/kg)
	D	SB	QP	HI = 1.0	ILCR = 1E-05		
Inorganics							
Arsenic	21	NA	19	1500	31	20	31
Cadmium	NA	NA	19	4700	110	0	110
Hexavalent Chromium	NA	NA	20	670	16	ND	16
Manganese	4100	650	NA	350	--	1950	1950

[a] Final facility-wide background values for the Ravenna Army Ammunition Plant from the *Phase II Remedial Investigation Report for the Winklepeck Burning Grounds at the Ravenna Army Ammunition Plant, Ravenna, Ohio* (USACE 1999).
-- = Toxic endpoint not evaluated for this COC.
COC = Constituent of concern.
EPC = Exposure point concentration.
HI = Hazard index.
HHRA = Human health risk assessment.
ILCR = Incremental lifetime cancer risk.
D = Ditch exposure unit.
NA = Not applicable. Not a COC at this aggregate.
ND = No data available.
SB = Settling Basin exposure unit.
QP = Quarry Ponds exposure unit.

Risk-based cleanup goals calculated in the HHRA for COCs in soil and sediment, background concentrations for inorganics, and preliminary cleanup goals for the Resident Subsistence Farmer are presented in Tables 3-4 and 3-5, respectively.

Estimated EPCs for arsenic [12 mg/kg in shallow surface soil (0-1 ft BGS) and 16 mg/kg in subsurface soil (1-3 ft BGS) and benzo(a)pyrene (0.084 mg/kg in shallow surface soil and not detected in subsurface soil] are less than the selected preliminary cleanup goals for these COCs for the Resident Subsistence Farmer Scenario.

Table 3-4. Soil Preliminary Cleanup Goals for Resident Subsistence Farmer Scenario at FBQ

COC	EPC[a] (mg/kg)	Risk-Based Cleanup Goal from HHRA (mg/kg) Adult HI = 1.0	Adult ILCR = 1E-05	Child HI = 1.0	Child ILCR = 1E-05	Background[b] Surface	Background[b] Subsurface	Preliminary Cleanup Goal Surface	Preliminary Cleanup Goal Subsurface
Inorganics									
Arsenic	12 (16)	130	6.7	22	5.7	15	20	15	20
Semivolatiles									
Benzo(a)pyrene	0.084	--	0.59	--	0.97	NA	NA	0.59	0.59

[a] Shallow (0-1 ft below ground surface [BGS]) surface soil and subsurface soil (1-3 ft BGS) are used for Resident Subsistence Farmer. EPCs are presented for surface soil. EPCs for subsurface soil are in (parentheses).
[b] Final facility-wide background values for the Ravenna Army Ammunition Plant from the *Phase II Remedial Investigation Report for the Winklepeck Burning Grounds at the Ravenna Army Ammunition Plant, Ravenna, Ohio* (USACE 1999).
-- = Toxic endpoint not evaluated for this COC.
COC = Constituent of concern.
EPC = Exposure point concentration.
HI = Hazard index.
HHRA = Human health risk assessment.
ILCR = Incremental lifetime cancer risk.
NA = Not applicable. Background concentrations are used for inorganic COCs only.

Estimated sediment EPCs for benz(a)anthracene, benzo(a)pyrene, and benzo(b)fluoranthene are less than the preliminary cleanup goals for these COCs for the Resident Subsistence Farmer Scenario.

Table 3-5. Sediment Preliminary Cleanup Goals for Resident Subsistence Farmer Scenario at FBQ

COC	EPC (mg/kg) D	EPC (mg/kg) SB	EPC (mg/kg) QP	Risk-Based Cleanup Goal from HHRA (mg/kg) Adult HI = 1.0	Adult ILCR = 1E-05	Child HI = 1.0	Child ILCR = 1E-05	Background[a] (mg/kg)	Preliminary Cleanup Goal (mg/kg)
Inorganics									
Antimony	NA	NA	130	250	--	31	--	0	31
Arsenic	21	NA	19	130	6.7	22	5.7	20	20
Lead	NA	NA	621	--	--	--	--	27	400[b]
Manganese	4100	NA	NA	15000	--	2900	--	2000	2900
Mercury	NA	NA	30	170	--	23	--	0.059	23

Table 3-5. Sediment Preliminary Cleanup Goals for Resident Subsistence Farmer Scenario at FBQ (continued)

COC	EPC (mg/kg)			Risk-Based Cleanup Goal from HHRA (mg/kg)				Background[a] (mg/kg)	Preliminary Cleanup Goal (mg/kg)
				Adult		Child			
	D	SB	QP	HI = 1.0	ILCR = 1E-05	HI = 1.0	ILCR = 1E-05		
Semivolatiles									
Benz(a)anthracene	0.64	NA	NA	--	5.9	--	9.7	NA	5.9
Benzo(a)pyrene	0.53	0.11	0.52	--	0.59	--	0.97	NA	0.59
Benzo(b)fluoranthene	0.60	NA	NA	--	5.9	--	9.7	NA	5.9

[a] Final facility-wide background values for the Ravenna Army Ammunition Plant from the *Phase II Remedial Investigation Report for the Winklepeck Burning Grounds at the Ravenna Army Ammunition Plant, Ravenna, Ohio* (USACE 1999).
[b]No risk-based cleanup goals were calculated for lead. U. S. Environmental Protection Agency has defined residential soil-lead hazards as 400 ppm for play areas [40 *Code of Federal Regulations (CFR)* 745, “Lead: Identification of Dangerous Levels of Lead: Final Rule”].
-- = Toxic endpoint not evaluated for this COC.
COC = Constituent of concern.
EPC = Exposure point concentration.
HI = Hazard index.
HHRA = Human health risk assessment.
ILCR = Incremental lifetime cancer risk.
D = Ditch exposure unit.
NA = Not applicable. Not a COC at this aggregate or background criteria only apply to inorganics.
SB = Settling Basin exposure unit.
QP = Quarry Ponds exposure unit.

3.3.4.2 Surface Water Preliminary Cleanup Goals

Risk-based cleanup goals calculated in the HHRA for COCs in surface water, background concentrations for inorganics, and preliminary cleanup goals are presented for the National Guard Trainee in Table 3-6.

The estimated EPCs for both arsenic and bis(2-ethylhexyl)phthalate are less than the preliminary cleanup goals established for the National Guard Trainee.

Table 3-6. Surface Water Preliminary Cleanup Goals for National Guard Trainee Scenario at FBQ

COC	EPC (mg/L)	Risk-Based Cleanup Goal from HHRA (mg/L)		Background[a] (mg/L)	Preliminary Cleanup Goal (mg/L)
	SB	HI = 1.0	ILCR = 1E-05		
Inorganics					
Arsenic	0.0090	0.78	0.048	0.0032	0.048

Table 3-6. Surface Water Preliminary Cleanup Goals for National Guard Trainee Scenario at FBQ (continued)

COC	EPC (mg/L)	Risk-Based Cleanup Goal from HHRA (mg/L)		Background[a] (mg/L)	Preliminary Cleanup Goal (mg/L)
	SB	HI = 1.0	ILCR = 1E-05		
Semivolatiles					
bis(2-Ethylhexyl)phthalate	0.0045	0.084	0.0084	NA	0.0084

[a] Final facility-wide background values for the Ravenna Army Ammunition Plant from the P*hase II Remedial Investigation Report for the Winklepeck Burning Grounds at the Ravenna Army Ammunition Plant, Ravenna, Ohio* (USACE 1999).
COC = Constituent of concern.
EPC = Exposure point concentration.
HI = Hazard index.
HHRA = Human health risk assessment.
ILCR = Incremental lifetime cancer risk.
NA = Not applicable. Background criteria only apply to inorganics.
SB = Settling Basin exposure unit.

Risk-based cleanup goals calculated in the HHRA for COCs in surface water, background concentrations for inorganics, and preliminary cleanup goals for the Resident Subsistence Farmer are presented in Table 3-7.

Table 3-7. Surface Water Preliminary Cleanup Goals for Resident Subsistence Farmer Scenario at FBQ

COC	EPC (mg/L)		Risk-Based Cleanup Goal from HHRA (mg/L)				Background[a] (mg/L)	Preliminary Cleanup Goal (mg/L)
			Adult		Child			
	D	SB	HI = 1.0	ILCR = 1E-05	HI = 1.0	ILCR = 1E-05		
Inorganics								
Arsenic	NA	0.0090	0.17	0.0089	0.042	0.011	0.0032	0.0089
Manganese	11	NA	6.0	--	2.6	--	0.39	2.6
Semivolatiles								
bis(2-Ethylhexyl)phthalate	NA	0.0045	0.052	0.0043	0.029	0.012	NA	0.0043

[a] Final facility-wide background values for the Ravenna Army Ammunition Plant from the *Phase II Remedial Investigation Report for the Winklepeck Burning Grounds at the Ravenna Army Ammunition Plant, Ravenna, Ohio* (USACE 1999).
-- = Toxic endpoint not evaluated for this COC.
COC = Constituent of concern.
EPC = Exposure point concentration.
HI = Hazard index.
HHRA = Human Health Risk Assessment.
ILCR = Incremental lifetime cancer risk.
D = Ditch exposure unit.
NA = Not applicable. Not a COC at this aggregate or background criteria only apply to inorganics.
SB = Settling Basin exposure unit.

3.3.4.3 Groundwater Preliminary Cleanup Goals

No groundwater COCs were identified for the National Guard Trainee. Risk-based cleanup goals calculated in the HHRA for COCs in groundwater, background concentrations for inorganics, and preliminary cleanup goals for the Resident Subsistence Farmer are presented in Table 3-8.

Table 3-8. Groundwater Preliminary Cleanup Goals for Resident Subsistence Farmer Scenario at FBQ

COC	EPC (mg/L)		Risk-Based Cleanup Goal from HHRA (mg/L)				Background[a] (mg/L)		Preliminary Cleanup Goal (mg/L)	
			Adult		Child					
	BR	UC	HI = 1.0	ILCR = 1E-05	HI = 1.0	ILCR = 1E-05	BR	UC	BR	UC
Inorganics										
Manganese	4.2	6.8	1.6	--	0.46	--	1.3	1.0	1.3	1.0
Explosives										
2,4,6-Trinitrotoluene	0.0093	NA	0.018	0.028	0.0052	0.040	NA		0.0052	
2,4-Dinitrotoluene	0.00022	NA	0.072	0.0012	0.021	0.0018	NA		0.0012	
Volatiles										
Trichloroethene	0.0081	NA	1.2	0.018	0.53	0.033	NA		0.018	

[a] Final facility-wide background values for the Ravenna Army Ammunition Plant from the *Phase II Remedial Investigation Report for the Winklepeck Burning Grounds at the Ravenna Army Ammunition Plant, Ravenna, Ohio* (USACE 1999).
-- = Toxic endpoint not evaluated for this COC.
COC = Constituent of concern.
EPC = Exposure point concentration.
HI = Hazard index.
HHRA = Human health risk assessment.
ILCR = incremental lifetime cancer risk.
BR = Bedrock aquifer.
NA = Not applicable. Not a COC at this aggregate or background criteria only apply to inorganics.
UC = Unconsolidated aquifer.

The estimated EPCs for 2,4-DNT and TCE are less than the preliminary cleanup goals established for the Resident Subsistence Farmer.

3.3.5 Risk Management Considerations

3.3.5.1 Soil and Dry Sediment

For the National Guard Trainee, one dry sediment COC (manganese at the Ditch) is recommended as a COC for further evaluation. No other soil or dry sediment (Ditch and Settling Basin EUs) COCs are identified for evaluation of remedial alternatives for this receptor for the following reasons:

- All detected concentrations of arsenic in deep surface soil (0-3 ft BGS) are less than the preliminary cleanup goal established for the National Guard Trainee (Table 3-9).

- The EPC for manganese in deep surface soil (0-3 ft BGS) is less than the background and preliminary cleanup goal established for the National Guard Trainee (Table 3-9). Also, only one individual detected concentration (out of 97 total sample results) is above the preliminary cleanup goal for manganese in deep surface soil. It is unlikely that a National Guard Trainee would be exposed to concentrations at this single location over the entire exposure period for this representative receptor (936 hr/year for 25 years).

- The sediment EPC for arsenic in the Ditch is less than the preliminary cleanup goal established for this chemical. Furthermore, only one individual detected concentration (out of seven total sample results) is above the preliminary cleanup goal in Ditch sediment. It is unlikely that a National Guard Trainee would be exposed to concentrations at this single location over the entire exposure period for this representative receptor (936 hr/year for 25 years).

- The EPC for manganese at the Settling Basins is less than background and the preliminary cleanup goal. Furthermore, only one individual detected concentration (out of 16 total sample results) is above the preliminary cleanup goal for manganese at the Settling Basins. It is unlikely that a National Guard Trainee would be exposed to concentrations at this single location over the entire exposure period for this representative receptor (936 hr/year for 25 years).

For residential land use, one sediment COC (manganese at the Ditch) is recommended as a COC for further evaluation. No other soil or dry sediment (Ditch and Settling Basin EUs) COCs are identified for evaluation of remedial alternatives for residential land use for the following reasons:

- The EPCs for arsenic in shallow surface (0-1 ft BGS) and subsurface (1-3 ft BGS) soil are less than the background and preliminary cleanup goal established for the Resident Subsistence Farmer (Table 3-10). Furthermore, the ten individual detected concentrations (out of 60 total sample results) that are above the preliminary cleanup goal for arsenic are scattered throughout the shallow surface soil and the five individual detected concentrations (out of 37 total sample results) that are above the preliminary cleanup goal for arsenic are not clustered together in the subsurface soil at FBQ. Arsenic concentrations surrounding these individual locations are below preliminary cleanup goals. It is unlikely that a resident would be exposed to concentrations at individual locations over the entire exposure period (e.g., 24 hr/day for 350 days/year for 30 years for an Adult Resident Subsistence Farmer).

- Benzo(a)pyrene was detected only once in shallow surface soil (0-1 ft BGS) and the detected concentration is less than the preliminary cleanup goal for the Resident Subsistence Farmer Scenario (Table 3-10). Also, it is unlikely that a resident would be exposed to concentrations at this single location over the entire exposure period (e.g., 24 hr/day for 350 days/year for 30 years for an Adult Resident Subsistence Farmer).

- The sediment EPC for arsenic (21 mg/kg) at the Ditch just barely exceeds background (20 mg/kg); however, only one detected concentration in sediment exceeds background and arsenic is not elevated above background in the surrounding soil indicating no AOC-related source to the sediment. As noted above, it is unlikely that a resident would be exposed to concentrations at this single location over the entire exposure period.

- All detected sediment concentrations of benz(a)anthracene and benzo(b)fluoranthene are less than the preliminary cleanup goals established for these chemicals for Resident Subsistence Farmer (Table 3-10).

- The sediment EPCs for benzo(a)pyrene are less than the preliminary cleanup goal for Resident Subsistence Farmer in both the Ditch and Settling Basins (Table 3-10). Only one detected concentration (out of 7 total sample results) is above the preliminary cleanup goal for benzo(a)pyrene in the Ditch, while all individual concentrations are below the preliminary cleanup goal for benzo(a)pyrene in the Settling Basins. Also, as noted above, it is unlikely that a resident would be exposed to concentrations at this single location over the entire exposure period.

3.3.5.2 Surface Water and Wet Sediment

No surface water COCs are recommended for evaluation of remedial alternatives for the representative receptor (National Guard Trainee) because the EPCs for arsenic and bis(2-ethylhexyl)phthalate are less than the preliminary cleanup goals established for this receptor (Table 3-11). Furthermore, all individual arsenic concentrations at the Settling Basins are below its preliminary cleanup goal and only one of the ten individual concentrations for bis(2-ethylhexyl)phthalate exceeds its preliminary cleanup goal at the Settling Basins. It is unlikely that a National Guard Trainee would be exposed to concentrations at this single location over the entire exposure period (i.e., for 936 hr/year for 25 years).

For residential land use one surface water COC (manganese) is recommended for further evaluation. The surface water EPC for manganese at the Ditch exceeds the preliminary cleanup goal and manganese was detected above background in sediment from the ditch. No other surface water COCs are recommended for evaluation of remedial alternatives for the residential land use for the following reasons (Table 3-11):

- The surface water EPC for arsenic at the Settling Basins (0.0090 mg/L) just barely exceeds the preliminary cleanup goal (0.0089 mg/L); however, arsenic was detected in only one surface water sample and arsenic is not present above background in the surrounding soil or sediment at this EU indicating no AOC-related source to the surface water. Also, it is unlikely that a resident would be exposed to concentrations at this single location over the entire exposure period (e.g., 24 hr/day for 350 days/year for 30 years for an Adult Resident Subsistence Farmer).

- The surface water EPC for bis(2-ethylhexyl)phthalate at the Settling Basins (0.0045 mg/L) just barely exceeds the preliminary cleanup goal (0.0043 mg/L); however, only one detected concentration (0.011 mg/kg) exceeds the preliminary cleanup goal (other sample concentrations range from 0.0014 to 0.0037 mg/kg) and all reported detections are estimated (J qualifier) concentrations. Bis(2-ethylhexyl)phthalate is a common laboratory contaminant and was detected in a blank sample for the Settling Basins. In addition to this uncertainty in the analytical results, bis(2-ethylhexyl)phthalate was not detected in the surrounding soil (although it was detected in 2 of 16 sediment samples from this EU) indicating no AOC-related source to the surface water. As noted previously, it is unlikely that a resident would be exposed to concentrations at individual locations over the entire exposure period (e.g., 24 hr/day for 350 days/year for 30 years for an Adult Resident Subsistence Farmer).

For the representative receptor (National Guard Trainee), three wet sediment COCs (arsenic, cadmium, and hexavalent chromium) were identified for the Quarry Ponds in the HHRA. None of these metals are identified as sediment COCs for evaluation of remedial alternatives as feasibility study constituents of concern (FSCOCs) for this receptor for the following reasons (Table 3-9):

- The sediment EPCs for arsenic and cadmium are less than the preliminary cleanup goals for these metals. Only two detected concentrations (out of 17 total sample results) in the Quarry Ponds wet sediment are above the preliminary cleanup goal for arsenic. All detected concentrations of cadmium in the Quarry Ponds sediment are below its preliminary cleanup goal.

- The sediment EPC for hexavalent chromium (20 mg/kg) is slightly greater than its preliminary cleanup goal (16 mg/kg). The preliminary cleanup goal for hexavalent chromium is driven entirely by inhalation of dust exposure. The inhalation exposure scenario for the National Guard Trainee includes a very high dust loading factor to account for potential dust generation during the use of heavy equipment and is derived from a study conducted for tank movement on hard ground. Sediment at the Quarry Ponds is normally underwater and the presence of water over the sediment will greatly reduce the potential for dust generation. Further, while it is possible National Guard activities could generate significant airborne dust for short periods of time and at locations adjacent to vehicles, it is very unlikely that these activities would generate such high concentrations 24 hr/day and across the entire AOC. Because the preliminary cleanup goal for hexavalent chromium is based solely on the dust loading assumptions and the EPC only slightly exceeds this preliminary cleanup goal, hexavalent chromium is not a COC for evaluation of remedial alternatives.

For residential land use, three wet sediment COCs (antimony, lead, and mercury) are recommended as sediment COCs for evaluation of remedial alternatives. As shown in Table 3-10, the EPCs for antimony, lead, and mercury at the Quarry Ponds exceed the preliminary cleanup goals established for residential land use. These metals have been detected above background in soil at FBQ; therefore, a potential source to the Quarry Pond sediment exists. No other wet sediment COCs are identified for evaluation of alternatives for the following reasons:

- The EPC for arsenic at the Quarry Ponds is less than its preliminary cleanup goal for the Resident Subsistence Farmer. Furthermore, three individual detected concentrations (out of 17 total sample results) in the Quarry Ponds sediments are above the preliminary cleanup goal for arsenic. As noted above, it is unlikely that a resident would be exposed to concentrations at individual locations over the entire exposure period (e.g., 24 hr/day for 350 days/year for 30 years for an Adult Resident Subsistence Farmer).

- The EPC for benzo(a)pyrene at the Quarry Ponds is less than its preliminary cleanup goal for the Resident Subsistence Farmer. Furthermore, only one individual concentration (out of 17 total sample results) for benzo(a)pyrene at the Quarry Ponds is above its preliminary cleanup goal for this receptor. As noted earlier, it is unlikely that a resident would be exposed to concentrations at this single location over the entire exposure period.

3.3.5.3 Groundwater

No groundwater COCs were identified for the National Guard Trainee.

2,4,6-TNT is recommended for evaluation of remedial options because the EPC exceeds the preliminary cleanup goal and it has been detected in soil at FBQ; however, the 2,4,6-TNT detected in soil is not upgradient of the 2,4,6-TNT in groundwater. Therefore, the source to groundwater is uncertain. The EPC for manganese also exceeds the preliminary cleanup goal established for the Resident Subsistence Farmer (Table 3-12); however, manganese is not present above background in the overlying soil indicating no AOC-related source to the groundwater.

Table 3-9. Soil and Sediment COCs for Evaluation of Remedial Alternatives for National Guard Trainee Land Use at FBQ

COC[a]	Freq. of Detect	Measured Concentration (mg/kg) Avg.	Max[b]	EPC[c]	Bkg[d] (mg/kg)	Detects > Bkg[e]	Preliminary Cleanup Goal[f] (mg/kg)	Detects > Preliminary Cleanup Goal[e]	Risk Management Considerations	Rec[g]
Deep Surface Soil (0-3 ft BGS)										
Arsenic	96/97	13	27	13	15	22	31	0	All detects less than preliminary cleanup goal	NC
Manganese	97/97	578	2310	627	1450	2	1800	1	EPC less than background and preliminary cleanup goal	NC
Dry Sediment: Ditch										
Arsenic	7/7	14	33	21	20	1	31	1	EPC less than preliminary cleanup goal	NC
Manganese	7/7	1220	4100	4100	1950	2	1950	2		FSCOC
Wet Sediment: Quarry Ponds										
Arsenic	17/17	14	32	19	20	3	31	2	EPC less than background and preliminary cleanup goal	NC
Cadmium	14/17	2.8	19	19	0	14	110	0	All detects less than preliminary cleanup goal	NC
Chromium, hexavalent	13/17	15	33	20	NA	13	16	7	EPC only slightly greater than preliminary cleanup goal, which is based solely on the inhalation of dust pathway (large amounts of dust are not likely from wet sediment)	NC

Table 3-9. Soil and Sediment COCs for Evaluation of Remedial Alternatives for National Guard Trainee Land Use at FBQ (continued)

COC[a]	Freq. of Detect	Measured Concentration (mg/kg)			Bkg[d] (mg/kg)	Detects > Bkg[e]	Preliminary Cleanup Goal[f] (mg/kg)	Detects > Preliminary Cleanup Goal[e]	Risk Management Considerations	Rec[g]
		Avg.	Max[b]	EPC[c]						
Dry Sediment: Settling Basins										
Manganese	16/16	377	2560	646	1950	1	1950	1	EPC less than background/preliminary cleanup goal	NC

[a]Constituent of concern (COC) identified in the Human Health Risk Assessment (HHRA).
[b]Maximum detected concentration.
[c]Exposure point concentration (EPC) is 95% upper confidence limit (UCL) of the mean or maximum detected concentration depending on number of samples and data distribution.
[d] Final facility-wide background values for the Ravenna Army Ammunition Plant from the *Phase II Remedial Investigation Report for the Winklepeck Burning Grounds at the Ravenna Army Ammunition Plant, Ravenna, Ohio* (USACE 1999). Chemicals not detected in background are assigned a value of 0.
[e]Number of detected concentrations exceeding the background criterion or preliminary cleanup goal. Figure 2-4 displays all of these soil and sediment locations.
One deep surface soil sample (FBQso-002 at a depth of 0 to 1 ft) had manganese detected (2310 mg/kg) above its preliminary cleanup goal of 1800 mg/kg.
One dry sediment sample in the Ditch aggregate (FBQsd-143) had arsenic detected (33.3 mg/kg) above its preliminary cleanup goal of 31 mg/kg.
For dry sediment in the Ditch aggregate, the following locations had manganese detected at concentrations above its preliminary cleanup goal of 1950 mg/kg: FBQsd-141 (4100 mg/kg) and FBQsd-142 (2180 mg/kg).
For wet sediment in the Quarry Ponds aggregate, the following locations had arsenic detected at concentrations above its preliminary cleanup goal of 31 mg/kg: FBQsd-156 (32.4 mg/kg) and FBQsd-155 (31.3 mg/kg).
For wet sediment in the Quarry Ponds aggregate, seven locations had hexavalent chromium detected at concentrations above its preliminary cleanup goal of 16 mg/kg: FBQsd-148 (33 mg/kg); FBQsd-144(30 mg/kg); FBQsd-152 (30 mg/kg); FBQsd-153 (26 mg/kg); FBQsd-150 (25 mg/kg); FBQsd-154 (23 mg/kg); and FBQsd-151 (18 mg/kg).
One dry sediment in the Settling Basins aggregate (FBQsd-126) had manganese detected (2560 mg/kg) above its preliminary cleanup goal of 1950 mg/kg.
[f]Preliminary cleanup goal from Tables 3-2 and 3-3.
[g]Recommendation for COCs for evaluation of remedial alternatives.
Detects = Detectable concentrations.
FSCOC = COC for evaluation of remedial alternatives.
NA = Not available.
NC = Not recommended as a COC for remedial alternative evaluation.

Table 3-10. Soil and Sediment COCs for Evaluation of Remedial Alternatives for Resident Subsistence Farmer Land Use at FBQ

COC[a]	Freq. of Detect	Measured Concentration (mg/kg) Avg.	Max[b]	EPC[c]	Bkg[d] (mg/kg)	Detects > Bkg[e]	Preliminary Cleanup Goal[f] (mg/kg)	Detects > Preliminary Cleanup Goal[e]	Risk Management Considerations	Rec[g]
Shallow Surface Soil (0-1 ft BGS)										
Arsenic	60/60	11	27	12	15	9	15	9	EPC less than background/preliminary cleanup goal	NC
Benzo(a)pyrene	1/8	0.19	0.084	0.084	NA	NA	0.59	0	All detects less than preliminary cleanup goal	NC
Subsurface Soil (1-3 ft BGS)										
Arsenic	36/37	15	25	16	20	5	20	5	EPC less than background/preliminary cleanup goal	NC
Dry Sediment: Ditch										
Arsenic	7/7	14	33	21	20	1	20	1	EPC very similar to background, only 1 detected concentration exceeds background	NC
Manganese	7/7	1220	4100	4100	1950	2	2900	1		FSCOC
Benz(a)anthracene	2/7	0.41	1.1	0.64	NA	NA	5.9	0	All detects less than preliminary cleanup goal	NC
Benzo(a)pyrene	2/7	0.37	0.84	0.53	NA	NA	0.59	1	EPC less than preliminary cleanup goal	NC
Benzo(b)fluoranthene	2/7	0.40	0.98	0.60	NA	NA	5.9	0	All detects less than preliminary cleanup goal	NC
Wet Sediment: Quarry Ponds										
Antimony	14/17	18	128	128	0	14	31	3	Detected in soil above background	FSCOC
Arsenic	17/17	14	32	19	20	3	20	3	EPC less than background/preliminary cleanup goal	NC
Lead	17/17	385	1490	621	27	13	400	5		FSCOC
Mercury	17/17	3.7	35	30	0.059	17	23	1	Detected in soil above background	FSCOC
Benzo(a)pyrene	5/17	0.34	2	0.52	NA	NA	0.59	1	EPC less than preliminary cleanup goal	NC

Table 3-10. Soil and Sediment COCs for Evaluation of Remedial Alternatives for Resident Subsistence Farmer Land Use at FBQ (continued)

COC[a]	Freq. of Detect	Measured Concentration (mg/kg) Avg.	Max[b]	EPC[c]	Bkg[d] (mg/kg)	Detects > Bkg[e]	Preliminary Cleanup Goal[f] (mg/kg)	Detects > Preliminary Cleanup Goal[e]	Risk Management Considerations	Rec[g]
Dry Sediment: Settling Basins										
Benzo(a)pyrene	9/16	0.18	0.11	0.11	NA	NA	0.59	0	All detects less than preliminary cleanup goal	NC

[a]Constituent of concern (COC) identified in the Human Health Risk Assessment (HHRA).

[b]Maximum detected concentration.

[c]Exposure point concentration (EPC) is 95% upper confidence limit (UCL) of the mean or maximum detected concentration depending on number of samples and data distribution.

[d] Final facility-wide background values for the Ravenna Army Ammunition Plant from the *Phase II Remedial Investigation Report for the Winklepeck Burning Grounds at the Ravenna Army Ammunition Plant, Ravenna, Ohio* (USACE 1999). Chemicals not detected in background are assigned a value of 0.

[e]Number of detected concentrations exceeding the background criterion or preliminary cleanup goal. Figure 2-4 displays all of these soil and sediment locations.

For shallow surface soil, ten locations had arsenic detected above its preliminary cleanup goal of 15 mg/kg: FBQss-044 (27.1 mg/kg); FBQss-006 (18.1 mg/kg); FBQss-048 (18 mg/kg); FBQss-019 (17.8 mg/kg); FBQss-001 (17.6 mg/kg); FBQss-033 (17.4 mg/kg); FBQss-011 (16.8 mg/kg); FBQss-056 (16.4 mg/kg); and FBQss-057 (16.2 mg/kg).

For subsurface soil, five locations had arsenic detected above its preliminary cleanup goal of 20 mg/kg: FBQso-026 (24.6 mg/kg); FBQso-019 (24.3 mg/kg); FBQso-032 (24.2 mg/kg); FBQso-051 (21 mg/kg); and FBQso-017 (20.3 mg/kg).

One dry sediment sample in the Ditch aggregate (FBQsd-143) had arsenic detected (33.3 mg/kg) above its preliminary cleanup goal of 20 mg/kg.

One dry sediment sample in the Ditch aggregate (FBQsd-141) had manganese detected (4100 mg/kg) above its preliminary cleanup goal of 2900 mg/kg.

One dry sediment sample in the Ditch aggregate (FBQsd-163) had benzo(a)pyrene detected (0.84 mg/kg) above its preliminary cleanup goal of 0.59 mg/kg.

For sediment in the Quarry Ponds aggregate, three locations had antimony detected at concentrations above its preliminary cleanup goal of 31 mg/kg: FBQsd-146 (128 mg/kg); FBQsd-156 (48.7 mg/kg); and FBQsd-155 (40.9 mg/kg).

For wet sediment in the Quarry Ponds aggregate, three locations had arsenic detected at concentrations above its preliminary cleanup goal of 20 mg/kg: FBQsd-143 (33.3 mg/kg); FBQsd-156 (32.4 mg/kg); and FBQsd-155 (31.3 mg/kg).

For sediment in the Quarry Ponds aggregate, five locations had lead detected at concentrations above its preliminary cleanup goal of 400 mg/kg: FBQsd-148 (1,490 mg/kg); FBQsd-155 (1,430 mg/kg); FBQsd-146 (1,300 mg/kg), FBQsd-158 (1,060 mg/kg), and FBQsd-156 (572 mg/kg).

One wet sediment in the Quarry Ponds aggregate (FBQsd-146) had mercury detected (35 mg/kg) above its preliminary cleanup goal of 23 mg/kg.

One wet sediment in the Quarry Ponds aggregate (FBQsd-148) had benzo(a)pyrene detected (2 mg/kg) above its preliminary cleanup goal of 0.59 mg/kg.

[f]Preliminary cleanup goal from Tables 3-4 and 3-5.

[g]Recommendation for COCs for evaluation of remedial alternatives.

Detects = Detectable concentrations.

FSCOC = COC for evaluation of remedial alternatives.

NA = Not applicable. Background criteria are used only for naturally occurring inorganic constituents.

NC = Not recommended as a COC for remedial alternative evaluation.

Table 3-11. Surface Water COCs for Evaluation of Remedial Alternatives for National Guard Trainee Land Use at FBQ

COC[a]	Freq. of Detect	Measured Concentration (mg/kg) Avg.	Max[b]	EPC[c]	Bkg[d] (mg/kg)	Detects > Bkg[e]	Preliminary Cleanup Goal[f] (mg/kg)	Detects > Preliminary Cleanup Goal[e]	Risk Management Considerations	Rec[g]
Surface Water: Settling Basins										
Arsenic	1/10	0.0060	0.020	0.0090	0.0032	1	0.048	0	EPC less than preliminary cleanup goal	NC
Bis(2-ethylhexyl)phthalate	9/10	0.0028	0.011	0.0045	NA	NA	0.0084	1	EPC less than preliminary cleanup goal	NC

[a]Constituent of concern (COC) identified in the Human Health Risk Assessment (HHRA).
[b]Maximum detected concentration.
[c]Exposure point concentration (EPC) is 95% upper confidence limit (UCL) of the mean or maximum detected concentration depending on number of samples and data distribution.
[d] Final facility-wide background values for the Ravenna Army Ammunition Plant from the *Phase II Remedial Investigation Report for the Winklepeck Burning Grounds at the Ravenna Army Ammunition Plant, Ravenna, Ohio* (USACE 1999). Chemicals not detected in background are assigned a value of 0.
[e]Number of detected concentrations exceeding the background criterion or preliminary cleanup goal.
[f]Preliminary cleanup goal from Table 3-6.
[g]Recommendation for COCs for evaluation of remedial alternatives.
Detects = Detectable concentrations
NA = Not available.
NC = Not recommended as a COC for remedial alternative evaluation.

Table 3-12. Surface Water and Groundwater COCs for Evaluation of Remedial Alternatives for Resident Subsistence Farmer Land Use at FBQ

COC[a]	Freq. of Detect	Measured Concentration (mg/L) Avg.	Max[b]	EPC[c]	Bkg[d] (mg/L)	Detects > Bkg[e]	Preliminary Cleanup Goal[f] (mg/L)	Detects > Preliminary Cleanup Goal[e]	Risk Management Considerations	Rec[g]
Surface Water: Ditch										
Manganese	1/1	11	11	11	0.39	1	2.6	1	Detected in Ditch sediment above background	FSCOC
Surface Water: Settling Basins										
Arsenic	1/10	0.0060	0.020	0.0090	0.0032	1	0.0089	1	EPC approximately equals preliminary cleanup goal and no AOC-related source from soil/sediment	NC
Bis(2-ethylhexyl)phthalate	9/10	0.0028	0.011	0.0045	NA	NA	0.0043	1	EPC approximately equals preliminary cleanup goal and no AOC-related source from soil/sediment	NC
Groundwater: Bedrock										
Manganese	6/6	1.0	4.2	4.2	1.0	2	1.0	2	No AOC-related source from soil	NC
2,4,6-Trinitrotoluene	2/6	0.0034	0.018	0.0093	NA	NA	0.0052	1	Detected in soil	FSCOC
2,4-Dinitrotoluene	1/6	0.00016	0.00031	0.00022	NA	NA	0.0012	0	EPC less than preliminary cleanup goal	NC
Trichloroethene	2/6	0.0049	0.012	0.0081	NA	NA	0.018	0	EPC less than preliminary cleanup goal	NC
Groundwater: Unconsolidated										
Manganese	6/6	2.1	6.8	6.8	1.0	4	1.0	4	No AOC-related source from soil	NC

[a]Constituent of concern (COC) identified in the Human Health Risk Assessment (HHRA).
[b]Maximum detected concentration.
[c]Exposure point concentration (EPC) is 95% upper confidence limit (UCL) of the mean or maximum detected concentration depending on number of samples and data distribution.
[d] Final facility-wide background values for the Ravenna Army Ammunition Plant from the *Phase II Remedial Investigation Report for the Winklepeck Burning Grounds at the Ravenna Army Ammunition Plant, Ravenna, Ohio* (USACE 1999). Chemicals not detected in background are assigned a value of 0.
[e]Number of detected concentrations exceeding the background criterion or preliminary cleanup goal.
[f]Preliminary cleanup goal from Tables 3-7 and 3-8.
[g]Recommendation for COCs for evaluation of remedial alternatives.
Detects = Detectable concentrations
FSCOC = COC for evaluation of remedial alternatives.
NA = Not available.
NC = Not recommended as a COC for remedial alternative evaluation.

3.3.5.4 Summary of COCs for Evaluation of Remedial Alternatives

A summary of COCs for evaluation of remedial alternatives is provided in Table 3-13 for all media.

Table 3-13. Summary of COCs for Evaluation of Remedial Alternatives

Exposure Medium	COC for Evaluation of Remedial Alternatives	
	Representative Receptor (Restricted Land Use)	**Residential Receptor (Residential Land Use)**
Soil	None	None
Sediment		
Main Ditch	Manganese	Manganese
Quarry Ponds	None	Antimony, Lead, Mercury
Settling Basins	None	None
Surface Water		
Main Ditch	None	Manganese
Quarry Ponds	None	None
Settling Basins	None	None
Groundwater		
Bedrock	NA	2,4,6-Trinitrotoluene
Unconsolidated	NA	None

NA = Not applicable – receptor not exposed to this medium.
COC = Constituent of concern.

A summary of the preliminary cleanup goals for the COCs identified for evaluation of remedial alternatives is provided in Table 3-14 for the representative receptor (National Guard Trainee) and residential land use.

Table 3-14. Summary of COCs and Preliminary Cleanup Goals for Evaluation of Remedial Alternatives for FBQ

COC	Soil Preliminary Cleanup Goal (mg/kg)	Sediment Preliminary Cleanup Goal[a] (mg/kg)	Surface Water Preliminary Cleanup Goal (mg/L)	Groundwater Preliminary Cleanup Goal (mg/L)
Representative Land Use (Mounted Training, no digging – National Guard Trainee)				
Manganese	--	1950	--	--
Residential Land Use (Resident Subsistence Farmer)				
Antimony	--	31[b]	--	--
Lead	--	400[b]	--	--
Manganese	--	2900	1.0	--
Mercury	--	23[b]	--	--
2,4,6-Trinitrotoluene	--	--	--	0.0052

[a]Preliminary cleanup goals are the same for wet and dry sediments.
[b]COC at Quarry Ponds. Sediment is wet at this exposure unit (EU).
-- = Chemical is not a COC for evaluation of remedial alternatives for this medium.
COC = Constituent of concern.

3.4 ECOLOGICAL PROTECTION

The ERA performed for FBQ is available in the RI Report and summarized in Chapter 2 of this FS. Ohio EPA Levels I and II were performed for FBQ and show a number of exceedances of observed concentrations compared to ESVs. The ERA in the RI Report identifies a variety of ecological receptor populations that could be at risk and identifies the COPECs and COECs that could contribute to potential risks from exposure to contaminated media.

The ERA for FBQ also reported the ecological field work conducted at the AOC: ecological reconnaissance of existing vegetation and animal life. These findings were published in the RI Report and are summarized in Section 3.4.2.1 of this FS. A facility-wide biology and surface water study provided further information for consideration at FBQ. This information has been published in a separate report (USACE 2005a) and summarized in the RI Report (a short summary is included in Section 3.4.2.1 of this FS). All the studies document the presence of healthy and functioning terrestrial and aquatic ecosystems.

The risk assessment predictions (e.g., HQs) and field observations were combined in a weight-of-evidence assessment. This combination of information shows that (1) while ESV exceedance and HQs being greater than 1 suggest risk to plants and selected animals at FBQ, and (2) the field observations reveal the ecological system with the plants and animals is functioning well and organisms appear to be healthy. Further, where surface water is involved, the use attainments are being met per Ohio guidance. Because of the combined finding that ecological systems are healthy as well as other reasons; no ecological preliminary cleanup goals are recommended and no remediation for ecological risks is justified at FBQ. The rationale for this is explained in detail below.

3.4.1 Ecological Preliminary Cleanup Goals for FBQ

It is recommended that no quantitative preliminary cleanup goals to protect ecological receptors be developed at FBQ. This recommendation comes from applying steps in the Facility-Wide Ecological Risk Work Plan (USACE 2003a) and specifically steps in Figure III to reach a Scientific Management Decision Point (SMDP) that few ecological resources are at risk. This recommendation is based principally on the following weight-of-evidence conclusions:

1. Field observations (Level I of Ohio EPA protocol) indicate there are currently few adverse ecological effects (USACE 2005a), and there is ample nearby habitat to maintain ecological communities at FBQ and elsewhere on RVAAP. These observations imply that remediation to protect ecological resources is not necessary.

2. The extent of soil contamination is very limited and is not expected to impact ecological resources such as populations and communities.

3. A few adverse ecological effects from military training activities, (e.g., mounted training and no digging) may occur; for example, tank trails and brush-hogging can reduce the vegetation. Any remediation of habitat would tend to be re-disturbed by repeated military training activities and, thus, reduce the benefits of any remediation.

4. Potential remediation to meet human health preliminary cleanup goals would reduce overall contaminant concentrations.

5. Additional removal of sediment or soil to further reduce any adverse ecological effects would destroy habitat without substantial benefit to the ecological resources at FBQ.

Stewardship of the environment will be a major consideration in the phases of planning, design, and implementation of the military mission of National Guard training. Presently, ecological risk is possible based on the risk assessment that used exposure scenarios considered to be protective of the ecological receptors at FBQ. However, biological measurements (healthy aquatic ecosystem) at the ponds at FBQ corroborate the likely low ecological risk. Potential removal of soil or sediment to achieve human health preliminary cleanup goals would reduce the overall concentration of some contaminants and would have the effect of lowering the already low ecological exposure and risk. Some habitat alteration by training exercises (dismounted training and no digging) may occur and result in vegetation cut-back and/or removal by the actions of tank trails and brush hogging (simpler or different habitat), shorter food chains in those patches (simpler ecosystem), and lower exposure (fewer organisms).

However, these few changes would be minor compared to the existing habitat disturbances. These predictions and observations, along with the relatively low concentrations of various COECs, make a case for no remediation recommended for ecological resources at FBQ.

3.4.2 Ecological Cleanup Goal Development Weight of Evidence

Ohio EPA guidance (Ohio EPA 2003) allows decisions regarding the need for remediation to be made at the completion of each level of the ERA process. The remedial alternatives evaluation process includes the development of ecological cleanup goals or COPEC concentrations used to define areas where remediation is needed to achieve protectiveness for ecological resources. A decision whether it is necessary to remediate because of potential harm to ecological receptors and whether it is necessary to set ecological cleanup goals for ecological receptors at FBQ is not included in the Phase II Report. The following weight-of-evidence discussions provide input for that decision.

This section provides a rationale for why remediation for protection of ecological receptors, and the associated development of quantitative preliminary cleanup goals, is not warranted for ecological risks at this time. The rationale has the following elements:

- Onsite and near-site field studies show a healthy terrestrial and aquatic ecosystem at the ponds (Level I of the Ohio EPA protocol) and studies (Facility-Wide Biological and Water Quality Study) despite the identification of COPECs.

- Land use at the AOC (military training) may alter ecological habitats, and the military mission overrides the results of the HQ and field-truthing study.

- No unique ecological resources are found at FBQ, and nearby habitat offers home ranges for wildlife to escape from military land use activities.

- The extent of soil contamination is very limited and; therefore, is not expected to impact ecological resources such as populations and communities.

- Significant contaminant migration is not expected to occur from soil to nearby aquatic environments.

- Mitigations are of two types (chemical and physical) where removal of impacted soils/dry sediment (i.e., chemical) would lower exposure and ecological risk, and physical alteration such as vegetation removal is a trade-off.

- Protection of ecological resources would be provided automatically as a benefit of any human health-driven remediation activities at FBQ.

Table 7-1 provides more information about this dual protectiveness of human health and ecological resources. Each of these elements is explained below regarding the need for ecological preliminary cleanup goals or remediation to protect ecological receptors and a recommendation follows.

3.4.2.1 <u>Ecological Reconnaissance and USEPA/USACE Biology and Surface Water Study Show Functioning Ecological System</u>

Level IV of the ERA process (Ohio EPA 2003) is an evaluation of exposures and any observable adverse ecological effects at the AOC. Observation of a healthy ecological community can mitigate the conclusions resulting from risk calculations based on theoretical exposure models. Although a Level IV risk assessment was not done, some field observations have been made at FBQ. These observations indicate that despite the presence of COPECs, little adverse ecological effect has occurred at the AOC.

Ecological Reconnaissance

Descriptions of vegetation and animals found at FBQ are detailed in the RI Report (USACE 2005b). Vegetation consists of many old-field communities with corridors and small and large patches of forest vegetation. Animals consist of soil invertebrates, many species of insects, mammals, and birds. However, no known threatened or endangered species or unique natural resources are present at FBQ; substantiation of this is provided in Chapter 7 (ERA - Natural Resources) of the RI Report for FBQ. Therefore, National Guard training would be carried out in an environment in which the impact would be limited to “normal” ecological resources.

The three quarry ponds totaling 2.9 acres are the primary aquatic habitats at FBQ. Two small drainages totaling 0.5 acres are located in the central portion of FBQ. Eleven small settling basins totaling 1.23 acres are located in the southwest portion of FBQ. The settling basins are generally dry except during precipitation events.

USEPA/USACE Biology and Surface Water Study

The three Quarry Ponds represent a dominant portion of the aquatic resources of FBQ. Aquatic life, including fish, have been documented in one or more ponds as noted in the facility-wide biology and surface water study (USACE 2005f).

Habitat evaluations rated the ponds as fair, although aquatic vegetation is sparse along much of the shoreline because of steep slopes (USACE 2005f). The macroinvertebrate community is similar to reference sites, although the community is less abundant and diverse along the shoreline due to the sparse vegetation. Fish community results are similar to reference sites and include three species. Surface water quality, although water quality standards, above does not appear to impact the biological community. Sediment sampling results indicated moderate contamination, with lead and zinc measured above the Probable Effect Concentration. While surface water and sediment chemical levels are above respective thresholds, other biological indicators and summaries indicate lack of adverse impact to the fish and other biological communities.

3.4.2.2 <u>Intensive and Potentially Extensive Habitat Alteration Anticipated</u>

At FBQ, potential habitat disturbance because of National Guard mounted training and no digging activities may occur at any one acre (i.e., size of home range of small wildlife species). Some small areas at the FBQ may be cleared of vegetation; stress to vegetation already exists at FBQ (i.e., FBQ is a previously disturbed area). Thus, any additional disturbance of vegetation would not necessarily add more stress. Additionally, environmental stewardship and sustainable resource practices are implemented to ensure that the lands and natural resources are maintained properly to be available for future training activities. Other places may have soil compaction and potentially disturbed vegetation, but there is already stress of that type too. Minor impacts on surface soil (0-1 ft BGS) may involve small petroleum, oil, and lubricant (POL) leaks and exhaust from vehicles. Tracked and wheeled operations could result in maneuver damage up to 4 ft BGS. Subsurface disturbance activities are not planned; digging and occupying fighting positions that extend below ground will be prohibited. Thus, any habitat disturbance at FBQ would be limited.

The amount of minor future potential habitat disturbance is not known at this time and therefore, a scenario has been developed to predict what could happen. It is assumed that up to 50% (worst case scenario) of the area may be disturbed. Mostly, the vegetation may potentially be disturbed, while the soil would be disturbed to a lesser extent. FBQ consists of about 45 acres of habitat. Thus, the potential disturbance area could be up to 23 acres. The potential acreage to be disturbed is small compared to the total facility acreage. For example, FBQ is part of a facility that is approximately 22,000 acres; therefore, this area represents 45 acres out of 22,000 acres or approximately 0.2% of the total area. Potential disturbance to this small area would be insignificant to ecological function and sustainability.

Any potential habitat disturbance from military training may involve only a few acres within thousands of acres of adjacent habitats at RVAAP. For example, most of FBQ (about 45 acres) consists of old field and cutover forest communities including patches of trees (see next Section 3.4.2.3 on nearby habitats). There are many hundreds of acres of these types of habitats at RVAAP. The other habitats at FBQ are also part of the great diversity of habitat types near FBQ and across thousands of acres at RVAAP.

The impacts to habitat at FBQ would be minimal due to an already disturbed habitat, the diversity of habitat in adjacent areas and elsewhere on the facility, and the continuation of environmental stewardship.

3.4.2.3 Nearby Habitats Offer Home Ranges to Wildlife

As stated above, ecological resources are "normal", and nearby, terrestrial and aquatic habitats are available to receive wildlife that leaves the training area. Some vegetation, especially bushes and old-field vegetation, as well as some trees, may be removed from within FBQ. Old-field vegetation could be mowed or cleared in another way. Wildlife may be disturbed by the movement and noise of training equipment as well as trainees. Wildlife can leave and enter adjacent old fields and forest patches and vegetative corridors. As implied earlier, RVAAP has thousands of acres of habitat like that at FBQ, and wildlife can find new home ranges there; therefore, any lack of protection as a result of not developing or applying ecological preliminary cleanup goals would be minimal because sufficient reservoirs of habitat and wildlife exist to maintain RVAAP -wide ecological communities.

Wildlife and water fowl have alternative ponds and other water resources.

3.4.2.4 Limited Extent of Soil Contamination

Because COPECs are determined based on comparisons of MDCs versus ESVs (as opposed to EPCs versus ESVs) and because the medium-specific ESVs are intended to protect sensitive, multiple receptors, some of which may not be present at FBQ, the identification of COPECs is considered to be a conservative screening process and COPEC concentrations are not necessarily at harmful levels. COPEC concentrations are usually based on the maximum, but the average concentration can also be used in screening comparisons to ESVs and other toxicological thresholds according to the Facility-Wide Ecological Risk Work Plan.

For example, of the 21 inorganic COPECs in surface soil (0-1 ft BGS) (Table 3-15):

- Four COPECs (calcium, magnesium, potassium, and sodium) do not have ESVs and are generally only toxic at very high concentrations;

- Six COPECs have EPCs < background criteria, and another eight have EPCs < three times the background criteria;

- The EPC for antimony is four times background; and

- Cadmium and hexavalent chromium do not have background criteria.

Table 3-15. COPECs in Surface Soil (0-1 ft BGS) at FBQ Compared to Background and ESV

COPEC	Freq of Detect	Average Result (mg/kg)	Maximum Detect (mg/kg)	EPC (mg/kg)	Bkg (mg/kg)	Number of Detects > BKG	ESV (mg/kg)	Number of Detects > ESV
Inorganics								
Aluminum	60/60	10900	17200	11800	17700	0	600	60
Antimony	15/60	2.0	74	4.1	0.96	14	5	2
Arsenic	60/60	11	27	12	15	9	9.9	40
Barium	60/60	87	1070	116	88	11	283	2
Cadmium	31/60	0.22	4	0.34	0	31	4	0
Chromium	60/60	18	89	20	17	19	0.40	60
Chromium, hexavalent	7/8	3.7	6.8	6.8	NA	NA	0.40	7
Cobalt	60/60	11	37	12	10	27	20	1
Copper	60/60	26	559	41	18	25	14	32
Iron	60/60	25900	110000	28700	23100	35	200	60
Lead	60/60	57	887	83	26	20	41	16
Manganese	60/60	657	2310	738	1450	2	100	60
Mercury	12/60	0.063	1.2	0.10	0.040	12	0.0005	12
Nickel	60/60	18	85	21	21	8	30	4
Selenium	34/60	1.2	7.9	1.4	1.4	17	0.21	34
Vanadium	60/60	21	36	22	31	1	2	60
Zinc	60/60	99	1330	136	62	35	8.5	60
Organics-Explosives								
1,3,5-Trinitrobenzene	6/60	0.09	1.7	0.14	NA	NA	0.86	1
2,4,6-Trinitrotoluene	11/60	1.9	99	4.6	NA	NA	71	1
Organics-Pesticide/PCB								
4,4'-DDE	2/8	0.00085	0.00037	0.00037	NA	NA	0.60	0
Organics-Semivolatile								
Benz(a)anthracene	1/8	0.21	0.19	0.19	NA	NA	5.2	0
Benzo(a)pyrene	1/8	0.19	0.084	0.084	NA	NA	1.5	0
Benzo(b)fluoranthene	1/8	0.22	0.26	0.23	NA	NA	60	0
Benzo(k)fluoranthene	1/8	0.19	0.085	0.085	NA	NA	148	0
Chrysene	1/8	0.23	0.37	0.27	NA	NA	4.7	0
Di-n-butyl phthalate	1/5	0.22	0.24	0.23	NA	NA	200	0
Fluoranthene	2/8	0.27	0.87	0.44	NA	NA	122	0
Pyrene	1/8	0.26	0.64	0.37	NA	NA	79	0
Organics-Volatile								
Carbon disulfide	1/8	0.011	0.069	0.027	NA	NA	0.094	0

Bkg = Background criteria.
COPEC = Constituent of potential ecological concern.
Detects = Detectable concentrations.
EPC = Exposure point concentration.
ESV = Ecological screening value.
PCB = Polychlorinated biphenyl.
DDE = Dichlorodiphenyldichloroethylene.

Thus the inorganic COPECs are not highly elevated above background and such a small factor is assumed to mean low exposure and low risk. Even though a few COPECs show a concentration greater than 3 times background criteria or do not have background criteria, ecological reconnaissance at the AOC shows a healthy and functioning terrestrial ecosystem. Furthermore, while the preliminary cleanup goals for 12 inorganic COPECs exceed the ESVs, the background criteria for 10 of these inorganics is also greater than the ESVs.

For the 15 organic COPECs in surface soil (0-1 ft BGS):

- Three explosives have no ESV;
- Ten (one pesticide, eight SVOCs, one VOC) have no detected concentrations (in eight samples) that exceed ESVs; and
- Two explosives have only one detected concentration (in 60 samples) that exceeds the ESV.

These results indicate that the extent of contamination is very limited and; therefore, is not expected to impact ecological resources such as populations and communities. Results for subsurface soil (1-3 ft BGS) are similar.

3.4.2.5 No to Low Contaminant Migration

The facility-wide surface water sampling and assessment revealed that, in general, surface water quality in the streams at RVAAP was good to excellent with few exceedances of Ohio Water Quality Standards criteria. Intact riparian buffers around the streams contributed to good habitat and absence of substantial silt deposits. Evidence suggests that an additional remedial investigation effort, on an installation-wide basis, of the streams included in that report is not warranted. Contamination is not currently present in the sediments in the sampled reaches, and the surface water appears to be similarly free of contaminants. However, this does not preclude investigating surface water and sediment on an individual basis as required by Ohio EPA.

At FBQ, offsite migration is not possible from the upper two ponds because the ponds have no exit drainage. Offsite migration is possible from the lower pond via a siphon and drainage ditch to habitat west and downgradient of the ponds. It is possible any contamination could migrate offsite and, indeed, there was limited ecological risk identified in the SERA west of the ponds.

Onsite contaminant migration is anticipated to be minimal. AOC conditions (slope, soil type, and plant cover) are only slightly conducive to erosion. Also, there is no indication that organic compounds in soil are presently leaching to surface water and sediment in the pond, and this may apply to inorganics as well. There has been little migration from surface soil to subsurface soil. The AOC conditions are unlikely to change in a way that would lead to increases in surface water or sediment concentrations as a result of erosion or leaching from the soil. Accordingly, future conditions are unlikely to pose an increase in exposure and risk to aquatic ecological receptors.

3.4.2.6 Mitigation Trade-Off of Reducing Chemical Risk but Harming Environment

There is a trade-off of two kinds of risk: physical alterations and residual contamination. The localized ecosystem either can have clean soil because of removal and replacement but have a highly disturbed habitat as a result, or it can have exposure to contaminants in the soil in a habitat that is minimally disturbed. In some cases, it can be appropriate to allow plants and animals low in the food chain to be exposed to potentially toxic concentrations, sparing important habitat, if animals higher in the food chain (especially top carnivores) are not receiving toxic exposures. In other cases, especially when human health is threatened, it is necessary to alter or destroy habitat to prevent exposure to soil contaminants (Suter et al. 1995).

The military mission requires activities at FBQ that could alter some habitat and could create some intermittent noise. Wildlife is expected to respond by moving away from the noise and likely returning to their cover and food when the noise abates.

There may be little benefit to removing contaminated soil or sediment because COPEC concentrations are not necessarily at harmful levels as described previously. For example, of the 16 COPECs in surface soil (0-1 ft BGS) (Table 3-15), 6 have average concentrations below background criteria, and only cadmium and lead have concentrations above twice the background criteria. Thus, concentrations are not likely to be an exposure and risk issue.

3.4.2.7 Mitigation of Ecological Risk with Any Human-health Based Remediation

Potential remedial actions at FBQ to reduce sediment concentrations of COCs below preliminary cleanup goals for human health (Section 3.3) would also result in a decrease in ecological risk. Any sediment removal would decrease the concentrations of COPECs and reduce the number of COPECs in sediment to which ecological receptors are exposed, thereby reducing ecological risk. Any sediment that is replaced because the concentration of human COCs were above preliminary cleanup goals would no longer have elevated concentrations of any COPECs, reducing risk to ecological receptors from the COPECs. Removal of impacted sediment triggered by human health preliminary cleanup goals it would directly reduce the contaminant concentrations to which ecological receptors are exposed regardless of potential ecological preliminary cleanup goals. When a human health cleanup goal is chosen it offers dual protectiveness to human health and ecological resources after any habitat disturbance has been reversed through ecological succession or environmental management.

In conclusion, sediment or soil removals at FBQ are possible. The motive would be to apply human health preliminary cleanup goals to protect receptors associated with anticipated future land use (i.e., the National Guard Trainee). These removals would consequently reduce exposure and risk to any remaining ecological organisms at FBQ.

3.5 FATE AND TRANSPORT ASSESSMENT OF COCS IN SOILS

Impacted soils at FBQ also were evaluated to assess their potential to impact groundwater both at the AOC (residential land use exposure scenario) and at an exposure point downgradient of the AOC (National Guard Trainee land use exposure scenario) to ensure residual concentrations in soils are protective of groundwater under both potential land use exposure scenarios. The process for identifying soil constituents potentially impacting groundwater is detailed in Appendix 3A and summarized below:

- Assessment started with the soils CMCOPCs and CMCOCs identified in the fate and transport evaluation conducted in the RI.

- Constituents were assessed across media using AOC-specific analytical data and background information to refine the list of soils CMCOPCs and CMCOCs.

- Constituents evaluated further if necessary using a refined version of the modeling performed in RIs. The refinements include updated source areas, updated source concentrations, and an updated depth to the water table (averaged over the new source areas) to further define potential for impacted soils to leach to groundwater.

3.5.1 Refined Soil Contributions to Groundwater Assessment

Based on the results of the Phase I/Phase II RI for FBQ, six constituents were evaluated for potential impacts in groundwater beneath the source and all except for selenium were evaluated for potential impacts to groundwater at downgradient receptors. Upon further analysis, none of these constituents were predicted or identified to impact groundwater at the AOC or downgradient of the AOC, as summarized below.

- Chromium (total) is removed from further consideration of future groundwater impacts at FBQ because the source concentration is less than subsurface soil background, there is no pattern of detections indicative of migration, and observed groundwater and surface water results are below the MCL. The source concentration (25.9 mg/L - less than subsurface background) results in predicted groundwater impact beneath the AOC roughly 76 times greater than observed concentrations in groundwater due to the nature of the modeling, which included conservative assumptions (constant source, no degradation/attenuation of contamination). If background concentrations in soils produced predicted groundwater concentrations, then actual observed concentrations in groundwater should be similar to predicted modeling results.

- Manganese is removed from further consideration of future groundwater impacts at FBQ because there only 2 of 97 exceedances of background; the soil EPC is less than subsurface soil background; and observed groundwater results are at or below background.

- 2,4,6-TNT is removed from further consideration of future groundwater impacts at FBQ, because detections were limited to surface soils (0-1 ft BGS) and modeling indicates no leaching to groundwater.

- SESOIL source load modeling in the RI identified RDX as a CMCOPC with maximum impact predicted in 7 years. Given the history of the AOC, the maximum impact has likely previously occurred. RDX is removed from further consideration of future groundwater impacts at FBQ because there is only a single detection in soils, the predicted time of maximum impact to groundwater is 7 years (so maximum impact has likely passed), and RDX has not been detected in surface water or groundwater samples at FBQ.

- TCE was detected in 3 of 13 soil samples [2 of 8 in surface soil (0-1 ft BGS) and 1 of 5 in subsurface (1-3 ft BGS) soil] with the 3 detections J-qualified and not located in an area of observed groundwater impacts. Based on observed soil and groundwater sample results, TCE was removed from further consideration of future groundwater impacts.

3.5.2 Refined AOC-Specific Modeling Results

Based on analyses of the fate and transport assessment performed in support of the RI for FBQ, no COCs were identified for further analysis using the SESOIL/AT123D models previously developed with refined input parameters.

Impacted soils at FBQ are not predicted to impact underlying groundwater beneath the AOC. Therefore, soil remediation for protection of groundwater is not required at FBQ, and the AOC may be released for residential land use with respect to future groundwater impacts from impacted soils.

3.6 COCs FOR REMEDIAL ALTERNATIVE EVALUATION

The final list of COCs for evaluation of remedial alternatives were identified for FBQ in the previous sections (Sections 3.3, 3.4, and 3.5) and based on risk management considerations including:

- Comparison of EPC to preliminary cleanup goal concentrations (including background concentrations);

- Comparison of EPC to upgradient concentrations for sediment, surface water, and groundwater;

- Consideration of soil as the primary source of contamination (i.e., if soil concentrations are below background at an AOC, that AOC is not contributing to contamination in other media); and

- Other site-specific and receptor-specific considerations.

A summary of COCs and media identified for evaluation of remedial alternatives is provided below for FBQ. COCs identified in soils/dry sediments will be carried forward for evaluation of remedial alternatives in Sections 5, 6, and 7 of this FS. COCs identified in aqueous media (i.e., groundwater, surface water, and wet sediment) will be carried forward for evaluation of remedial options in Chapter 5 of this FS. Those media where no COCs were identified for both the representative receptor (National Guard Trainee) and residential land use are recommended for no further action with respect to these media.

One COC (manganese) is recommended for evaluation of remedial alternatives for sediment in the ditch at FBQ for the representative receptor (National Guard Trainee). Four inorganics are recommended for evaluation of remedial alternatives/options for sediment for residential land use at FBQ (Table 3-16). Manganese is also recommended for evaluation of remedial options for surface water. 2,4,6-TNT is recommended for evaluation of remedial options for groundwater.

Table 3-16. Summary of COCs at FBQ

Soil	Sediment	Surface Water	Groundwater
Representative Land Use (Mounted Training, no digging – National Guard Trainee)			
--	Manganese	--	--
Residential Land Use (Resident Subsistence Farmer)			
--	Antimony[a]	--	--
--	Lead[a]	--	--
--	Manganese	Manganese	--
--	Mercury[a]	--	--
--	--	--	2,4,6-Trinitrotoluene

[a]COC at Quarry Ponds. Sediment is wet at this EU.
-- = No COCs identified for evaluation of alternatives in the FS for this medium.
COC = Constituent of concern.
EU = Exposure unit.
FS = Feasibility Study.

3.7 EXTENT AND VOLUME CALCULATIONS

Estimated volumes are generated for impacted soils/dry sediments at FBQ where COCs in these media were identified (Section 3.6) to be evaluated further in the FS. Analytical data collected during the remedial investigations were used to generate a three dimensional volume model for each final AOC-related COC using a geologic modeling and geospatial visualization program. The volumes of soils/dry sediments exceeding preliminary cleanup goals for National Guard Trainee and Resident Subsistence Farmer land use are summarized in Table 3-17. Supplemental information and data are presented in Appendix 3B.

Table 3-17. Estimated Volumes of Impacted Soils/Dry Sediments

AOC/Scenario	Surface Area (ft^2)	In Situ		In Situ with Constructability[a]		Ex situ[a,b]	
		Volume (ft^3)	Volume (yd^3)	Volume (ft^3)	Volume (yd^3)	Volume (ft^3)	Volume (yd^3)
FBQ National Guard Trainee Land Use – Sediment*	1,380	1,840	68	2,300	85	2,760	102
FBQ Resident Subsistence Farmer Land Use – Sediment*	750	1,000	37	1,250	46	1,500	56

*Volumes are calculated based on sediment samples collected at 0.5 ft in depth and removal depths of 1.0 ft

[a] Includes 25% constructability factor.

[b] Includes 20% swell factor.

AOC = Area of concern.

FBQ = Fuze and Booster Quarry Landfill/Ponds.

The volume of dry sediment to be remediated is higher for the National Guard Trainee than the Resident Subsistence Farmer because the COC to be remediated is manganese. Manganese preliminary cleanup goals are driven by inhalation toxicity. The National Guard Trainee has very high inhalation exposure because the trainee is assumed to breathe very hard and mounted training is assumed to kick up a great deal of dust; therefore, the preliminary cleanup goal for the National Guard Trainee (1,950 mg/kg based on background) is lower than the preliminary cleanup goal for the Resident Subsistence Farmer (2,900 mg/kg).

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4.0 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

Agencies responsible for remedial actions under CERCLA must ensure selected remedies meet ARARs. The following sections describe proposed ARARs for FBQ.

4.1 INTRODUCTION

CERCLA Sections 121(d)(1) and (2) provide that remedial actions selected for a site must attain a degree of cleanup of hazardous substances, pollutants, and contaminants that: (1) ensures protection of human health and the environment; and (2) complies with ARARs. ARARs are developed in accordance with the statutory and regulatory provisions set forth in CERCLA and the National Contingency Plan (NCP).

A remedial action will comply with ARARs if the remedial action attains the standard established in the ARAR for a particular hazardous substance. When a hazardous substance, pollutant, or contaminant will remain onsite at the completion of a remedial action, then that substance must meet any limit or standard set forth in any legally ARAR, criteria, or limitation under a federal environmental law. These standards apply unless such standard, requirement, criteria, or limitation is waived in accordance with CERCLA Section 121(d)(4). Any promulgated standard, requirement, criteria, or limitation under a state environmental or facility siting law that is more stringent than any federal standard, requirement, criteria, or limitation, and that has been identified by the state in a timely manner, can be an ARAR as well.

Regulatory language interpreting and implementing the statutory directive is provided in the NCP. One provision, 40 *Code of Federal Regulation (CFR)* Section 300.400(g), provides that the lead agency (US Army) and support agency (Ohio EPA) shall identify applicable requirements based upon an objective determination of whether the requirement specifically addresses a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site. Under 40 *CFR* Section 300.430(e), the lead agency has the ultimate authority to decide what requirements are ARARs for the potential remedial activities.

Identifying ARARs involves determining whether a requirement is legally applicable, and if it is not legally applicable, then whether a requirement is relevant and appropriate. Individual ARARs for each site must be identified on a site-specific basis. Applicable requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria or limitations promulgated under federal or state environmental or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site (40 *CFR* Section 300.5).

If it is determined that a requirement is not legally applicable to a specific release, the requirement may still be relevant and appropriate to the circumstances of the release. Determining whether a rule is relevant and appropriate is a two-step process that involves determining whether the rule is relevant, and, if so, whether it is appropriate. A requirement is relevant if it addresses problems or situations sufficiently similar to the circumstances of the remedial action contemplated. It is appropriate if its use is well suited to the site.

In addition to ARARs, the lead and support agencies may identify other advisories, criteria, or guidance to be considered for a particular release. The "to be considered" (TBC) category consists of advisories, criteria, or guidance that were developed by USEPA, other federal agencies, or states that may be useful in developing CERCLA remedies. TBCs will be considered as guidance or justification for a standard used in the remediation if no other standard is available for a situation to help determine the necessary level of cleanup for protection of health or the environment. This may occur if no ARAR is available for a particular COC, or if there are multiple contaminants and/or multiple pathways not considered when establishing the standards in the ARAR so that use of the ARAR does not allow the remedial action to be protective of human health or the environment.

While onsite actions must comply with both applicable and relevant and appropriate requirements, offsite actions must comply with only applicable requirements. Also, a determination of relevance and appropriateness may be applied to only portions of a requirement, so that only parts of a requirement need be complied with, whereas a determination of applicability is made for the requirement as a whole, so that the entire requirement must be complied with.

CERCLA provides for a permit waiver for remedial actions that are conducted onsite and in accordance with the NCP. Although the administrative requirement of permits has been waived by the statute, substantive requirements of rules that would otherwise be enforced through permits are still applicable. The Ohio EPA Division of Emergency and Remedial Response (DERR) has addressed this issue in two policies, one in final form and one in draft form. The policy in final form, Final Policy Number DERR-00-RR-001, ARARs, 7/30/1998, states that: "…cleanup projects will not be subject to the administrative requirements of permits, including permit applications, public notice, etc.", particularly when the cleanup project is governed by an enforcement order. The policy in draft form, Draft Policy Number DERR-00-RR-034, Use of ARARs in the Ohio EPA Remedial Response Program, 9/2/03, states that: "It has been DERR's policy to require responsible parties to acquire and comply with all necessary permits, including all substantive and administrative requirements." Permit waivers are specifically addressed in Section VII. General Provisions (Paragraph No. 12e) of the DFFO:

> "It is Ohio EPA's position that if state law related to a remedial or removal action requires a permit, then a permit must be acquired in accordance with CERCLA Section 120(a)(4). It is Respondent's position that these Orders implement a CERCLA-based remediation program and that a permit is not required in accordance with CERCLA Section 121(e). The Parties agree that the remedial or removal actions anticipated at the RVAAP are not of the type that routinely require a permit under state law. If Ohio EPA determines that a permit is required for a particular remedial or removal action at the RVAAP, the Parties will meet and attempt in good faith to resolve to [sic] this issue."

Any remedial response action at RVAAP must be conducted in accordance with the DFFOs, which provide that, irrespective of ARARs, "all activities undertaken … pursuant to these Orders shall be performed in accordance with the requirements of CERCLA, the NCP, and all other applicable federal and state laws and regulations."

4.2 POTENTIAL ARARS

USEPA classifies ARARs as chemical-specific, action-specific, and location-specific to provide guidance for identifying and complying with ARARs (USEPA 1988):

- Chemical-specific ARARs are health- or risk-based numerical values or methodologies which, when applied to site-specific conditions, allow numerical values to be established. These values establish the acceptable amount or concentration of a chemical that may be found in, or discharged to, the ambient environment (USEPA 1988).

- Action-specific ARARs are rules, such as performance or design or other activity-based rules, which place requirements or limitations on actions.

- Location-specific ARARs are rules that place restrictions on the concentration of hazardous substances or the conduct of activities solely because they occur in special locations (USEPA 1988).

As explained in the following paragraph, rules from each of these categories are ARARs only to the extent that they relate to the degree of cleanup.

CERCLA Section 121 governs cleanup standards at CERCLA sites. ARARs originate in the subsection of CERCLA that specifies the degree of cleanup at each site, CERCLA Section 121(d). In Section 121(d)(2), CERCLA expressly directs that ARARs are to address specific contaminants of concern at each site, specifying the level of protection to be attained by any chemicals remaining at the site. CERCLA Section 121(d)(2) provides that with respect to hazardous substances, pollutants, or contaminants remaining onsite at the completion of a remedial action, an ARAR is:

> "Any standard, requirement, criteria, or limitation under any Federal environmental law … or any promulgated standard, requirement, criteria, or limitation under a State environmental or facility siting law that is more stringent than any Federal standard, requirement, criteria, or limitation"

CERCLA Section 121(d)(2) further provides that the remedial action attain a level of control established in rules determined to be ARARs.

In some cases, most ARARs will be chemical-specific. Action- or location-specific requirements will be ARARs to the extent that they establish standards addressing contaminants of concern that will remain at the site. In addition, CERCLA Section 121(d)(1) directs that remedial actions taken to achieve a degree of cleanup that is protective of human health and the environment are to be relevant and appropriate under the circumstances presented by the release. Accordingly, any chemical-, action-, or location-specific requirements will be ARARs to the extent that they ensure that the degree of cleanup will be protective of human health and the environment under the circumstances presented by the release. An evaluation of the regulatory requirements has shown none are chemical-specific ARARs, for the contamination identified in various media at the FBQ. None of the requirements included promulgated standards or cleanup criteria for the identified contaminants.

4.2.1 Potential Action-Specific ARARs for Piles of Debris Waste

Depending on its chemical contaminants, waste debris may be managed as clean fill, as construction and demolition debris (C&DD), as solid waste, or as hazardous waste. C&DD that is identified as solid waste or hazardous waste is managed in accordance with those program requirements. Clean hard fill and C&DD are managed in accordance with State of Ohio C&DD rules at OAC Chapter 3745-400. Potential ARARs for waste piles of debris include rules for disposal of construction and demolition debris and for use of clean hard fill.

Generally, C&DD encompasses materials from any manmade physical structure that are not identified as solid wastes, hazardous wastes, or materials from mining operations, nontoxic fly ash, spent nontoxic foundry sand and slag. [OAC Section 3745-400-1(F)] "Clean hard fill" means C&DD that consists only of reinforced or non-reinforced concrete, asphalt concrete, brick, block, tile, and/or stone which can be reused as construction material. [OAC Section 3745-400-1(E)]

Potential ARAR OAC Section 3745-400-05 establishes requirements and limits regarding where clean hard fill, as defined in the previous paragraph, can be used. The rule provides that clean hard fill may be reused as construction material, or it may be used to bring a site up to a consistent grade, or it may be disposed of in a licensed C&DD or other landfill. If used to grade a site where generated, no paperwork is required, but if clean hard fill is taken offsite and used to grade a site, then a "Notice of Intent to Fill" must be filed with the Ohio EPA. If use of clean hard fill creates a nuisance or a safety hazard, that problem must be addressed with a cover or other appropriate measures (OAC Section 3745-400-05). Clean hard fill may be stored onsite for two years after active use of the pile has ceased (removing and adding to the pile), after which time storage constitutes illegal disposal.

Potential ARAR OAC Section 3745-400-04 establishes requirements and limits regarding disposal of C&DD. The rule provides that C&DD may be disposed of in a licensed solid waste landfill, in a licensed C&DD landfill, by open burning under a permit, or in any other manner that is not prohibited by State laws and rules, as long as disposal does not create a nuisance, health hazard, water pollution, or a violation of solid or hazardous waste rules.

OAC Section 3745-400-03 provides for three exclusions of facilities from C&DD requirements: (1) those facilities where construction debris, brush, and trees from clearing are used as fill at the same facility; (2) any site where clean hard fill is used in legitimate fill activities; and (3) sites where debris is reused, recycled, or stored rather than disposed of. OAC Section 3745-400-06 provides a location restriction for a new C&DD facility: a location cannot be established within a 100-year floodplain (although this requirement can be waived under certain conditions).

4.2.2 Potential Action-Specific ARARs for Environmental Medial that are RCRA Hazardous Wastes

If soil at FBQ is determined to be Resource Conservation and Recovery Act (RCRA) hazardous, certain hazardous waste requirements are triggered when the soil is generated (excavated). Some RCRA requirements prescribe standards for treatment of hazardous materials. These requirements are generally not ARARs because they do not relate directly to the degree of cleanup or to specific chemicals but rather to the method used to obtain the degree of cleanup. Some RCRA requirements prescribe standards for disposal of hazardous materials. Standards that directly address land disposal may be potential ARARs at FBQ. These are: (1) land disposal requirements (LDRs) prohibiting disposal of specific chemicals until they are treated to a protective level, and (2) minimum technical requirements (MTRs) for land disposal units.

USEPA cautions that LDRs should not be used to determine site-specific cleanup levels for soils (USEPA 2002). The purpose of LDRs is to require appropriate treatment of RCRA hazardous wastes that are to be land disposed of to minimize short and long-term threats to human health or the environment. Performing treatment to meet certain standards is different from the CERCLA approach to remediation, which is analyzing risk and then developing soil cleanup standards based on the risk present, and may result in soil cleanup levels that are different from those of a risk-based approach. Nevertheless, if RCRA hazardous materials are managed in a way that generates RCRA hazardous waste, and if that waste is land disposed of onsite, then the material must meet the standards established in the LDRs.

RCRA hazardous waste must be present for LDRs to be triggered as potential ARARs. This requires: (1) that soil contain contaminants that either derive from RCRA listed wastes or that exhibit a characteristic of RCRA hazardous waste; and (2) that soils are managed in a way that “generates” hazardous waste. Several methods of soil management that do not “generate” hazardous waste and so do not trigger LDRs are available for use. These methods are: the AOC approach, use of a staging pile, use of a storage or treatment corrective action management unit (CAMU), or use of a temporary unit (TU).

If soils are managed in a manner that generates hazardous waste, such as removing soil to an aboveground container and depositing the soil within the land unit for disposal, then LDRs become potential ARARs. LDRs attach to the waste at the time it is removed from the unit under an AOC approach, or at the time the soil is excavated and lifted out of the unit. Potential LDR ARARs in Ohio are variances from treatment standards at OAC Section 3745-700-44, LDR standards for contaminated debris at OAC Section 3745-47, Universal Treatment Standards (UTS) at OAC Section 3745-270-48, and Alternative Standards for Contaminated Soil at OAC Section 3745-270-49.

Ohio has adopted the alternative soil treatment standards as promulgated by USEPA in its Phase IV LDR rule, effective August 1998. The rules provide that if RCRA hazardous wastes are present, then the material must meet either one of two sets of LDRs before being disposed of in a land unit: (1) the UTS; or (2) the contaminated soil (technology-based treatment) standards promulgated in Phase IV of the LDRs, whichever is greater. Or, if a generator so chooses, he may use the generic treatment standards at

OAC Section 3745-270-40 which apply to all hazardous wastes. Only the alternative soil treatment standards are explained in this document. Under the alternative soil treatment standards, all soils subject to treatment must be treated as follows:

1. For non-metals, treatment must achieve 90% reduction in total constituent concentration [primary constituent for which the waste is characteristically hazardous as well as for any organic or metal underlying hazardous constituent (UHC)], subject to item 3 below.

2. For metals and carbon disulfide, cyclohexanone, and methanol, treatment must achieve 90% reduction in constituent concentrations as measured in leachate from the treated media (tested according to the Toxicity Characteristic Leaching Procedure (TCLP) or 90% reduction in total constituent concentrations (when a metal removal treatment technology is used), subject to item 3 below.

3. When treatment of any constituent subject to treatment to a 90% reduction standard would result in a concentration less than 10 times the UTS for that constituent, treatment to achieve constituent concentrations less than 10 times the UTS is not required. This is commonly referred to as "90% capped by 10xUTS."

4. USEPA and Ohio EPA have established a site-specific variance from the soil treatment standards, which can be used when treatment to concentrations of hazardous constituents greater (i.e., higher) than those specified in the soil treatment standards minimizes short- and long-term threats to human health and the environment. In this way, on a case-by-case basis, risk-based LDR treatment standards approved through a variance process could supersede the soil treatment standards. Any variance granted cannot rely on capping, containment, or other physical or institutional controls.

If CAMUs are used as disposal units at FBQ, then the design and treatment standards established at OAC Section 3745-57-72 will be potentially relevant and appropriate to the response action. Only CAMU-eligible wastes can be disposed of in a CAMU. CAMU-eligible waste includes hazardous and non-hazardous waste that are managed for implementing cleanup, depending on the Director’s approval or prohibition of specific wastes or waste streams. Use of a CAMU for disposal does not trigger LDRs or MTRs as long as the standards specified in the rule are observed. The Director will incorporate design and treatment standards into a permit or order. Design standards include a composite liner and a leachate collection system that is designed and constructed to maintain less than a thirty centimeter depth of leachate over the liner. A composite liner is a system consisting of two components; each component has detailed specifications and installation requirements. The Director may approve alternate requirements if he can make the findings specified in the rule. Treatment standards are similar to LDR standards for contaminated soil, although alternative and adjusted standards may be approved or required by the Director, as long as the adjusted standard is protective of human health and the environment.

Table 4-1. Potential Action ARARs for Disposal of RCRA Hazardous Waste

Media and Citation	Description of Requirement	Potential ARAR Status	Standard
Soil Contaminated with RCRA Hazardous Waste OAC Section 3745-400-49 OAC Section 3745-400-48 UTS	These rules prohibit land disposal of RCRA hazardous wastes subject to them, unless the waste is treated to meet certain standards that are protective of human health and the environment. Standards for treatment of hazardous contaminated soil prior to disposal are set forth in the two cited rules. Use of the greater of either technology-based standards or UTS is prescribed.	LDRs apply only to RCRA hazardous waste. This rule is considered for ARAR status only upon generation of a RCRA hazardous waste. If any soils are determined to be RCRA hazardous, and if they will be disposed of onsite, then this rule is potentially Applicable to disposal of the soils.	All soils subject to treatment must be treated as follows: 1) For non-metals, treatment must achieve 90% reduction in total constituent concentration (primary constituent for which the waste is characteristically hazardous as well as for any organic or metal UHC), subject to 3) below; 2) For metals and carbon disulfide, cyclohexanone, and methanol, treatment must achieve 90% reduction in constituent concentrations as measured in leachate from the treated media (tested according to the TCLP or 90% reduction in total constituent concentrations (when a metal removal treatment technology is used), subject to 3) below; 3) When treatment of any constituent subject to treatment to a 90% reduction standard would result in a concentration less than 10 times the UTS for that constituent, treatment to achieve constituent concentrations less than 10 times the UTS is not required. This is commonly referred to as "90% capped by 10xUTS."
Debris Contaminated with RCRA Hazardous Waste OAC Section 3745-400-49 OAC Section 3745-400-47	These rules prescribe conditions and standards for land disposal of debris contaminated with RCRA hazardous waste. Debris subject to this requirement for characteristic RCRA contamination that no longer exhibits the hazardous characteristic after treatment does not need to be disposed of as a hazardous waste. Debris contaminated with listed RCRA contamination remains subject to hazardous waste disposal requirements.	If RCRA hazardous debris is disposed of onsite, then these rules are potentially Applicable to disposal of the debris.	Standards are extraction or destruction methods prescribed in OAC Section 3745-400-47. Treatment residues continue to be subject to RCRA hazardous waste requirements.

Table 4-1. Potential Action ARARs for Disposal of RCRA Hazardous Waste (continued)

Media and Citation	Description of Requirement	Potential ARAR Status	Standard
Soils/Debris Contaminated with RCRA Hazardous Waste – Variance OAC Section 3745-400-44	The Director will recognize a variance approved by the USEPA from the alternative treatment standards for hazardous contaminated soil or for hazardous debris.	Potentially applicable to RCRA hazardous soil or debris that is generated and placed back into a unit and that will be land disposed of onsite.	A site-specific variance from the soil treatment standards can be used when treatment to concentrations of hazardous constituents greater (i.e., higher) than those specified in the soil treatment standards minimizes short- and long-term threats to human health and the environment. In this way, on a case-by-case basis, risk-based LDR treatment standards approved through a variance process could supersede the soil treatment standards.
Soils Disposed of in a CAMU OAC Section 3745-57-53	Only CAMU-eligible waste can be disposed of in a CAMU. CAMU-eligible waste includes hazardous and non-hazardous waste that are managed for implementing cleanup, depending on the Director's approval or prohibition of specific wastes or waste streams. Use of a CAMU for disposal does not trigger LDRs or MTRs as long as the standards specified in the rule are observed. The Director will incorporate design and treatment standards into a permit or order.	Potentially applicable to RCRA hazardous waste that is disposed of in a CAMU.	Design standards include a composite liner and a leachate collection system that is designed and constructed to maintain less than a thirty centimeter depth of leachate over the liner. A composite liner means a system consisting of two components; each of which has detailed specifications and installation requirements. The Director may approve alternate requirements if he can make the findings specified in the rule. Treatment standards are similar to LDR standards for contaminated soil, although alternative and adjusted standards may be approved or required by the Director, as long as the adjusted standard is protective of human health and the environment. Treatment standards are de facto cleanup standards for wastes disposed of in a CAMU.

CAMU = Corrective Action Management Unit.
LDR = Land Disposal Restrictions.
MTR = Minimum technical requirement.
OAC = Ohio Administrative Code.
RCRA = Resource Conservation and Recovery Act.
TCLP = Toxicity characteristic leaching procedure.
UHC = Underlying Hazardous Constituent.
UTS = Universal Treatment Standard.

4.2.2.1 Potential Location-Specific ARARs for FBQ

Location requirements include those established for potential remedial activities conducted within wetlands or within a floodplain area, or with respect to threatened and endangered species. Generally, for wetlands and floodplains, rules require that alternatives to remedial activity within the sensitive area be pursued, and if that is not feasible, then adverse effects from any actions taken within the sensitive area be mitigated to the extent possible. These requirements do not relate to specific chemicals, nor do they further the degree of cleanup in the sense of protecting human health or the environment from the effects of harmful substances. Rather, their purpose is to protect the sensitive areas to the extent possible. Under CERCLA Section 121(d), relevance and appropriateness are related to the circumstances presented by the release of a hazardous substance, with the goal of attaining a degree of cleanup and control of further releases that ensures protection of human health and the environment.

Rules ensuring protection of sensitive resources do not represent requirements that are relevant and appropriate to circumstances presented by the release of a hazardous substance, with a goal of attaining a degree of cleanup and control of further releases that ensure protection of human health and the environment. Location requirements for wetlands and floodplains do not relate to the degree of cleanup as much as they relate to protection of these sensitive areas from the effects of remedial activities. This purpose of the rule requirements does not address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site as an ARAR; that is, the rule requirements are not sufficiently relevant and appropriate under CERCLA Section 121(d) as related to the circumstances of the release, degree of cleanup, or protectiveness of remedial action, to include these requirements as ARARs.

The Endangered Species Act (ESA) exists to protect the habitat or body of flora and fauna that are threatened or endangered. Once again, these rules do not relate to specific chemicals, nor do they further the degree of cleanup in the sense of protecting human health or the environment from the effects of harmful substances. The purpose of these rules is to protect sensitive areas and plant and animal life to the degree possible. This purpose does not address problems or situations sufficiently similar to those encountered at the CERCLA site that its use is well suited to the particular site as an ARAR; that is, the rule requirements are not sufficiently relevant and appropriate under CERCLA Section 121(d) as related to the circumstances of the release, degree of cleanup, or protectiveness of the remedial action, to include these requirements as ARARs.

Having determined that these requirements are not ARARs, it bears repeating that any action taken by the Federal Government must be conducted in accordance with requirements established under the National Environmental Policy Act (NEPA), ESA, and federal and state wetlands and floodplains construction and placement of materials considerations, even though these laws and rules do not establish standards, requirements, limitations, or criteria relating to the degree of cleanup for chemicals remaining onsite at the close of the response action.

Table 4-2 summarizes potential ARARs for FBQ.

Table 4-2. Potential ARARs for FBQ (RVAAP-16)

Media and Citation	Requirements	Prerequisites/Site Conditions	Standards
Debris Waste Piles OAC Section 3745-400-04	Potential ARAR OAC Section 3745-400-04 establishes requirements and limits for disposal of C&DD. Generally, C&DD encompasses materials from any manmade physical structure that are not identified as solid wastes, hazardous wastes, or materials from mining operations, nontoxic fly ash, spent nontoxic foundry sand and slag. The rule provides that C&DD may be disposed of in a licensed solid waste landfill, in a licensed C&DD landfill, by open burning under a permit, or in any other manner that is not prohibited by State laws and rules.	Potentially applicable for determining whether debris in waste piles qualify as C&DD and whether the C&DD can be disposed of onsite.	OAC Section 3745-400-04 provides that waste may be disposed of in any manner that does not create a nuisance, health hazard, water pollution, or a violation of solid or hazardous waste rules.
Debris Waste Piles OAC Section 3745-400-05	Potential ARAR OAC Section 3745-400-05 establishes requirements and limits for use of "clean hard fill." "Clean hard fill" means C&DD that consists only of reinforced or nonreinforced concrete, asphalt concrete, brick, block, tile, and/or stone which can be reused as construction material. [OAC Section 3745-400-1(E)] If used to grade a site where generated, no paperwork is required, but if clean hard fill is taken offsite and used to grade a site, then a "Notice of Intent to Fill" must be filed with the Ohio EPA.	Potentially applicable for determining whether debris in waste piles quality as clean hard fill and whether the material can be used for fill material onsite.	Clean hard fill may be reused as construction material, or it may be used to bring a site up to a consistent grade, or it may be disposed of in a licensed C&DD or other landfill. If use of clean hard fill creates a nuisance or safety hazard, that problem must be addressed with a cover or other appropriate measures.

ARAR = Applicable and relevant or appropriate requirements.
C&DD = Construction & demolition debris.
OAC = Ohio Administrative Code.
Ohio EPA = Ohio Environmental Protection Agency.

5.0 TECHNOLOGY TYPES AND PROCESS OPTIONS

This chapter describes the identification and screening of technology types and process options for COCs in impacted media at FBQ (as summarized in Section 3.6). The identification and screening determines suitable technologies and process options that can be assembled into remedial alternatives capable of mitigating the existing contamination. The *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA* (USEPA 1988) established a structured process for this purpose. A series of steps is used to reduce the universe of potential remedial options to a smaller group of viable ones, from which a final remedy may be selected. These steps include:

- Identifying suitable general classes of response actions, or general response actions (GRAs), (Section 5.1).

- Identifying technologies and process options applicable to the general response actions and performing an initial screening for soils/dry sediments (Section 5.2).

- Performing a detailed evaluation of the screened technologies and process options for soils/dry sediments in terms of effectiveness, implementability, and cost (Section 5.3).

Remediation of impacts to aqueous groundwater, surface water, and wet sediments are not addressed in this FS, however, a preliminary evaluation of options to address impacts to groundwater, surface water, and wet sediments is included in Appendix 5 to support future considerations regarding the need for remedial action either on an AOC-specific or a facility-wide basis.

The Federal Remediation Technologies Roundtable (FRTR) provided guidance for the evaluation of remedial technologies. FRTR provides a screening matrix which assesses the effects potential technologies have on the types of contaminants. This guidance was used as a point of reference throughout this initial screening of technologies.

5.1 GENERAL RESPONSE ACTIONS

This section describes the GRAs and remedial technologies that are potentially applicable at FBQ. GRAs are actions that will satisfy the RAOs (Section 3.1) for a specific medium, and may include various process options. GRAs are not remedial alternatives but are potential components of remedial alternatives. Proposed remedial alternatives are presented in Chapter 6 and include GRAs or combinations of the GRAs presented below. GRAs were selected based on the media of concern (soils/dry sediments). GRAs include no action, land use controls, monitoring, containment, removal, treatment, and disposal/handling.

5.1.1 No Action

In this GRA, no action would be undertaken to reduce any hazard to human health or the environment. Any current actions, restrictions, or monitoring would be discontinued. This action complies with the CERCLA requirement to provide an appropriate option or component of a remedial alternative if no unacceptable risks are present and to provide a baseline against which other alternatives can be compared.

5.1.2 Land Use Controls and 5-year Reviews

Land use controls are applicable similarly to both soil and aqueous media. Generally, land use controls reduce the potential for exposure to contaminants, but do not reduce contaminant volume or toxicity. These controls are utilized to supplement and affect the engineering component(s) of a remedy (e.g., treatment, removal, etc.) during short and long-term implementation.

The primary goal of land use controls is to restrict the use of, or limit access to, real property using physical, legal, and/or administrative mechanisms to ensure protectiveness of the remedy. Particular land use controls under consideration at FBQ include measures that will restrict land use changes over the long-term, such as governmental controls and enforcement tools. Governmental controls could include a Facility Master Plan and installation-specific regulations to manage property and enforce management strategies, while enforcement tools may involve administrative orders or consent decrees. Land use controls can be used to supplement engineering controls; however, land use controls are not to be used as the sole remedy at a CERCLA site unless the use of active measures such as treatment and/or containment of source material are determined to not be practicable [(40 *CFR* Section 300.430(a)(1)(iii)(D)].

If land use controls are selected as a component of a remedial alternative achieving National Guard Trainee land use, the effectiveness of the remedy must undergo 5-year reviews. The primary goal of the 5-year reviews is to evaluate the implementation and performance of a remedy to determine if the remedy is or will be protective of human health and the environment. The 5-year reviews may be discontinued upon the AOC achieving preliminary cleanup goals for residential use and unrestricted release.

5.1.3 Containment

Containment can effectively reduce contaminant mobility and the potential for exposure. However, containment actions do not reduce contaminant volume or toxicity. When consolidation is used in conjunction with containment, the overall area of contamination is reduced, thereby reducing the area of potential exposure to individuals. The primary containment technology considered for soils/dry sediments at FBQ is capping with consolidation. Capping involves covering an area with a low-permeability material (e.g., native soil, clay, concrete, asphalt, synthetic liner, or multi-layered) to reduce infiltration of water and the migration of COCs.

5.1.4 Removal

Removal of impacted soils/dry sediments would reduce the potential for long-term human and environmental exposure. For example, impacted soils/dry sediments could be excavated and disposed of either onsite in a designated location or offsite in an appropriately licensed disposal facility. Excavation would minimize long-term direct human contact with and the local migration of impacted material.

5.1.5 Treatment

The treatment options evaluated for impacted soils/dry sediments at FBQ include various physical, chemical, biological, and thermal technologies. Physical processes involve either physically binding the contaminants to reduce their mobility or the potential for exposure or extracting them from a medium to reduce volumes. Chemical treatment processes add chemicals (in situ or ex situ) to react with contaminants to reduce their toxicity or mobility. Biological treatment involves using microbes to degrade or concentrate contaminants. Thermal treatment such as incineration uses high temperatures to volatilize, decompose, or melt contaminants.

5.1.6 Disposal and Handling

Disposal and handling of soils/dry sediments would involve the permanent and final placement of waste materials in a manner that protects human health and the environment. Soils and dewatered sediments could be disposed of onsite in an engineered facility, or offsite in a permitted or licensed facility such as a regulated landfill. Similarly, concentrated waste resulting from treatment processes could be disposed of either onsite in a permanent disposal cell or offsite in an approved disposal facility. Transportation could be accomplished using a variety of modes. Truck, railcar, and/or barge transportation could be used to move soils onsite or ship waste materials offsite.

5.2 INITIAL SCREENING OF TECHNOLOGIES ~ SOILS/DRY SEDIMENTS

This section describes the identification and initial screening of potential technologies to achieve soil/ dry sediment RAOs at FBQ (Section 3.6). Technology types and process options for FBQ were selected on the basis of their applicability to the environmental media of interest (e.g., soils/dry sediments). Process options were either retained or eliminated from further consideration on the basis of technical implementability and effectiveness with respect to soils/dry sediments COCs. Results of the initial technology screening are summarized in Table 5-1.

5.2.1 No Action

No action would be taken to implement remedial technologies to reduce any hazard to human health or the environment. Any current actions, restrictions, or monitoring would be discontinued. This action complies with the CERCLA requirement to provide an appropriate option or component of a remedial alternative if no unacceptable risks are present. The No Action technology shall be retained as a process option to be further evaluated.

5.2.2 Land Use Controls and 5-year Reviews

Actions being considered for FBQ include land use controls and 5-year reviews. Land use controls are legal, administrative, and physical mechanisms employed to restrict the use of, or limit access to, real property to prevent or reduce risks to human health and the environment. The implementability of these mechanisms depends on:

- The entity assuming responsibility for initiating, implementing, and maintaining the controls;
- The arrangements made between property owners in different governmental jurisdictions and the authority of local governments; and
- Specific characteristics of the AOC.

Legal impediments and costs affect implementability and schedules. NCP has outlined criteria to evaluate when the use of land use controls would be acceptable as a component of a remedial alternative. Sites containing residual contamination above acceptable concentrations for residential land use require 5-year reviews to determine whether the integrity of the controls remains intact. When the AOC achieves preliminary cleanup goals that allow for unlimited use and residential exposure, then at that time 5-year reviews may be discontinued.

5-year reviews will include the review of sampling and monitoring plans and results from monitoring activities, conducting of interviews to provide additional information about the AOC's status, and inspections. The sampling and monitoring plans would be tailored to the selected remedial alternative so that monitoring objectives are fulfilled. An adequate monitoring program includes periodic sampling of media that could be affected by the continued presence of contaminants. Environmental monitoring would be required for any remedial alternative which does not allow for residential land use.

All land use controls and 5-year review options will be retained for further evaluation.

5.2.3 Containment

Containment actions prevent or minimize contaminant migration and eliminate exposure pathways. Contaminated medium is neither chemically nor physically changed, nor are the volumes of contaminated media reduced. The containment action considered for impacted soils/dry sediments at FBQ is capping. Capping can reduce surface water infiltration through contaminated media and minimize the release of dust and vapors to the atmosphere. Process options consist of varying cap construction materials of native soil, clay, synthetic liner, multi-layered, asphalt, and concrete.

Native and/or clay soils can be used to construct a cap to provide an exposure barrier to contaminated soils/dry sediments. In conjunction with surface controls, such a cap can be effective in reducing contaminant migration by wind and water erosion. However, soil caps are susceptible to weather effects including cracking. Synthetic liners or multi-layered caps of different media would not be as susceptible to cracking and also would provide adequate exposure barriers. Asphalt and concrete caps have similar limitations as native and clay soil caps if not properly maintained. Existing building slabs and paved surfaces can be effective in reducing direct human contact and wind and water erosion.

Capping is a mature, commercially available technology for remediation and is applicable to all COCs at FBQ. Where remedial treatments are not recommended (based on the evaluation of effectiveness, implementation, and cost), permanent caps may provide sustained isolation of contaminants and prevent the mobilization of soluble compounds over the long term and eliminate exposure pathways. Capping tends to be less expensive than other remedial technologies. Simple compacted soil covers or asphalt/concrete covers are far more susceptible to weathering (erosion, ultraviolet light, and freeze/thaw cycle). Therefore, capping systems require periodic inspection and repair to maintain effectiveness. Capping systems that utilize synthetic liners or a combination of different media (e.g., RCRA caps) would be less susceptible to cracking due to climatic effects. Capping does not lessen toxicity, mobility, or volume of hazardous wastes, but does mitigate vertical migration. In addition, the presence of a cap may hinder any additional soil treatment if the contaminated soil is found to require treatment at a later date.

Capping is not retained as an option for FBQ due to AOC-specific conditions. The FBQ COC is associated with sediment in a drainage ditch. Constructing and maintaining a cap within the ditch while not impairing drainage conveyance would be problematic.

5.2.4 Removal

Removing contaminated soils/dry sediments involves bulk excavation techniques via conventional excavation equipment. The techniques utilized are dependent upon the areas and locations to be excavated. Large mechanical excavators would be used for easily accessible areas. Where space is limited, smaller mechanical devices or hand tools may be required. Excavation would require the use of dust and surface runoff controls to ensure the safety of workers and the general public. Runoff controls are especially important for any areas draining to a wetland. Excavated soils/dry sediments can then be transported and disposed of at an onsite or offsite disposal facility. Alternatively, soils/dry sediments can be treated to destroy or immobilize COCs. Soils/dry sediments removal is applicable to all COCs at FBQ.

Contaminated soils/dry sediments removal is retained as an option to be further evaluated.

5.2.5 Treatment

Process options evaluated for soils/dry sediments treatment include various in situ and ex situ physical, chemical, biological, and thermal options.

5.2.5.1 <u>In Situ Physical/Chemical Treatment</u>

In situ physical and chemical treatment process options evaluated included chemical oxidation/reduction (Redox), electrokinetic separation, fracturing (enhancement), soil flushing, soil vapor extraction, and stabilization/solidification (S/S).

Chemical Redox: Chemical Redox processes involve the addition of appropriate chemicals to raise or lower the oxidation state of the reactant. Oxidation chemically converts hazardous contaminants to non-hazardous or less toxic compounds that are more stable, less mobile, and/or inert. The oxidizing agents most commonly used are ozone, hydrogen peroxide, hypochlorites, chlorine, and chlorine dioxide. Non-halogenated SVOCs are resistant to oxidation, and metals may form toxic byproducts or become mobilized. Most of FBQ is underlain by unconsolidated materials (sandy and silty clays, silty and clayey sand). Bedrock beneath the AOC consists of sandstone. RI slug test data for unconsolidated zone wells show relatively moderate hydraulic conductivity values ranging from 2.5E-05 to 3.3E-03 cm/sec. Results from Shelby tube analyses ranged from 5.87E-08 to 1.03E-06 cm/sec, indicative of low hydraulic conductivities. Based on these data, introduction and adequate dispersal of sufficient quantities of reagents within the unconsolidated zone is likely not feasible. For these reasons, chemical Redox is not retained for further evaluation.

Electrokinetic separation: Electrokinetic separation is a method by which low-voltage direct current is applied across the contaminated soil area via ceramic electrodes. Positively charged organics and metal ions move toward the cathode and negatively charged ions move toward the anode. The charged contaminants move by either electromigration or electroosmosis. In electromigration, charged particles are transported through the substrate. In contrast, electroosmosis is the movement of a liquid containing ions relative to a stationary charged surface. Of the two, electromigration is the main mechanism for the electrokinetic separation process. The direction and rate of movement of an ionic species will depend on its charge, both in magnitude and polarity, as well as the magnitude of the electroosmosis-induced flow velocity. Non-ionic species, both inorganic and organic, will also be transported along with the electroosmosis induced water flow. The two common approaches to soil treatment are “enhanced removal” and “treatment without removal”. Enhanced removal is achieved by electrokinetic transport of contaminants toward the polarized electrodes to concentrate the contaminants for subsequent removal and ex situ treatment. Treatment without removal involves the forced movement of the charged contaminants through in situ treatment zones. The polarity of the electrodes is periodically reversed to aid in soil treatment (FRTR 2005). The reliance of charged ions for effectiveness renders this process not effective at treating explosives.

Electrokinetic separation is retained as a process option for FBQ.

Fracturing (Enhancement): Fracturing is a remediation enhancement technique used to increase the efficiency of other in situ remediation technologies. Fracturing, as the name implies, involves the creation of horizontal and/or vertical fractures in the subsurface soil matrix to improve soil permeability. Typical methods used include (FRTR 2005):

- Blast-Enhanced Fracturing: Blast-enhanced fracturing involves the use of controlled detonation of explosives in the subsurface.

- Hydraulic Fracturing: Hydraulic fracturing involves the injection of pressurized water into the subsurface to initialize a fracture followed by an injection of slurry of water, sand and thick gel under high pressure to propagate the fracture.

- Pneumatic Fracturing: Pneumatic fracturing involves the injection of highly pressurized air through injection wells to expand existing soil fractures and create new fractures.

- Lasagna™ Process: The Lasagna™ Process combines hydraulic fracturing with electrokinetic separation via electroosmosis. Horizontal fractures are created in the subsurface soil matrix to enhance contaminant movement while in situ electrodes move contaminant ions through a treatment zone.

The FRTR ranks this treatment technology as average for nonhalogenated and halogenated SVOCs and is considered "worse" for inorganics. Conditions at FBQ involve surficial soils/dry sediments that render the installation of horizontal and vertical fractures impractical and undesirable respectively. Therefore, fracturing is not retained.

Soil Flushing: Soil flushing is the application or injection of water into an area of contaminated soils/dry sediments to bring the water tables in contact with and promote leaching of soil contaminants. The dissolved contaminants then are extracted and treated. Cosolvent enhancement is a method by which solvents (i.e., acids, bases, or surfactants) are mixed with the water to enhance contaminant solubility and removal. Soil flushing is highly effective for treating metals, but ineffective for explosives (FRTR 2005). Conditions at FBQ render implementation of in situ soil flushing problematic. Contaminated soils/dry sediments at FBQ are surficial in nature and associated with drainage ditches and areas prone to flooding. Properly implementing and controlling the soil flushing process under these conditions would be difficult. Consequently, this process is not retained for further evaluation at FBQ.

Soil Vapor Extraction: Soil vapor extraction (SVE) is an in situ unsaturated (vadose) zone soil remediation technology in which a vacuum is applied to the soils/dry sediments to induce the controlled flow of air and remove volatile and some semivolatile contaminants from the soil. The gas leaving the soil may be treated to recover or destroy the contaminants, depending on local and state air discharge regulations. Vertical extraction vents are typically used at depths of 1.5 m (5 ft) or greater and have been successfully applied as deep as 91 m (300 ft). Horizontal extraction vents (installed in trenches or horizontal borings) can be used as warranted by contaminant zone geometry, drill rig access, or other site-specific factors. This process is only effective for VOCs and some SVOCs (FRTR 2005) and is not generally applicable to the COCs present at FBQ. In addition, the surficial nature of impacted soils/dry sediments are not conducive to SVE techniques.

Stabilization/solidification: S/S immobilizes contaminants within a matrix by chemical fixation or vitrification. Chemical fixation is typically accomplished using an auger/caisson system to mix contaminated soils with chemical agents and/or cement additives. Fixation processes can result in a significant increase in total waste volume (i.e., up to a doubling of volume) and usually require leachate testing to ensure contaminant mobility has been sufficiently reduced. Vitrification processes immobilize inorganic contaminants while destroying organic pollutants by applying an electric current to melt soil and other earthen materials at temperatures on the order of 1600-2000°C. The resulting glass and crystalline mass is inert. Organic combustion products and water vapor are typically captured and treated through an off-gas treatment system. Vitrification is an immobilizing technology. Since organic compounds are generally not immobilized, it is generally considered ineffective for treating explosives.

The presence of contaminated surficial soils/dry sediments in potentially inundated areas at FBQ renders the in situ application of S/S processes difficult. Therefore, this process is not retained for further consideration.

5.2.5.2 Ex Situ Physical/Chemical Treatment

Ex situ physical/chemical treatment options apply to contaminated soils/dry sediments which have first been removed by excavation (i.e., removal).

Chemical Extraction: Chemical extraction is the application of a chemical extractant to collect and concentrate contaminants from soil. The collected contaminants are then placed in a separator (e.g., centrifuge) to remove the solvent for disposal. Two types of chemical extraction are typically performed: acid extraction and solvent extraction.

Acid extraction uses hydrochloric acid to extract heavy metal contaminants from soils. In this process, soils are first screened to remove coarse solids. Hydrochloric acid is then introduced into the soil in the extraction unit. The residence time in the unit generally ranges between 10 and 40 min depending on the soil type, contaminants and contaminant concentrations. The soil-extractant mixture is continuously pumped out of the mixing tank and separated using hydrocyclones. The separated soil is dewatered and mixed with an acid-neutralizing agent (e.g., lime) to neutralize any remaining acid. The acid solution is regenerated using a precipitant and flocculent to remove dissolved metals (FRTR 2005).

Solvent extraction is accomplished with the use of an organic solvent. This process is often combined with other technologies such as stabilization, incineration, or soil washing, but may be used as a stand-alone technology in some instances. The solvent must be carefully selected since soils may contain residual solvent concentrations subsequent to treatment. Solvent extraction processes are highly effective in treating SVOCs and metals, but ineffective for explosives.

Chemical extraction is retained for further evaluation.

Chemical Redox: Ex situ chemical Redox is identical to the in situ process described in Section 5.2.5.1 with the exception that soils/dry sediments are removed for treatment. Potentially large amounts of chemical waste products would be generated through this option, requiring additional waste treatment and disposal. This process primarily has been proven effective for treating mobile inorganics such as cyanide and chromium. For these reasons, chemical Redox is not retained for further evaluation.

Dehalogenation: Dehalogenation uses various methods to remove a halogen molecule from organic chemicals within the soil. This method is only effective at treating halogenated VOCs and SVOCs, which are not present in large quantities at FBQ; therefore, it is eliminated from further evaluation.

Soil Washing: Soil washing achieves volume reduction of contaminated soils/dry sediments in two ways: by dissolving or suspending the contaminants in the wash solution or by concentrating the contaminants into a smaller volume through particle size separation. Soil washing systems that incorporate both techniques are generally the most effective. Soil washing involves pre-treating contaminated soils to remove larger objects, then washing the soils with water (with or without additives to improve contaminant extraction) to remove target constituents. Conventional soil washing systems are not typically effective for soils containing large amounts of clay and silt. Incorporating other physical and chemical processes can enhance the effectiveness of soil washing. During the soil washing operation, the majority of the process water is filtered and recycled back into the treatment system. A small volume of this water stream would require periodic discharge. Following treatment, the reduced soil fraction may be further treated (such as solidification) if required. The resulting “clean” soils could be placed back onsite or reused at another site.

Soil washing is commonly applied to soils impacted with SVOCs, fuels, heavy metals and select VOCs and pesticides. This process has limited application experience in treating explosives. Soil washing is retained for further evaluation.

Stabilization/Solidification: Ex situ S/S immobilizes contaminants within excavated soils/dry sediments using chemical fixation and vitrification. These processes are described in detail in Section 5.2.5.1. These processes are highly effective for immobilizing inorganic contaminants, preventing exposures or migrations to exposure points. Treating explosives or SVOCs may be limited. S/S is retained for further evaluation.

5.2.5.3 Biological Treatment

Enhanced Bioremediation: Technologies involve destruction or transformation techniques in which favorable environments are created for microorganisms or plant systems to grow and use contaminants as a food or energy source. Processes include slurry-phase, solid phase, and anaerobic biodegradation. Biological treatment is generally most effective for treating organic contaminants. Bioremediation in soil is typically not applicable for treating inorganic contaminants (metals such as arsenic and manganese) and of limited effectiveness for PAHs and explosives. Consequently, enhanced bioremediation is not retained for further evaluation.

Monitored Natural Attenuation: Monitored Natural Attenuation (MNA) is a passive remedial measure that relies on natural processes to reduce the contaminant concentration over time. MNA is a viable remedial process option if it can reduce contamination within a reasonable time frame, given the particular circumstances of the AOC, and if it can result in the achievement of remediation objectives. Use of MNA as a component of a remedial alternative is appropriate along with the use of other measures, such as source control or containment measures. MNA, like enhanced bioremediation is generally of negligible to limited effectiveness for inorganic contaminants, PAHs and explosives. Similarly, MNA is not retained for further evaluation.

5.2.5.4 Thermal Treatment

Thermal treatment uses high temperatures to volatilize, decompose, or oxidize the contaminants. Various forms of thermal treatment technology including incineration, pyrolysis, and low temperature thermal desorption are described below:

- Incineration: High temperatures are applied in the presence of oxygen to combust organic compounds, converting them to carbon dioxide and water.

- Pyrolysis: Organic compounds are decomposed by high heat in the absence of oxygen, resulting in gaseous compounds and fixed carbon ash.

- Thermal Desorption: Heat volatilizes water and organics, which are collected and passed through a vapor treatment system.

Thermal treatment processes are generally used for the treatment of organic compounds and would not be effective for treating inorganic compounds. These options are not retained for further evaluation due to the potential for hazardous by-products from metal contamination in the soils.

5.2.6 Disposal and Handling

Both onsite and offsite disposal options were considered for the disposal of contaminated soils/dry sediments. The following technologies were retained for FBQ. Handling options involved truck, railcar, or barge alternatives to transport wastes.

5.2.6.1 Onsite Disposal

Onsite disposal of soils/dry sediments in an engineered structure has been retained for further consideration. Land encapsulation is a proven and well-demonstrated technology. A facility would be designed and constructed to contain the excavated materials or residuals after treatment. An onsite, engineered structure has been determined to be potentially applicable although such a facility may not be practicable due to logistical issues.

5.2.6.2 Offsite Disposal

Among the offsite disposal options considered were a new facility at a location in Ohio, or an existing federal or commercially licensed facility. A new offsite disposal facility in Ohio could be designed to reduce potential exposure and minimize the migration of impacted material. A properly designed disposal facility is considered protective of public health. This option could be considered if land is made available or treatment significantly reduces waste volume. Therefore, a newly constructed offsite disposal facility has been determined to be potentially applicable and is retained for further consideration for FBQ.

Existing federal or commercially licensed and permitted disposal facilities exist for the types of waste at RVAAP and are retained for further consideration. An offsite disposal at an existing site is retained for further evaluation.

5.2.6.3 Handling

Offsite disposal requires waste materials to be transported to the selected disposal facility. A number of transportation options exist including trucks, railcars, and barges. These modes of transportation could be used individually or in combination to haul waste materials from RVAAP to the disposal facility. The scenarios for transportation could include trucking to a rail loading facility, direct trucking to the disposal facility, or trucking to a barge loading facility. Railcar is not considered feasible as an operable spur is not present at FBQ. Similarly, barges are not retained as a sufficient navigable waterway is not located proximate to the AOC. Trucks have been used successfully for the types of waste that will be generated at FBQ and will be retained for further consideration.

5.2.7 Process Options Retained from Initial Screening

The process options retained through the initial screening process are summarized in Table 5-2. These options are further evaluated (Section 5.3) to identify the best set of options from which to develop remedial alternatives for FBQ.

Table 5-2. Summary of Process Options Retained from Initial Screening for Soils/Dry Sediments

Process Option
No Action
Land Use Controls and 5-year Reviews
Bulk Removal
Excavation
In Situ Physical/Chemical
Electrokinetic Separation
Ex Situ Physical/Chemical
Chemical Extraction
Soil Washing
Stabilization/Solidification
Disposal
Onsite Engineered Land Encapsulation
Offsite Newly Constructed Facility
Onsite Existing Facility
Handling
Truck

5.3 DETAILED SCREENING OF TECHNOLOGIES

The remedial action technologies retained from the initial screening process described in Section 5.2 were further evaluated against criteria of effectiveness, implementability, and cost (three of the NCP balancing criteria). The rationale for either retaining or eliminating options is presented below and summarized in Table 5-3 for soils/dry sediments.

5.3.1 Criteria Used for Detailed Screening

Remedial action technologies retained from the initial screening process were further evaluated using three criteria (i.e., effectiveness, implementability, and cost) to determine the most appropriate technologies for remediating FBQ. The remedial options retained from detailed screening process were used to develop the remedial alternatives described in Chapter 6.

5.3.1.1 Effectiveness

The effectiveness criterion assesses the ability of a remedial technology to protect human health and the environment by reducing the toxicity, mobility, or volume of contaminants. Each technology was evaluated for the ability to achieve RAOs, potential impacts to human health and the environment during construction and implementation, and overall reliability of the technology.

5.3.1.2 Implementability

Each process option technology was evaluated for implementability in terms of technical feasibility, administrative feasibility, and availability of the necessary materials, equipment, and work force. The assessment considers each technology's short and long term implementability. Short-term implementability considerations include constructability of the remedial technology, near term reliability, and the ability to obtain necessary approvals, with other agencies, and the likelihood of obtaining a favorable community response. Long-term implementability evaluates the ease of undertaking additional remedial actions if necessary, monitoring the effectiveness of the remedy, and operation and maintenance (O&M).

5.3.1.3 Cost

The cost criterion evaluates each remedial process in terms of relative capital and O&M costs. Costs for each technology are rated qualitatively, on the basis of engineering judgment, in terms of cost effectiveness. Therefore, a low cost remedial technology would be rated as highly cost effective, while a costly technology would be evaluated as being of low cost effectiveness.

5.3.2 No Action

The no action alternative provides a baseline for comparison with all other remedial alternatives and is required by CERCLA. Under this alternative, any access restrictions, remedial actions, monitoring will be discontinued. This alternative provides no additional protection for human health and the environment. No remedial actions would be taken to reduce, contain, or remove contaminated soils and no effort would be made to prevent or minimize human and environmental exposure to residual contaminants. Offsite migration of contaminants would not be mitigated under this alternative.

Potential effects on human health and the environment under this alternative are evaluated in the RI Report. The RI Report indicated human health risks for current use at FBQ are in exceedance of the acceptable cancer risk of 1E-06 and the HI is in exceedance of 1. Under the no action alternative, there would be no reduction in the mobility, volume, or toxicity of SRCs.

5.3.3 Land Use Controls and 5-year Reviews

Land use controls and 5-year reviews generally are not used as the sole remedy, but are integrated and supplement implementation of an engineering remedy. The protectiveness of a remedy utilizing land use controls can be enhanced by layering or employing mutually reinforcing land use controls.

Effectiveness: Land use controls are physical, legal and administrative mechanisms designed to maintain the elements of a remedy and ensure its protectiveness. Land use controls would increase the protection of human health and the environment over baseline (i.e., no action) conditions by restricting or limiting AOC use.

Although there would be no reduction in volume, toxicity, or mobility of contaminants in media onsite, future risk could be maintained at acceptable levels provided durable land use controls could be implemented, maintained, and enforced. 5-year reviews (including the environmental monitoring program) should continue as long as the land use controls remain in effect to ensure appropriate controls continue to be implemented and maintained.

Implementability: Access restrictions are currently in place at FBQ. The US Army has managed this land in the past under internal polices and procedures and future use of FBQ will involve AOC transfer between two US Army organizations. These process options would be easily implemented.

Cost: Implementing land use controls are moderate to highly cost effective. Potential legal fees, compensation for implementing land use controls, administrative fees, and possible property purchases could decrease the cost effectiveness of this alternative. The high cost effectiveness rating would include only legal fees; the moderate rating would be the purchase of a real estate interest (e.g., a negative easement). Both high and moderate cost ratings include environmental monitoring to conduct 5-year reviews. Capital cost would be low but O&M costs could be significant. Environmental monitoring would include periodic sampling and is considered to be low capital and low O&M costs.

Land use controls and 5-year reviews are retained for inclusion in remedial alternatives for FBQ.

5.3.4 Removal

Removal technologies protect human health and the environment by physically separating the impacted materials from potential receptors. The removal process option (i.e., excavation of soils/dry sediments) was retained for FBQ for detailed screening.

<u>Effectiveness</u>: Soils/dry sediments removal is effective in protecting human health and the environment and reducing future residual risk. The potential for exposure to fugitive dust, contaminant leaching, and generation of contaminated surface water runoff would be greatly reduced with implementation of this option.

<u>Implementability</u>: Soils/dry sediments excavation is easily implemented using readily available resources and conventional earth-moving equipment. Some ancillary construction activities may be necessary such as temporary roads, a staging area for loading and unloading, soil erosion control, excavation dewatering, water treatment, dust control, and additional clearing and grubbing. Administrative coordination between remediation activities and OHARNG operations would need to be well planned to minimize impacts.

<u>Cost</u>: The cost effectiveness of soils/dry sediments removal is rated moderate to low. Capital costs related to soil removal are moderate. O&M costs would be low.

Removal technologies are retained.

5.3.5 Physical/Chemical Treatment

Site-specific laboratory or pilot scale data are not currently available to assess the potential effectiveness of the physical treatment technologies. Published literature, previous experience at other sites, and vendor information were used to judge effectiveness, implementability, and cost.

5.3.5.1 <u>In Situ Electrokinetic Separation</u>

In situ electrokinetic separation was initially screened as potentially applicable to the FBQ. Results of the detailed screening analysis are presented below.

<u>Effectiveness</u>: Electrokinetic separation is effective at further concentrating metals and polar organic compounds for more directed and lower-volume removal. It is most effective in low permeability clayey soils due to the tendency for clay particles to be charged.

<u>Implementability</u>: Implementing in situ electrokinetic at FBQ would be difficult. Contaminated soils/dry sediment is located in drainage ditches and areas prone to flooding. Soils/dry sediments would require excavation and possibly further treatment after separation. The materials would be lower in volume than the original waste material. This process is best used in small areas with diffuse concentrations. The variable soils encountered at FBQ may hinder implementation. Qualified vendors and equipment are readily available to perform this treatment operation.

Cost: The cost effectiveness of in situ electrokinetic separation technology is rated moderate to low. Capital costs would be high, although no O&M costs beyond the initial treatment are expected. Disposal costs would be decreased with this treatment alternative due to the decreased volume of waste requiring disposal, assuming that remaining contaminant concentrations do not require additional disposal requirements.

Electrokinetic separation is not retained for further evaluation for the FBQ. Potential implementation difficulties due to AOC conditions combined with cost effectiveness considerations render this option undesirable.

5.3.5.2 Ex Situ Chemical Extraction and Soil Washing

Chemical extraction and soil washing are similar technologies which utilize a solvent to extract contaminants from soils/dry sediments media. Both technologies were initially screened to be applicable to FBQ. Detailed screening results are described below.

Effectiveness: Chemical extraction and soil washing are proven effective technologies for numerous organic and inorganic contaminants. The treatment effectiveness for COCs, particularly SVOCs and explosive constituents, is uncertain. Laboratory and conceptual design studies would need to be conducted on soils from FBQ to assess treatment processes. Both chemical extraction and soil washing likely would produce waste streams requiring additional treatment and/or disposal.

Implementability: Chemical extraction or soil washing would be moderately difficult to implement onsite. Formulating a solvent mixture capable of treating RVAAP's COCs may be problematic. In addition, chemical extraction typically involves solvent recovery by conventional distillation. Heating solvent containing explosives may present safety issues. Alternatively, discharging solvent from chemical extraction or soil washing processes may require substantial pretreatment and approval processing from regulatory agencies.

Cost: Both chemical extraction and soil washing are moderate to low in terms of cost effectiveness. The small total volumes of contaminated soils/dry sediments and high start up costs for the treatment systems reduce the cost effectiveness of these technologies.

Chemical extraction and soil washing are not retained for FBQ due to the questionable effectiveness of the technology, difficulty of implementation, and low potential cost effectiveness.

5.3.5.3 Ex Situ Stabilization/Solidification

Effectiveness: Ex situ S/S consists of chemical fixation or vitrification. S/S via chemical fixation is one of the oldest most established remediation technologies available. It has been successfully used to reduce the mobility of metal and organic-contaminants in waste. Treatment effectiveness generally is limited for SVOCs and explosives. Treatment of soils/dry sediments by S/S poses minimal risks to the local community and workers. Some dust may be generated during excavation; however, the amount generated would be equivalent to that generated with any remedial alternative requiring excavation and soil handling. Most chemical fixation processes result in a significant volume increases (up to double the original volume) and are typically most effective at treating metal-contaminated waste to meet disposal facility acceptance criteria.

Vitrification is typically used to address highly concentrated mobile contaminants, unlike those at the FBQ. Vitrification poses a much higher risk to onsite workers compared to other treatment operations due to the high temperatures and specialized equipment required. Verifying that all of the contaminated soils have been successfully vitrified can be difficult, since the resulting glass matrix acts as a barrier to sampling not only at the glass matrix-soil interface, but also within the glass matrix itself.

Implementability: Ex situ S/S via chemical fixation is easy to moderate to implement at FBQ. Contaminated soils/dry sediments would require excavation and transport to a central staging area for onsite treatment. The S/S materials likely would be of greater volume than original waste amounts. The treated waste would then be manifested and sent offsite by a licensed transporter for disposal at a licensed disposal facility. Qualified vendors and equipment are readily available to perform this treatment operation.

Vitrification is moderate to difficult to implement. Vitrification has successfully treated organic and metal contaminants, but generally for much higher contaminants concentrations and smaller quantities of wastes. While some volume reduction occurs during melting, the total volume of the final waste material often increases due to the addition of glass formers. Qualified vendors and equipment are available to perform this treatment operation.

Cost: The cost effectiveness of chemical fixation technologies for FBQ is moderate. Disposal costs may be significantly increased due to the larger waste volumes requiring disposal. Vitrification is low in terms of cost effectiveness with high capital costs for implementation. The small total volumes of contaminated soils/dry sediments and high start up costs for the treatment systems reduce the cost effectiveness of these technologies.

Ex situ S/S via chemical fixation is not retained for FBQ. This treatment technology would be a viable option for large amounts of soils/dry sediments requiring removal and treatment. However, the limited amounts of modeled volume (as shown in Appendix 3B), setting up a treatment process for the limited volumes is not practical. Vitrification is not retained due to the uncertainties associated with confirmation sampling, high cost, and potential dangers to onsite workers during implementation.

5.3.6 Disposal and Handling

Initial screening results indicated three disposal options and one handling are potentially applicable to FBQ. Detailed screening evaluations for these remedial technologies are presented below.

5.3.6.1 Onsite Disposal at a New Engineered Structure

This option involves the design and construction of a new disposal facility onsite.

Effectiveness: Onsite disposal at a new engineered structure would be effective for physically separating impacted materials from potential receptors. Effectiveness concerns for onsite disposal include the ability of the AOC to meet engineering design criteria (i.e., geologic conditions, foundation soils, groundwater, seismic activity) for the siting and licensing of a disposal cell in the state of Ohio.

Implementability: The design and construction of a new disposal facility onsite would be difficult. Siting studies, facility design, environmental assessments and/or environmental impact statements, and public review would be required prior to implementation of this option. The public may have concerns regarding a new onsite disposal facility if adequate disposal capacity existed elsewhere. These requirements could result in unacceptable delays. During the selection process, activities related to the construction and operation of the facility would be analyzed, and studies would be required to eliminate or minimize unacceptable impacts. The State of Ohio siting and licensing process also would render this alternative technology difficult to implement administratively. This option will also introduce long term surveillance, monitoring, and maintenance requirements.

Cost: A new onsite disposal cell would be low in terms of cost effectiveness. Capital costs would be substantial and would be accompanied by moderate to high O&M costs for maintenance. There would be no disposal fees associated with a dedicated onsite facility.

The design and construction of a new disposal facility onsite is not retained for FBQ. The difficulty in implementing this option combined with low cost effectiveness render this option undesirable.

5.3.6.2 Offsite Disposal at a New Engineered Structure

This option involves the design and construction of a new offsite disposal facility.

Effectiveness: The design and construction of a new offsite disposal facility would be effective in protecting human health and the environment by physically separating impacted materials from potential receptors.

Implementability: Establishing a new disposal facility offsite would be similarly difficult as the design and construction of an onsite structure. The new offsite facility would face the technical requirements and potential public concerns as described in Section 5.4.7.1.

Cost: The cost effectiveness of a new offsite disposal cell would be low. Capital costs would be high with moderate to high O&M costs. There would be no disposal fees associated with a dedicated offsite facility.

The design and construction of a new disposal facility offsite is not retained for FBQ. This option is difficult to implement and has a low cost effectiveness thereby making this option undesirable.

5.3.6.3 Offsite Disposal at an Existing Facility

This option involves the utilization of an existing disposal facility to manage wastes.

Effectiveness: The use of an existing disposal facility would be effective in protecting human health and the environment. Many licensed and permitted facilities can accept waste streams similar to those anticipated to be generated at RVAAP. These facilities are very effective at isolating the material so as to prevent its impacting human health or the environment. By removing, but not treating contaminated soil, no reduction in toxicity, mobility, or volume is achieved. However, future risk is reduced by removing this material from the RVAAP. Offsite disposal options would be effective in terms of containing wastes generated by the AOC remediation and separating impacted materials from potential receptors.

Implementability: Using an existing facility to dispose of waste would be easily implemented based on previous disposal activities conducted at RVAAP. Additional contracts would need to be negotiated if impacted material is to be sent to a facility not currently contracted. A number of properly permitted facilities are available in the United States that could serve as locations for disposal of some or all of the potential waste streams. Additionally, a number of licensed transporters should be available to haul properly documented waste.

Since several facilities may be contracted to receive different waste streams, a mechanism would need to be in place to ensure that the waste was properly segregated and that the regulatory agencies are satisfied with the procedures.

Cost: The cost effectiveness of utilizing a licensed and permitted disposal facility is rated to be moderate. There would be no long-term O&M costs since soil contaminated above cleanup goals would be removed from the AOC.

Offsite disposal at an existing facility is retained.

5.3.7 Handling

Effectiveness: The transportation options for hauling contaminated soils involve the individual use of trucks for shipment from the AOC to the selected disposal facility. Trucks have been used extensively at other sites and are very effective due to their adaptability to route conditions. Trucks become less effective with greater haul distances due to safety concerns.

Implementability: The use of trucks is commonly implemented for transporting contaminated soils. Truck transportation uses readily available resources and conventional transportation equipment. Waste would be manifested or a bill-of-lading secured with all supporting documentation and a licensed transporter secured.

Cost: The cost effectiveness of transporting wastes by truck is moderate to low, depending on hauling distance.

Truck transportation is retained.

5.4 RETAINED PROCESS OPTIONS FOR SOILS/DRY SEDIMENTS

Table 5-4 summarizes the process options retained through the detailed screening process (Sections 5.2 and 5.3) for impacted soils/dry sediments at FBQ.

Table 5-4. Retained Process Options for Soils/Dry Sediments

General Response Action	Technology Type	Process Option
Land Use Controls and 5-year Reviews	Controls	Government, Enforcement, Informational, Legal Mechanisms, Physical Mechanisms
		Physical barriers, permanent markers, security personnel
	Environmental Monitoring	Groundwater, Surface Water
Removal	Bulk Removal	Excavation (Soils/Dry Sediments)
Disposal and Handling	Offsite (Soils/Dry Sediments)	Trucks

These options were used individually or in combination in the development of remedial alternatives described in Chapter 6 of this FS to address COCs in soils/dry sediments at FBQ.

Table 5-1. Initial Screening of Technology Types and Process Options for Soils/Dry Sediments

General Response Action	Technology Type	Process Options	Description	Screening Comments
No Action	None	None	No remedial technologies implemented to reduce hazards to potential human or ecological receptors.	Required to be carried through CERCLA analysis.
Land Use Controls and 5-year Reviews	Controls	Government Controls	The managing authority could include a Facility Master Plan and installation-specific regulations to manage property and enforce management strategies.	Potentially applicable. May limit future land use options, depending on alternative selected and amount of contamination remaining.
		Enforcement Tools	Administrative orders and consent decrees available under CERCLA, can prohibit certain land uses by a party or require proprietary controls be put in place.	
		Informational Devices	Registries or advisories put in place to provide information that residual or capped contamination is onsite.	
		Legal Mechanisms	Easements, deed restrictions, etc. placed on a property as part of a contractual mechanism.	
		Physical Mechanisms	Fences, berms, warning signs, and security personnel put in place to prevent contact with contaminated media.	
	Environmental Monitoring	Groundwater	Periodic monitoring of groundwater to ensure that contaminant migration from soils to groundwater is not occurring.	Potentially applicable. Required with alternatives where contamination remains above levels suitable for residential land use.
		Surface Water	Periodic monitoring of surface water to ensure contaminant migration from soils to surface water is not occurring.	Potentially applicable. Required with alternatives where contamination remains above levels suitable for residential land use.

Table 5-1. Initial Screening of Technology Types and Process Options for Soils/Dry Sediments (continued)

General Response Action	Technology Type	Process Options	Description	Screening Comments
Containment	Capping (Soils/Dry Sediments)	Native Soils/Dry Sediments	Uses native soils or sediment to cover contamination and reduce migration by wind and water erosion.	Not applicable. COC associated with sediment in drainage ditch. Impractical to construct a capping system within such a structure and maintain the ditch's intended use.
		Clay	Installation of clay cap to limit water infiltration. Susceptible to weathering effects (e.g. cracking).	
		Synthetic Liner	Synthetic materials used to limit water infiltration, not as susceptible to cracking as clay.	
		Multi-Layered	Multiple layers of different soil types used to limit water infiltration, not as susceptible to cracking as clay.	
		Asphalt/Concrete	Limits water infiltration, susceptible to cracking if not properly maintained.	
Removal	Bulk Removal	Excavation (Soils/Dry Sediments)	Mechanically or hydraulically operated units such as excavators, front-end loaders, and bulldozers, and/or hand tools are used for trenching and other subsurface excavation.	Potentially applicable for dry sediment.
Treatment	In Situ Physical/ Chemical (Soils/Dry Sediments)	Chemical Redox	Addition of chemicals to raise or lower oxidation state of contaminants, chemically converting hazardous materials to less hazardous or non-toxic.	Not applicable. Not effective for FBQ COCs.
		Electrokinetic Separation	Low voltage current applied to media by ceramic electrodes. Positively and negatively charged metal and organic ions migrate to opposite electrodes.	Potentially applicable for dry sediment.
		Fracturing	Creation through various methods of horizontal or vertical cracks in the media to enhance use of other remedial techniques.	Not applicable. COC associated with sediment in drainage ditch. Impractical to install horizontal fractures. Vertical fractures counter productive.
		Soil Flushing	Injection of water (with or without co-solvents) to promote leaching of contaminants.	Not applicable. FBQ conditions (i.e., sediment in drainage ditch) render in situ flushing impractical.
		Soil Vapor Extraction	Vacuum is applied to soil to control air movement and extract volatile contaminants in gaseous form.	Not applicable. Not effective for FBQ COC. Conditions (i.e., sediment in drainage ditch) render soil vapor extraction impractical.
		Stabilization/Solidification	Immobilizes contaminants in the matrix in which they are found, using various techniques such as cement injection or vitrification.	Not applicable. FBQ conditions (i.e., sediment in drainage ditch) render in situ stabilization / solidification difficult.

Table 5-1. Initial Screening of Technology Types and Process Options for Soils/Dry Sediments (continued)

General Response Action	Technology Type	Process Options	Description	Screening Comments
Treatment (continued)	Ex Situ Physical/ Chemical (Soils/Dry Sediments)	Chemical Extraction	Acids or solvents are applied to soils to remove contaminants, then passed through a separator to remove contaminants from the extraction.	Potentially applicable.
		Chemical Redox	See above (In Situ Chemical Redox).	Not applicable. Not effective for FBQ COC.
		Dehalogenation	Uses various methods to remove a halogen molecule from organics, reducing toxicity.	Not applicable. Not effective for FBQ COC.
		Soil Washing	Reduces contaminated media volume by dissolving or suspending contaminants, or physically separating uncontaminated portions from contaminated portions.	Potentially applicable.
		Stabilization/Solidification	See above (In Situ Stabilization/Solidification).	Potentially applicable.
	Biological (Soils/Dry Sediments)	Bioremediation	A favorable environment is created for microbe, fungus, or plant systems to utilize and breakdown contaminants.	Not applicable. Not effective for FBQ COC and AOC conditions.
		MNA	Passive remedial measure relies on natural processes to reduce contaminant concentration.	
	Ex Situ Thermal Treatment (Soils/Dry Sediments)	Incineration	High temperatures are applied to combust (in the presence of oxygen) organic contaminants.	Not applicable. Not effective for FBQ COC.
		Pyrolysis	Organic compounds are decomposed by applying heat in the absence of oxygen, resulting in gaseous components and a solid residue of fixed-carbon ash.	Not applicable. Not effective for FBQ COC.
		Thermal Desorption	Heat is applied to volatilize water and organics, which are carried to a gas treatment system.	Not applicable. Not effective for FBQ COC.

Table 5-1. Initial Screening of Technology Types and Process Options for Soils/Dry Sediments (continued)

General Response Action	Technology Type	Process Options	Description	Screening Comments
Disposal and Handling	Onsite (Soil/ Dry Sediments)	Engineered Land Encapsulation	An onsite facility is constructed to house contaminated media, preventing contaminant migration.	Potentially applicable.
	Offsite (Soils/Dry Sediments)	Newly Constructed Facility	A newly constructed offsite facility designed specifically to house the contaminated media being removed from the AOC.	Potentially applicable.
		Existing Facility	An existing disposal facility that meets the requirements to house contaminated media from the AOC.	Potentially applicable.
	Handling	Truck	Transportation of wastes from the AOC to the disposal facility.	Potentially applicable.
		Railcar		Not applicable. No operable rail spur located proximate to AOC.
		Barge		Not applicable. No sufficient navigable waterway located proximate to AOC.

AOC = Area of concern.
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act.
COC = Constituent of concern.
FBQ = Fuze and Booster Quarry Landfill/Ponds.
MNA = Monitored natural attenuation.

Table 5-3. Detailed Screening of Technology Types and Process Options for Soils/Dry Sediments

General Response Action	Technology Type	Process Options	Detailed Screening Criteria: Effectiveness	Detailed Screening Criteria: Implementability	Detailed Screening Criteria: Cost	Screening Results
No Action	None	None	Not effective. Required to be carried through the CERCLA analysis.	Easy	Highly cost effective. No costs associated with implementation.	Retained
Land Use Controls and 5-year Reviews	Controls	Government, Enforcement, Informational, Legal Mechanisms, Physical Mechanisms	Effective for mid to long term. Information devices effective for short-term.	Easy to moderate. Legal mechanisms may be easy to difficult to implement.	Moderate to high cost effectiveness.	Retained
		Physical barriers, permanent markers, security personnel	Short-term effectiveness in reducing exposure.	Easy	Moderate to high cost effectiveness.	Retained
	Environmental Monitoring	Groundwater and Surface Water	Documents AOC conditions. Does not reduce risk but will act as a preventative measure by providing information concerning changes in conditions.	Easy	Moderate to high cost effective.	Retained
Removal	Bulk Removal	Excavation (Soils/Dry Sediment)	Effective.	Easy	Moderate to low cost effectiveness.	Retained

Table 5-3. Detailed Screening of Technology Types and Process Options for Soils/Dry Sediments (continued)

General Response Action	Technology Type	Process Options	Detailed Screening Criteria: Effectiveness	Detailed Screening Criteria: Implementability	Detailed Screening Criteria: Cost	Screening Results
Treatment	Ex Situ Physical/Chemical (Soils/Dry Sediments)	Chemical Extraction	Treatment effectiveness for FBQ COCs uncertain pending treatability studies. Will produce waste streams requiring additional treatment or disposal.	Moderately difficult	Moderate to low cost effectiveness. Small soil volumes and treatment systems high start up cost reduce cost effectiveness of system.	Not Retained
		Soil Washing				
		Stabilization/Solidification	Generally limited effectiveness in treating high levels of SVOCs. A treatability study will be required to determine effectiveness for FBQ COC. May result in net increases in waste volumes.	Easy to moderate	Moderate to low cost effectiveness. Small soil volumes and treatment systems high start up cost reduce cost effectiveness of system.	Not Retained
Disposal and Handling	Onsite (Soils/Dry Sediments)	Engineered Land Encapsulation	Effective at physically separating contaminants from possible receptors.	Difficult	Low cost effectiveness.	Not Retained
	Offsite (Soils/Dry Sediments)	Newly Constructed Facility	Effective at physically separating contaminants from possible receptors.	Difficult	Low cost effectiveness.	Not Retained
		Existing Facility	Effective at physically separating contaminants from possible receptors.	Easy	Moderate cost effectiveness.	Not Retained
	Handling	Trucks	Effective	Easy	Moderate to low effectiveness, depending on distance	Retained

AOC = Area of concern.
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act.
COC = Constituent of concern.
FBQ = Fuze and Booster Quarry Landfill/Ponds.
SVOC = Semivolatile organic compound.

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6.0 DEVELOPMENT OF REMEDIAL ALTERNATIVES

This chapter describes the remedial alternatives assembled for impacted chemical contamination in soils/dry sediments at FBQ. The remedial alternatives were constructed by combining general response actions, technology types, and process options retained from the screening processes described in the previous chapter. Remedial alternatives should assure adequate protection of human health and the environment, achieve RAOs, meet ARARs, and permanently and significantly reduce the volume, toxicity, and/or mobility of COCs. These alternatives will not address any MEC contamination at FBQ. MEC contamination will be addressed under the MMRP.

The remedial alternatives presented herein address impacted soils/dry sediments at FBQ (Section 3.6) and the remedial alternatives encompass a range of potential remedial actions:

- Alternative 1: No Action;
- Alternative 2: Limited Action;
- Alternative 3: Excavation of Soils/Dry Sediments with Offsite Disposal ~ National Guard Trainee Land Use; and
- Alternative 4: Excavation of Soils/Dry Sediments with Offsite Disposal ~ Resident Subsistence Farmer Land Use.

Alternative 1 is the no action response required under the NCP. Alternative 2 relies on land use controls. No source control or removal actions are implemented under Alternative 2. Removal technologies (i.e., excavation) are included in Alternatives 3 and 4 and involve excavating impacted soils/dry sediments and disposal at an offsite facility.

Time periods for environmental monitoring were developed dependent on relevant ARARs and the specific technologies employed under each remedial alternative. For the no action alternative, the assumed time period is zero. For Alternative 2, O&M was assumed to be conducted for 30 years. For Alternatives 3 and 4, O&M sampling will not be conducted since the alternatives meet residential preliminary cleanup goals.

6.1 ALTERNATIVE 1: NO ACTION

Under Alternative 1, current access restrictions and monitoring programs at FBQ will be discontinued and no additional actions will be implemented. Alternative 1 provides no additional protection to human health and the environment over current conditions. This remedial alternative is required under NCP as a no action baseline against which other remedial alternatives can be compared.

Since soils/dry sediments will remain under Alternative 1, any impacts to groundwater also would continue. Existing legal and administrative mechanisms and physical mechanisms (e.g., RVAAP perimeter fence) would not be maintained or enforced. Environmental monitoring would not be performed. In addition, no restrictions on land use would be pursued.

6.2 ALTERNATIVE 2: LIMITED ACTION

Alternative 2 relies on land use controls to limit exposures to COCs in soils/dry sediments. Impacted media would be left in place with no active remedial measures implemented. Utilization of FBQ is assumed to correspond to OHARNG established future land use for FBQ. An O&M period would be implemented. A 30-year O&M period is assumed for costing purposes. Prior to implementation of Alternative 2, a Remedial Design detailing 5-year review requirements, location and frequency of environmental monitoring, and any land use controls to address chemical contamination in soils/dry sediments would be developed. 5-year reviews will be conducted to evaluate the protectiveness of this remedy until the AOC achieves conditions necessary for residential use. Additionally, land use controls may be required due to potential MEC issues; these would be developed and implemented by the US Army and OHARNG under the guidance of the MMRP.

A Remedial Design would be developed to address maintenance activities, monitoring requirements (such as 5-year reviews), and land use controls. The plan would address existing access restrictions. A more detailed discussion of the land use controls would be developed as part of the Remedial Design, including notification requirements for changes in land use or access restrictions. Coordination with any planned OHARNG AOC improvement and environmental monitoring activities would be necessary to ensure consistency with FBQ's designated land use and RAOs for FBQ. Pursuant to CERCLA, a review would be conducted every five years, as COCs would remain onsite above residential land use preliminary cleanup goals. 5-year reviews permit evaluation of all remedy components, including land use controls. Continued surveillance would ensure any land use changes or disturbances of impacted areas are identified.

6.3 ALTERNATIVE 3: EXCAVATION OF SOILS/DRY SEDIMENTS AND OFFSITE DISPOSAL ~ NATIONAL GUARD TRAINEE LAND USE

Alternative 3 consists of excavating impacted soils/dry sediments to meet the preliminary cleanup goals for the National Guard Trainee. Excavated soils/dry sediments would be subsequently disposed of offsite at the licensed disposal facility. Removing impacted soils/dry sediments would reduce the source of further impacts to groundwater and surface water via leaching and/or direct contact. Utilization of the AOC is assumed to correspond to OHARNG established future land use (National Guard Trainee). This alternative also attains preliminary cleanup goals for residential land use (Resident Subsistence Farmer). Because the alternative attains preliminary cleanup goals for a Resident Subsistence Farmer, O&M and CERCLA 5-year reviews with respect to chemical contamination will not be required. However, land use controls with respect to MEC issues will be implemented by the US Army and OHARNG. Alternative 3 will require coordination of remediation and monitoring activities with OHARNG and the US Army. Such coordination will minimize health and safety risks to onsite personnel and potential disruptions during remediation activities. Components of this remedial alternative include:

- Remedial Design Plan;
- Excavation;
- Handling of waste materials;

- Offsite disposal;
- Confirmatory sampling; and
- Restoration.

Remedial design plan. A remedial design plan would be developed prior to the initiation of remedial construction activities. This plan would detail preparation activities, the extent of the excavation, implementation and sequence of construction activities, decontamination, and segregation, transportation, and disposal of various waste streams. Engineering and administrative controls (e.g., erosion controls, health and safety controls) will be developed during the active construction period to ensure remedial workers and the environment are protected. Subsequent land use controls, reviews, and environmental monitoring and would not be necessary as there will be no soils/dry sediments onsite above residential land use preliminary cleanup goals after the implementation of this alternative.

Excavation. Impacted soils/dry sediments above National Guard Trainee land use preliminary cleanup goals would be excavated and transported to a staging area for loading trucks. The extent of impacted soils/dry sediments at FBQ is depicted in Figure 3B-1 (Appendix 3B). Total disposal volume (i.e., ex situ) is estimated to be 102 yd^3. Impacted soils/dry sediments removal would be accomplished using standard construction equipment such as excavators, bulldozers, front-end loaders, and scrapers. Excavation would be guided using a limited quantity of analytical samples. Oversize debris would be crushed or otherwise processed to meet disposal facility requirements. Movement of impacted soils/dry sediments would be performed using dump trucks and conventional construction equipment. Erosion control materials such as silt fences and straw bales would be installed to minimize erosion. Impacted soils/dry sediments would be kept moist or covered with tarps to minimize dust generation. Excavation would take place in stages to limit impacts to current activities. The safety of remediation workers, onsite employees, and the general public would be covered in a site-specific health and safety plan. The health and safety plan would address potential exposures and monitoring requirements to ensure protection.

Handling. Impacted soils/dry sediments would be hauled to a licensed and permitted disposal facility by truck. Trucks would be lined with polyethylene sheeting and covered with specially designed tarps or hard covers to prevent release of impacted soils/dry sediments. The trucks would be inspected prior to use and leaving the AOC. Appropriate bills-of-lading (in accordance with U. S. Department of Transportation (DOT) regulations for shipment of impacted materials on public roads) would accompany waste shipments. Only regulated and licensed transporters and vehicles would be used. The trucks will travel pre-designated routes and an emergency response plan will be developed in the event of a vehicle accident.

Transportation activities would be performed in accordance with a site-specific Transportation and Emergency Response Plan (TERP) developed in the remedial design plan. The TERP would evaluate the types and number of vehicles to be used; the safest transportation routes including considerations to minimize use of high traffic roads, public facilities, or secondary roads not designed for trucks; and emergency response procedures for responding to a vehicle accident.

Offsite Disposal. Impacted soils/dry sediments would be disposed of at an existing facility licensed and permitted to accept the characterized waste stream. The selection of an appropriate facility will consider the types of wastes, location, transportation options, and cost. Waste streams with different constituents and/or characteristics may be generated. Disposal cost savings may be possible by utilizing specific disposal facilities for different waste streams.

Confirmatory sampling. Confirmation sampling would be conducted after excavation of each area. The sampling would confirm National Guard Trainee land use preliminary cleanup goals have been achieved. Areas successfully remediated would be available for appropriate restricted land use only.

Restoration. Excavated areas that have attained the preliminary cleanup goals will be backfilled, if appropriate, with clean soil (un-impacted soil excavated from the AOC and offsite fill) and re-vegetated. Fill would be tested prior to placement to ensure compliance with acceptance criteria established in the design work plan.

6.4 ALTERNATIVE 4: EXCAVATION OF SOILS/DRY SEDIMENTS AND OFFSITE DISPOSAL ~ RESIDENT SUBSISTENCE FARMER LAND USE

Alternative 4 consists of excavating impacted soils/dry sediments above Resident Subsistence Farmer land use preliminary cleanup goals and subsequent offsite disposal of removed materials. Achieving the residential land use applies only to chemical contamination in soils/dry sediments. The soil media will not be residential until MEC issues at the AOC are addressed under the MMRP. Removing impacted soils/dry sediments would address future impacts to groundwater via leaching and/or direct contact. This remedial alternative also would require coordination of remediation and monitoring activities with OHARNG and the US Army to minimize health and safety risks to onsite personnel and disruption of their activities. The time period to complete this remedial action would not include a monitoring period. Components of this remedial alternative include:

- Remedial Design Plan;
- Excavation;
- Handling of waste materials;
- Offsite disposal;
- Confirmatory sampling; and
- Restoration.

Remedial design plan. A remedial design plan would be developed prior to the initiation of remedial actions. This plan would detail preparation activities, the extent of the excavation, implementation and sequence of construction activities, decontamination, and segregation, transportation, and disposal of various waste streams. Engineering and administrative controls (e.g., erosion controls, health and safety controls) will be developed during the active construction period to ensure remedial workers and the environment are protected.

Excavation. Impacted soils/dry sediments would be excavated and transported to a staging area for loading into trucks. The extent of impacted soils/dry sediments at FBQ above Resident Subsistence Farmer land use preliminary cleanup goals is depicted in Figure 3B-2 (Appendix 3B). Total disposal volume (i.e., ex situ) is estimated to be 56 yd^3. This soil removal volume is less than that for Alternative 3 to attain Nation Guard Trainee preliminary cleanup goals because the COC for remediation is manganese, which has a higher inhalation risk factor for the Trainee than for the Resident Subsistence Farmer. The Trainee is assumed to be exposed to higher levels of airborne dust due to operation of mounted training equipment (e.g., trucks, tracked vehicles). Standard construction equipment such as excavators, bulldozers, front-end loaders, and scrapers would be used to remove impacted material. Excavation would be guided using a limited quantity of analytical samples. Oversize debris would be crushed or otherwise processed to meet disposal facility requirements. Movement of impacted soils/dry sediments would be performed using dump trucks and conventional construction equipment. Erosion control materials such as silt fences and straw bales would be installed to minimize erosion. Impacted soils/dry sediments would be kept moist or covered with tarps to minimize dust generation. Excavating would be phased to limit impacts to current production activities. The safety of remediation workers, onsite employees, and the general public would be addressed in a site-specific health and safety plan. The health and safety plan would address potential exposures and monitoring requirements to ensure protection.

Handling. Impacted soils/dry sediments would be hauled to a licensed and permitted disposal facility by truck. Trucks would be lined with polyethylene sheeting and covered with specially designed tarps or hard covers to prevent release of impacted soils/dry sediments. The trucks would be inspected prior to use and surveyed for contamination prior to leaving the AOC. The appropriate bill-of-lading (in accordance with DOT regulations for shipment of impacted materials on public roads) would accompany the waste shipment. Only regulated and licensed transporters and vehicles would be used. The transport vehicles will travel pre-designated routes with an emergency response plan developed to address potential vehicle accident.

Transportation activities would be performed in accordance with a site-specific TERP developed in the remedial design plan. The TERP would evaluate the types and number of vehicles to be used; the safest transportation routes including considerations to minimize use of high traffic roads, public facilities, or secondary roads not designed for trucks; and emergency response procedures for responding to a vehicle accident.

Offsite Disposal. Impacted soils/dry sediments would be disposed of at an existing facility licensed and permitted to accept the characterized waste stream. The selection of an appropriate facility will consider the types of wastes, location, transportation options, and cost. Cost savings may be realized by utilizing specific disposal facilities for different waste streams.

Confirmatory sampling. Confirmation sampling would be conducted after excavation of each area. The sampling would confirm Resident Subsistence Farmer land use preliminary cleanup goals have been achieved. Areas successfully remediated would be free for residential land use.

Restoration. Excavated areas that have attained Resident Subsistence Farmer land use preliminary cleanup goals will be backfilled, if appropriate, with clean soil (un-impacted soil excavated from the AOC and offsite fill) and re-vegetated. Fill would be tested prior to placement to ensure compliance with acceptance criteria established in the design work plan.

Table 6-1. Summary of Remedial Alternatives

Alternative 1 – No Action This remedial alternative provides no further remedial action and is included as a baseline for comparison with other remedial alternatives. Access restrictions and environmental monitoring would be discontinued. The AOC will no longer have legal, physical, or administrative mechanisms to restrict AOC access. Additional actions regarding monitoring or access restrictions will not be implemented. 5-year reviews would not be conducted in accordance with CERCLA 121(c).
Alternative 2 – Limited Action This remedial alternative involves the implementation of land use controls and periodic monitoring (i.e., 5-year reviews) to detect any changes in the nature or extent of contamination at the AOC. Land use controls (e.g., administrative access and land use restrictions; warning and informational signs, no digging, no use of groundwater) would be developed and implemented by the US Army and OHARNG to deter unauthorized access to the AOC. 5-year reviews would be conducted in accordance with CERCLA 121(c).
Alternative 3 – Excavation of Soils/Dry Sediments with Offsite Disposal ~ National Guard Trainee Land Use This remedial alternative involves the removal and transportation of chemical contaminants in soils/dry sediments above National Guard Trainee land use preliminary cleanup goals for offsite disposal. Impacted soils/dry sediments would be excavated and transported to an offsite disposal facility licensed and permitted to accept these wastes. Confirmation sampling would be conducted to ensure National Guard Trainee land use preliminary cleanup goals have been achieved. Areas successfully remediated would be backfilled with clean soils/dry sediments, if appropriate. Alternative 4 does not include land use controls, CERCLA 5-year reviews, or O&M sampling as residential land use preliminary cleanup goals are attained through remedial actions conducted under this remedial alternative. However, land use controls with respect to MEC issues will be implemented by the US Army and OHARNG.
Alternative 4 – Excavation of Soils/Dry Sediments with Offsite Disposal ~ Resident Subsistence Farmer Land Use This remedial alternative involves the removal and transportation of chemical contaminants in soils/dry sediments above Resident Subsistence Farmer land use preliminary cleanup goals for offsite disposal. Impacted soils/dry sediments would be excavated and transported to an offsite disposal facility licensed and permitted to accept these wastes. Confirmation sampling would be conducted to ensure Resident Subsistence Farmer land use preliminary cleanup goals have been achieved. Areas successfully remediated would be backfilled with clean soils/dry sediments, if appropriate. Alternative 4 does not include land use controls, reviews, or O&M sampling as residential land use preliminary cleanup goals are attained through remedial actions conducted under this remedial alternative. However, land use controls with respect to MEC issues will be implemented by the US Army and OHARNG.

CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act.
O&M = Operations and maintenance.
OHARNG = Ohio Army National Guard.

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7.0 ANALYSIS OF REMEDIAL ALTERNATIVES

7.1 INTRODUCTION

This chapter presents a detailed analysis of the four remedial alternatives that have been formulated for further evaluation. From this set of alternatives, one or more will ultimately be chosen as the remedy for contaminated soils/dry sediments at FBQ. Under the CERCLA remedy selection process, the preferred remedial alternative is suggested in the Proposed Plan and set forth in final form in the ROD. A detailed evaluation of each alternative is performed in this chapter to provide the basis and rationale for identifying a preferred remedy and preparing the Proposed Plan.

To ensure the FS analysis provides information of sufficient quality and quantity to justify the selection of a remedy, it is helpful to understand the requirements of the remedy selection process. This process is driven by the requirements set forth in CERCLA Section 121. In accordance with these requirements (USEPA 1988), remedial actions must:

- Be protective of human health and the environment;
- Attain ARARs;
- Be cost effective;
- Use permanent solutions and alternative treatment technologies to the maximum extent practicable; and
- Satisfy the preference for treatment that, as a principle element, reduces volume, toxicity, or mobility.

CERCLA emphasizes long-term effectiveness and related considerations for each remedial alternative. These statutory considerations include:

- Long-term uncertainties associated with land disposal;
- The goals, objectives, and requirements of the Solid Waste Disposal Act;
- The persistence, toxicity, and mobility of hazardous substances, and their propensity to bio-accumulate;
- Short- and long-term potential for adverse health effects from human exposure;
- Long-term maintenance costs;

- The potential for future remedial action costs if the remedial alternative in question were to fail; and
- The potential threat to human health and the environment associated with excavation, transportation, and re-disposal, or containment.

These statutory requirements are implemented through the use of nine evaluation criteria presented in the NCP. These nine criteria are grouped into threshold criteria, balancing criteria, and modifying criteria, as described below. A detailed analysis of each alternative against the evaluation criteria is contained in the following sections. The detailed analysis includes further definition of each alternative, if necessary, compares the alternatives against one another and presents considerations common to alternatives.

7.1.1 Threshold Criteria

Two of the NCP evaluation criteria relate directly to statutory findings that must be made in the ROD. These criteria are thus considered to be threshold criteria that must be met by any remedy to be selected. The criteria are:

1. Overall protection of human health and the environment; and
2. Compliance with ARARs.

Each alternative must be evaluated to determine how it achieves and maintains protection of human health and the environment. Similarly, each remedial alternative must be assessed to determine how it complies with ARARs, or, if a waiver is required, an explanation of why a waiver is justified. An alternative is considered to be protective of human health and the environment if it complies with media-specific preliminary cleanup goals.

7.1.2 Balancing Criteria

The five balancing criteria represent the primary criteria upon which the detailed analysis of alternatives and the comparison of alternatives are based. The criteria are:

1. Long-term effectiveness and permanence;
2. Reduction of toxicity, mobility, or volume through treatment;
3. Short-term effectiveness;
4. Implementability; and
5. Cost.

Long-term effectiveness and permanence is an evaluation of the magnitude of residual risk (risk remaining after implementation of the alternative) and the adequacy and reliability of controls used to manage the remaining waste (untreated waste and treatment residuals) over the long term. Alternatives that provide the highest degree of long-term effectiveness and permanence leave little or no untreated waste at the AOC, make long-term maintenance and monitoring unnecessary, and minimize the need for land use controls.

Reduction of toxicity, mobility, or volume through treatment is an evaluation of the ability of the alternative to reduce the toxicity, mobility, or volume of the waste. The irreversibility of the treatment process and the type and quantity of residuals remaining after treatment also are assessed.

Short-term effectiveness addresses the protection of workers and the community during the remedial action, the environmental effects of implementing the action, and the time required to achieve media-specific preliminary cleanup goals.

Implementability addresses the technical and administrative feasibility of implementing an alternative and the availability of various services and materials required during implementation. Technical feasibility assesses the ability to construct and operate a technology, the reliability of the technology, the ease in undertaking additional remedial actions, and the ability to monitor the effectiveness of the alternative. Administrative feasibility is addressed in terms of the ability to obtain approval from federal, state, and local agencies.

Cost analyses provide an estimate of the dollar cost of each alternative. The cost estimates in this report are based on estimating reference manuals, historical costs, vendor quotes, and engineering estimates. Costs are reported in base year 2005 dollars, or present value (future costs are converted to base year 2005 dollars using a 3.1% discount factor). The present value analysis is a method to evaluate expenditures, either capital or O&M, which occur over different time periods. Present value calculations allow for cost comparisons of different remedial alternatives on the basis of a single cost figure. The capital costs have not been discounted due to their relatively short implementation duration. The cost estimates are for guidance in project evaluation and implementation and are believed to be accurate within a range of -30% to +50% in accordance with USEPA guidance (USEPA 1988). Actual costs could be higher than estimated due to unexpected conditions or potential delays. Details and assumptions used in developing cost estimates for each of the alternatives are provided in Appendix 7.

7.1.3 Modifying Criteria

The two modifying criteria below will be evaluated as part of the ROD after the public has had an opportunity to comment on the Proposed Plan. They are:

1. State acceptance; and
2. Community acceptance.

State Acceptance considers comments received from agencies of the State of Ohio. The primary state agency supporting this investigation is the Ohio EPA. Comments will be obtained from state agencies on the FS and the preferred remedy presented in the Proposed Plan. This criterion will be addressed in the responsiveness summary of the ROD.

Community Acceptance considers comments made by the community, including stakeholders, on the alternatives being considered. Input has been encouraged during the ongoing investigation process to ensure the remedy ultimately selected for the RVAAP is acceptable to the public. Comments will be accepted from the community on the FS and the preferred remedy presented in the Proposed Plan. This criterion will be addressed in the responsiveness summary of the ROD. Because the actions above have not yet taken place, the detailed analysis of alternatives presented below cannot account for these criteria at this time. Therefore, the detailed analysis is carried out only for the first seven of the nine criteria.

Detailed analyses of the retained remedial alternatives for FBQ are presented below. Each relevant set of alternatives are described and evaluated against the criteria outlined in Section 7.1.

7.2 DETAILED ANALYSIS OF REMEDIAL ALTERNATIVES FOR FBQ

Four remedial alternatives were retained for FBQ:

- Alternative 1: No Action (i.e. no remedial actions or controls conducted onsite);
- Alternative 2: Limited Action (e.g. land use controls and 5-year reviews);
- Alternative 3: Excavation of Soils/Dry Sediments and Offsite Disposal ~ National Guard Trainee Land Use; and
- Alternative 4: Excavation of Soils/Dry Sediments and Offsite Disposal ~ Resident Subsistence Farmer Land Use.

Each of these alternatives subsequently was analyzed in detail against the seven NCP evaluation criteria, as described below. The detailed analysis of these alternatives is summarized in Table 7-1.

7.2.1 Alternative 1: No Action

Under this alternative, impacted soils/dry sediments would remain in place at FBQ. Existing access restrictions (e.g., RVAAP perimeter fence) would not be continued. Environmental monitoring would not be performed and no restrictions on land use would be pursued. However, FBQ is assumed to be utilized in accordance with the OHARNG Integrated Natural Resources Management Plan (OHARNG 2001) and consistent with the OHARNG established future land use for FBQ which forms the basis for the exposure scenarios evaluated under restricted and residential land use (Section 3.2).

7.2.1.1 Overall Protection of Human Health and the Environment

The HHRA for FBQ evaluated risks for one soil EU and three sediment EUs (Ditches, Settling Basins, and Quarry Ponds). The Quarry Ponds are permanent bodies of water and are not included in the soil removal evaluated here.

Alternative 1 is not protective of human health for anticipated future OHARNG land use for soil and sediment. The HHRA for FBQ indicates potential future human health risks from soil and sediment are below the target risk of 1E-05 and below or within the CERCLA acceptable range of 1E-06 to 1E-04 ILCR under the restricted land use scenario (represented by a National Guard Trainee). The potential future human health risk could exceed an HI of 1 for non-carcinogenic compounds for soil and for sediment. Potential human health risks from exposure to soil and sediment (via ingestion, dermal contact, and inhalation) under the no action alternative for restricted land use are summarized below:

- Deep Surface Soil (0-3 ft BGS) HI = 2, ILCR = 4E-06; and
- Sediment
  - Ditch HI = 12, ILCR = 7E-06
  - Settling Basins HI = 2, ILCR = 1E-07.

The HIs estimated for exposure to deep surface soil (0-3 ft BGS) and Settling Basin sediment are associated primarily with manganese. The HIs for manganese in deep surface soil (2) and Settling Basin sediment (2) are less than the HIs estimated for the background criteria for this metal (soil HI = 4, sediment HI = 6) which also exceed 1. The HIs estimated for the remaining COPCs in these media are less than 1. Therefore, while Alternative 1 is not protective for the representative receptor (National Guard Trainee) land use scenario for deep surface soil (0-3 ft BGS) and Settling Basin sediment, the potential hazard at these two EUs is associated primarily with naturally occurring manganese. The HI estimated for exposure to Ditch sediment is also associated primarily with manganese; however it exceeds the background HI.

The ILCRs estimated for exposure to deep surface soil (0-3 ft BGS) and Ditch sediment are associated primarily with arsenic. The ILCRs for arsenic in deep surface soil (4E-06) and Ditch sediment (7E-06) are similar to the ILCRs estimated for the background criteria for surface soil (9E-06) and sediment (6E-06) for this metal.

Alternative 1 is protective of human health for the residential land use scenario (represented by the Resident Subsistence Farmer) for Settling Basin sediment. The HHRA for FBQ indicates potential future human health risks are below the target risk of 1E-05 and within the CERCLA acceptable range of 1E-06 to 1E-04 ILCR under the residential land use scenario. The potential future human health HIs are also below the target level of 1 for non-carcinogenic compounds at the FBQ. Potential human health risks from exposure to sediment (via ingestion, dermal contact, and inhalation) under the no action alternative for residential land use are summarized below for the Settling Basins:

- Settling Basin sediment HI = 0.09 (adult) and 0.5 (child), ILCR = 2E-06 (adult) and 1E-06 (child).

Alternative 1 is not protective of human health for the residential land use scenario (represented by a Resident Subsistence Farmer) for the shallow surface soil (0-1 ft BGS), subsurface soil (1-3 ft BGS), and Ditch sediment. The HHRA for FBQ indicates potential future human health risks slightly above 1E-05 but are within the CERCLA acceptable range of 1E-06 to 1E-04 under the residential land use scenario. The potential future human health HI could exceed 1 for non-carcinogenic compounds. Potential human health risks from exposure to soil and sediment (via ingestion, dermal contact, and inhalation) under the no action alternative for residential land use are summarized below:

- Shallow Surface Soil HI (0-1 ft BGS) = 0.2 (adult) and 1 (child), ILCR = 2E-05 (adult) and 2E-05 (child);

- Subsurface Soil HI (1-3 ft BGS)= 0.2 (adult) and 1 (child), ILCR = 2E-05 (adult) and 3E-05 (child); and

- Ditch sediment HI = 0.5 (adult) and 3 (child), ILCR = 4E-05 (adult) and 4E-05 (child).

The ILCRs estimated for exposure to shallow surface soil (0-1 ft BGS), subsurface soil (1-3 ft BGS), and sediment are associated primarily with arsenic. The ILCRs for arsenic in all three of these media range from 2E-05 (adult exposed to surface soil) to 4E-05 (child exposed to sediment) and are similar to the ILCRs estimated for the background criteria for this metal, which range from 2E-05 to 3E-05. The ILCRs estimated for the remaining COPCs in these media are less than or equal to 1E-05. The child HI estimated for exposure to Ditch sediment is associated primarily with manganese (HI = 1) and arsenic (HI = 1). These HIs are similar to the background HIs for these metals (0.7 for manganese and 0.9 for arsenic).

Therefore, while Alternative 1 is not protective for the residential land use scenario, the potential ILCRs and HIs are associated primarily with naturally occurring arsenic and manganese.

Alternative 1 provides no additional protection to human health and the environment over these baseline conditions. Soil and sediment that pose potentially unacceptable risks under potential future residential land use would not be remediated.

There would be no mitigation of identified risks to ecological receptors from COPECs in sediment under this alternative. There would be no impairment of ponds from increased resuspension resulting from remedial actions. Future land uses (military training, including heavy equipment) will likely reduce sustainability of terrestrial habitat for ecological receptors. Aquatic habitat in FBQ ponds would not decline in quality under Alternative 1.

7.2.1.2 Compliance with ARARs

Potential ARARs for remediation of soils/dry sediments at FBQ are presented in Chapter 4. These enforceable standards would be protective of representative receptors under both National Guard Trainee and Resident Subsistence Farmer land that could be exposed to COCs at FBQ. There are no identified chemical-specific or location-specific ARARs identified for Alternative 1. Action-specific ARARs would not apply unless an action is taken.

7.2.1.3 Long-Term Effectiveness and Permanence

Alternative 1 includes no methods to prevent exposures to or the spread of contamination. Existing security would discontinue and there would be no control of exposures to AOC contaminants. This alternative does not have controls in place and does not provide any additional access restrictions in the future. Under future National Guard Trainee and Resident Subsistence Farmer scenarios, there are potential unacceptable risks to human health and the environment in certain aggregates, since the impacted sediments would remain in place with no additional restrictions.

7.2.1.4 Reduction of Toxicity, Mobility, or Volume through Treatment

No reduction in contaminant toxicity, mobility, or volume is achieved, because no treatment process is proposed under this alternative. No monitoring would be performed to evaluate any potential decrease or mobility of contaminants onsite.

7.2.1.5 Short-Term Effectiveness

There are no significant short-term human health risks associated with Alternative 1 beyond baseline conditions. There would be no additional short-term health risks to the community, because no remedial actions would be implemented. There would be no transportation risks nor would workers be exposed to any additional health risks. Alternative 1 would not directly cause adverse impacts on soils, air quality, water resources, or biotic resources.

7.2.1.6 Implementability

No actions are proposed under this alternative.

7.2.1.7 Cost

The present value cost to complete Alternative 1 is zero. As discussed earlier, the no action alternative does not meet NCP threshold evaluation criteria (overall protection of human health and the environment/compliance with ARARs). Therefore, the no action alternative is not likely to be selected as the preferred remedial alternative for the AOC. There are also no capital costs associated with this alternative.

7.2.2 Alternative 2: Limited Action

Alternative 2 maintains the current status of FBQ and includes land use controls and 5-year reviews to identify potential exposures and/or changes in the nature or extent of AOC contamination. Land use controls would be implemented under a Remedial Design.

Pursuant to CERCLA, a review would be conducted every five years, as contaminants remain onsite above Resident Subsistence Farmer land use preliminary cleanup goals. These 5-year reviews will evaluate the effectiveness of land use controls and ensure any land use changes are identified.

This alternative will include O&M including inspections and reporting to assess potential offsite contaminant migration. This will continue as long as the contaminants that exceed residential cleanup goals continue to migrate. For costing purposes, the O&M period is estimated to last for 30 years.

7.2.2.1 <u>Overall Protection of Human Health and the Environment</u>

Alternative 2 is considered protective of human health with the appropriate application and maintenance of land use controls at the AOC. In addition, FBQ is assumed to be utilized in accordance with the OHARNG Integrated Natural Resources Management Plan (OHARNG 2001) and consistent with the OHARNG established future land use for FBQ.

The HHRA for FBQ indicates potential future human health risks from soil and sediment are below the target risk of 1E-05 and below or within the CERCLA acceptable range of 1E-06 to 1E-04 ILCR under the restricted land use scenario (represented by a National Guard Trainee). The potential future human health risk could exceed an HI of 1 for non-carcinogenic compounds for soil and for sediment. Potential human health risks from exposure to soil and sediment (via ingestion, dermal contact, and inhalation) under the no action alternative for restricted land use are summarized below:

- Deep Surface Soil HI (0-3 ft BGS) = 2, ILCR = 4E-06; and
- Sediment
  - Ditch HI = 12, ILCR = 7E-06
  - Settling Basins HI = 2, ILCR = 1E-07.

The HIs estimated for exposure to deep surface soil (0-3 ft BGS) and Settling Basin sediment are associated primarily with manganese. The HIs for manganese in surface soil (2) and Settling Basin sediment (2) are less than the HIs estimated for the background criteria for this metal (soil HI = 4, sediment HI = 6) which also exceed 1. The HIs estimated for the remaining COPCs in these media are less than 1. Therefore, while Alternative 2 is not protective for the restricted land use scenario for surface soil and Settling Basin, the potential hazard at these two EUs is associated primarily with naturally occurring manganese. The HI estimated for exposure to Ditch sediment is also associated primarily with manganese; however it exceeds the background HI.

No mitigation of identified risks to ecological receptors from COPECs in sediment would be conducted under this alternative. There would be no impairment of ponds from increased resuspension resulting from remedial actions. Future land uses (military training, including heavy equipment) will likely reduce sustainability of terrestrial habitat for ecological receptors. Aquatic habitat in FBQ ponds would not decline in quality under this alternative.

7.2.2.2 <u>Compliance with ARARs</u>

Potential ARARs for remediation of soils/dry sediments at FBQ are presented in Chapter 4. These federally enforceable standards would be protective of representative receptors under both National Guard Trainee and residential land use that could be exposed to COCs at FBQ. There are no identified chemical-specific or locations-specific ARARs identified for Alternative 2. Action-specific ARARs would not apply unless an action is taken.

7.2.2.3 Long-Term Effectiveness and Permanence

Alternative 2 is protective in the long term and relies on land use controls to eliminate or reduce exposures to contaminants. The effectiveness of this approach is strongly affected by the adequacy and reliability of the land use controls. Such controls may be subject to failure; however with appropriate documentation and procedures, land use controls can be expected to be effective in protecting human health and the environment while preserving the land uses required for operation at FBQ.

Under Alternative 2, contaminants would remain onsite above Resident Subsistence Farmer land use preliminary cleanup goals requiring reviews to be conducted at least once every five years per CERCLA requirements. The reviews would evaluate data obtained from ongoing monitoring and provide information on the presence and behavior of contaminants, as well as ensure land use and engineering controls are effective.

7.2.2.4 Reduction of Toxicity, Mobility, or Volume through Treatment

No reduction in contaminant toxicity, mobility, or volume is achieved, because no treatment process is proposed under this alternative.

7.2.2.5 Short-Term Effectiveness

Alternative 2 would not pose any additional short-term risks to workers or the community. Alterative 2 mitigation measures would require zero years to complete and include an O&M period. Following the implementation of land use controls, monitoring and 5-year reviews also would be conducted.

7.2.2.6 Implementability

Land use controls and improvements are technically implementable. No technical difficulties are anticipated in establishing or maintaining monitoring programs, access controls, etc. The existing facility-wide access restrictions at RVAAP should facilitate implementation and maintenance of future land use controls. Proposed land use controls and monitoring would bolster and support access restrictions already existing at FBQ.

7.2.2.7 Cost

The present value cost to complete Alternative 2 is approximately $160,061 (in base year 2005 dollars with a 3.1% discount factor). O&M costs (with monitoring, land use controls and 5-year CERCLA reviews) are estimated for a 30-year period for costing purposes. See Appendix 7 for a detailed description of Alternative 2 costs.

7.2.3 Alternative 3: Excavation of Soils/Dry Sediments with Offsite Disposal ~ National Guard Trainee Land Use

Alternative 3 includes excavation and offsite disposal of impacted soils/dry sediments above National Guard Trainee preliminary cleanup goals. An estimated 102 yd^3 (ex situ) of manganese-impacted dry sediment would be excavated and shipped offsite to a permitted disposal facility. Other technologies required would include monitoring and waste handling.

7.2.3.1 Overall Protection of Human Health and the Environment

In general, the long-term protectiveness of this alternative is high for the intended restricted land use at FBQ as represented by the National Guard Trainee.

The HHRA for FBQ indicates potential future human health risks from soil and sediment are below the target risk of 1E-05 and below or within the CERCLA acceptable range of 1E-06 to 1E-04 ILCR under the National Guard Trainee land use scenario. The potential future human health risk could exceed an HI of 1 for non-carcinogenic compounds for soil and for sediment.

The HIs estimated for exposure to deep surface soil (0-3 ft BGS) and Settling Basin sediment are associated primarily with manganese. The HIs for manganese in surface soil (2) and Settling Basin sediment (2) are less than the HIs estimated for the background criteria for this metal which also exceed 1. The HIs estimated for the remaining COPCs in these media are less than 1. The EPC of all COCs identified for this receptor for surface soil and Settling Basin sediment are below preliminary cleanup goals; therefore the no action alternative is protective of human health for the National Guard Trainee land use and no excavation is included for these EUs in this alternative.

Alternative 3 includes removal of sediment at the Ditch and to meet the National Guard Trainee land use preliminary cleanup goals. Areas of sediment removal are shown in Figure 3B-1 (Appendix 3B).

The HHRA estimated potential future human health risks for the restricted land use scenario (represented by a National Guard Trainee) for the no-action alternative (i.e., pre-remediation). Recall that manganese was the only FSCOC for Ditch sediment identified for evaluation in the FS alternatives for the National Guard Trainee (see Section 3.3.5.1, Table 3-9 and Table 3-10). The removal of all sediment locations in the Ditch with manganese concentrations that exceed its preliminary cleanup goal of 1,950 mg/kg (which is also the sediment background concentration) provides reasonable certainty that post-remediation manganese will be below background levels; the post-remediation ILCR for manganese may possibly be below the threshold of 1E-05 and the post-remediation HQ for manganese may possibly be below the threshold of 1.0 for the representative receptor (National Guard Trainee). This reduction in ILCR and HQ for manganese, coupled with the fact that EPCs for all other sediment COCs are already below their respective preliminary remediation goals, provides reasonable certainty that the total ILCR and total HI across all contaminants will be at or below the thresholds of 1E-05 and 1.0, respectively for the National Guard Trainee, unless influenced by background levels. Therefore, this alternative provides overall protection to the representative receptor (National Guard Trainee) for human health. Because manganese is the only FSCOC for residential land use and the preliminary cleanup goal for residential land use (2,900 mg/kg) is larger than that for the National Guard Trainee land use (1,950 mg/kg) (see Table 3-10), residential receptors would also be protected after remediation to National Guard preliminary cleanup goals.

The remedial actions conducted to protect human health also will reduce risks to ecological receptors that occupy or visit this AOC. There would be a temporary impairment of ponds from increased resuspension resulting from remedial actions. With engineering precautions, the adverse effects of these impacts would be mitigated. Aquatic habitat in FBQ ponds would eventually increase in quality due to remedial actions under this alternative.

7.2.3.2 Compliance with ARARs

Potential ARARs for remediation of sediments at FBQ are presented in Chapter 4. These enforceable standards would be protective of representative receptors under National Guard Trainee land use that could be exposed to COCs at FBQ. There are no identified chemical-specific or location-specific ARARs for Alternative 3. Action-specific ARARs would not apply unless action is taken.

7.2.3.3 Long-Term Effectiveness and Permanence

Alternative 3 is protective in the long term for both National Guard Trainee and residential land use. The sediments above residential land use preliminary cleanup goals would be excavated and transported offsite for disposal, thereby mitigating risks to human health and the environment. Under this alternative, land use controls would not be required upon the completion of remedial activities.

The AOC will undergo confirmation sampling to confirm the removal of the targeted manganese in sediment. No O&M monitoring or CERCLA 5-year reviews are required to be conducted for this alternative.

7.2.3.4 Reduction of Toxicity, Mobility, or Volume through Treatment

Alternative 3 does not achieve a reduction in contaminant toxicity, mobility, or volume since no treatment process is to be conducted.

7.2.3.5 Short-Term Effectiveness

The short-term effectiveness of Alternative 3 includes potential worker exposure during the excavation process. In addition, the surrounding community could be exposed during transportation of sediment. Workers would follow a health and safety plan and wear appropriate personal protective equipment (PPE) to minimize exposures. Mitigation measures such as erosion and dust control during construction would minimize short-term impacts.

Excavated soils will be transported by truck to a disposal facility. Risks will be mitigated during transport by inspecting vehicles before and after use, performing decontamination when needed, covering the transported waste, observing safety protocols, following pre-designated routes, and limiting the distance waste is transported in vehicles. Transportation risks (e.g., from continuous leaks) increase with distance and volume. Transportation of contaminated materials to an offsite disposal facility would strictly comply with applicable state and federal regulations. Pre-designated routes would be used and an emergency response program developed to respond to potential accidents.

Alternative 3 remedial actions would require approximately one month to complete. Upon the completion of remedial activities, the FBQ AOC would be released for National Guard Trainee use and Resident Subsistence Farmer use with respect to soils and dry sediments.

7.2.3.6 Implementability

Technically, this alternative is implementable. Excavating impacted sediment, constructing temporary roads (if necessary), and handling of waste materials are common construction activities. However, special engineering techniques may be required during construction activities to deal with potential MEC issues at FBQ. Multiple disposal facilities are available that can accept the waste. Construction and operation of the components of Alternative 3 would be straightforward with adequate resources readily available. Borrow sites for backfill and have not been selected, but are anticipated to be secured locally.

Acceptability of Alternative 3 would be affected by administrative requirements for transport and disposal and the requirements for National Guard Trainee land use. The DOT would regulate the transport of material. Consultation with the local engineering department would be undertaken to evaluate the impact of the truck traffic on the roads surrounding the RVAAP.

Careful planning would be needed between remedial action planners and OHARNG to minimize disruptions and/or impacts to OHARNG operations during implementation. Access routes for heavy equipment to remediation areas would be selected to minimize disruption. Additional steps would be undertaken to minimize hazards posed to tenant personnel. This type of planning will increase the difficulty of implementability, but will also reduce the risks to personnel.

7.2.3.7 Cost

The present value cost to complete Alternative 3 is approximately $66,688 (in base year 2005 dollars with a 3.1% discount factor). Removal, disposal, and confirmation sampling are included in this cost. See Appendix 7 for a detailed description of Alternative 3 costs.

7.2.4 Alternative 4: Excavation of Soils/Dry Sediments with Offsite Disposal ~ Resident Subsistence Farmer Land Use

Alternative 4 includes excavation and offsite disposal to remove impacted soils/dry sediments exceeding the residential land use preliminary cleanup goals (represented by the resident subsistence farmer scenario). An estimated 56 yd^3 yards (ex situ) of manganese-contaminated sediment would be excavated and shipped offsite to a permitted disposal facility. Other technologies required would include monitoring and waste material handling.

7.2.4.1 Overall Protection of Human Health and the Environment

In general, the long-term protectiveness of this alternative is high. The HHRA for FBQ indicates potential future human health risks from Settling Basin sediment are below the target risk of 1E-05 and within the CERCLA acceptable range of 1E-06 to 1E-04 ILCR under the residential land use scenario. The potential future human health HI of 1 for non-carcinogenic compounds is less than 1 for this EU.

The HHRA for FBQ indicates potential future human health risks slightly above 1E-05 but are within the CERCLA acceptable range of 1E-06 to 1E-04 under the residential land use scenario (represented by a Resident Subsistence Farmer). The potential future human health HI could exceed 1 for non-carcinogenic compounds.

The ILCRs estimated for exposure to shallow surface soil (0-1 ft BGS), subsurface soil (1-3 ft BGS), and sediment are associated primarily with arsenic. The ILCRs for arsenic in all three of these media are less than the ILCRs estimated for the background criteria for this metal. The ILCRs estimated for the remaining COPCs in these media are less than or equal to 1E-05. The EPC of all COCs identified for this receptor for shallow surface soil (0-1 ft BGS) and subsurface soil (1-3 ft BGS) are below preliminary cleanup goals; therefore the no action alternative is protective of human health for the restricted access scenario and no excavation is included for soil EU in this alternative.

Alternative 4 includes removal of Ditch sediment to meet the media-specific preliminary cleanup goals. Removing sediment containing contaminants above preliminary cleanup goals would limit cancer risks to below or equal to the target risk (and within the CERCLA acceptable cancer risk range) and to a non-carcinogenic HI of less than 1 except for risks driven by naturally occurring background concentrations of metals (e.g., the post-remediation HI from manganese will remain greater than 1).

The remedial actions taken to protect human health also will reduce risks to ecological receptors that occupy or visit this AOC. Ponds would be temporarily impaired from increased resuspension created by remedial actions. With engineering precautions, the adverse effects of remedial actions would be mitigated. Future land uses (military training, including heavy equipment) will likely reduce sustainability of terrestrial habitat for ecological receptors. Aquatic habitat in FBQ ponds would eventually increase in quality due to remedial actions under this alternative.

7.2.4.2 Compliance with ARARs

Potential ARARs for remediation of soils/dry sediments at FBQ are presented in Chapter 4. These enforceable standards would be protective of representative receptors Resident Subsistence Farmer land use who could be exposed to COCs at FBQ. There are no identified chemical-specific or location-specific ARARs identified for Alternative 4. Action-specific ARARs would not apply unless an action is taken.

7.2.4.3 Long-Term Effectiveness and Permanence

Alternative 4 would effectively reduce the long-term contamination for soils/dry sediments at FBQ. The sediments above Resident Subsistence Farmer land use preliminary cleanup goals would be excavated and transported offsite for disposal, thereby mitigating risks to human health and the environment. Under this alternative, land use controls would not be required upon the completion of remedial activities.

The AOC will undergo confirmation sampling to confirm the removal of the targeted manganese in sediment. No CERCLA 5-year reviews are required to be conducted for this alternative.

7.2.4.4 Reduction of Toxicity, Mobility, or Volume through Treatment

Alternative 4 does not involve treatment. Therefore, no reduction in the toxicity, mobility, or volume of impacted sediment is achieved.

7.2.4.5 Short-Term Effectiveness

Short-term effectiveness of Alternative 4 includes potential exposure for workers during excavation activities and the community during transportation of sediment. Workers would follow a health and safety plan and wear appropriate PPE to minimize exposures. Mitigation measures such as erosion and dust control would be used during construction to ensure minimization of short-term impacts.

Excavated soils will be transported by truck to a disposal facility. Risks will be mitigated during transport by inspecting vehicles ingressing/egressing the AOC, decontaminating when needed, covering the transported waste, observing safety protocols, following pre-designated routes, and limiting the distance the waste is transported in vehicles. Transportation risks (e.g., from continuous leaks) increase with distance and volume. Transportation of contaminated materials to an offsite disposal facility would strictly comply with applicable state and federal regulations. Pre-designated routes would be followed and an emergency response program would be in place to respond to any accidents.

Alternative 4 remedial actions would require approximately one month to implement. Upon the completion of the excavation and treatment operation, FBQ would be released for residential use.

7.2.4.6 Implementability

Technically and administratively, this alternative is implementable. Excavation of impacted soils, construction of temporary roads, and onsite truck transport of soil are conventional activities in construction projects of this kind. Multiple disposal facilities are available that can accept the waste. Construction and operation of Alternative 4 components would be straightforward with resources readily available. Special engineering techniques may be required during construction activities to deal with potential MEC issues at FBQ. Borrow sites for backfill have not been selected, but are anticipated to be secured locally.

The acceptability of Alternative 4 would be affected by the administrative requirements for transport and disposal. The DOT would regulate the transport of material. Local engineering departments would be consulted to evaluate impacts of truck traffic on roads surrounding the RVAAP.

Careful planning and coordination would be required between remedial action planners and OHARNG to minimize disruptions and/or impacts to OHARNG operations during Alternative 4 implementation. Access routes for heavy equipment to remediation areas would be selected to minimize disruption. Additional steps would be taken to minimize hazards posed to tenant personnel. This type of planning will increase the relative difficulty implementing this alternative, but reduce the risks to personnel.

7.2.4.7 Cost

The present value cost to complete Alternative 4 is approximately $61,650 (in base year 2005 dollars with a 3.1% discount factor). Implementing the removal, disposal and subsequent confirmation sampling are included in this cost. See Appendix 7 for a detailed description of Alternative 4 costs.

7.2.5 Comparative Analysis of FBQ Alternatives Using NCP Criteria

In this section, a comparative analysis of the four remedial alternatives applicable to FBQ is conducted to identify relative advantages and disadvantages of each based on the detailed analysis above. The comparative analysis provides a means by which remedial alternatives can be directly compared to one another with respect to common criteria. Overall protection and compliance with ARARs are threshold criteria that must be met by any alternative to be eligible for selection. The other criteria, consisting of short- and long-term effectiveness; reduction of contaminant toxicity, mobility, or volume through treatment; ease of implementation; and cost are the primary balancing criteria used to select a preferred remedy among alternatives satisfying the threshold criteria. A summary table illustrating the comparative analysis is provided in Table 7-2. The process for obtaining community and state acceptance is described in Chapter 8.

Four remedial alternatives were retained for FBQ:

- Alternative 1: No Action;
- Alternative 2: Limited Action;
- Alternative 3: Excavation of Soils/Dry Sediments and Offsite Disposal ~ National Guard Trainee Land Use;
- Alternative 4: Excavation of Soils/Dry Sediments and Offsite Disposal ~ Resident Subsistence Farmer Land Use.

Each of these alternatives subsequently was analyzed in detail against the seven NCP evaluation criteria as described below.

7.2.5.1 Overall Protection of Human Health and the Environment

Each of the four alternatives developed for the FBQ are protective of human health and the environment with the exception of Alternative 1. The degree of protection and permanence is a function of the extent the alternative utilizes containment removal or land use control strategies. Alternative 1 is not protective of human health for the most likely future land use for dry sediment. The HHRA for FBQ indicates potential future human health risks from soil and sediment are below the target risk of 1E-05 and below or within the CERCLA acceptable range of 1E-06 to 1E-04 ILCR under the restricted land use scenario (represented by a National Guard Trainee). The potential future human health risk could exceed an HI of 1 for non-carcinogenic compounds for soil and for sediment.

Alternative 2 is protective of human health and the environment assuming land use controls will be adequately instituted and maintained and onsite personnel will be properly trained for OHARNG future land use. Alternatives 3 and 4 can be protective of human health and the environment for the National Guard Trainee, Trespasser (Adult and Juvenile), and the Resident Subsistence Farmer.

7.2.5.2 Compliance with ARARs

Potential ARARs for remediation of sediments at FBQ are presented in Chapter 4. Each alternative could be designed and implemented to meet respective ARARs.

7.2.5.3 Long-Term Effectiveness and Permanence

Alternative 1 includes no long-term management measures to prevent exposures to or the spread of contamination and is rated low. Alternative 2 is protective in the long-term based on the implementation of land use controls. Relative to the other alternatives, Alternative 2 is rated medium since such controls can potentially fail.

Alternatives 3 and 4 are considered permanent and effective in the long term since the alternatives will result in achievement of preliminary cleanup goals at FBQ for residential land use. These alternatives are accordingly rated high.

7.2.5.4 Reduction in Contaminant Volume, Toxicity, and Mobility through Treatment

Alternatives 1 through 4 do not reduce contaminant toxicity, volume or mobility and are subsequently rated low.

7.2.5.5 Short-Term Effectiveness

Alternatives 1 and 2 have no short-term risks to the community beyond baseline conditions and are therefore rated high. Alternatives 3 and 4 involve the potential excavation and handling of impacted sediment and may expose workers to contaminated materials. Although mitigation measures are anticipated to reduce or eliminate these exposures/risks, Alternatives 3 and 4 are rated medium.

7.2.5.6 Implementability

The alternatives are considered implementable on a technical and availability-of-services basis. Alternative 1 is a No Action alternative and is therefore rated high. Alternative 2 involves the implementation of land use controls at the AOC. Currently, RVAAP has facility-wide access restrictions in effect, indicating the requirement for land use controls under Alternative 2 should not be difficult to institute and maintain. Therefore, Alternative 2 is also rated high. Alternatives 3 and 4 should be easily implementable, but relative to Alternative 2 are more complex. Therefore Alternatives 3 and 4 are rated medium.

7.2.5.7 Cost

Costs were estimated for comparison purposes only and are believed accurate within a range of -30% to +50%. The estimated present value cost (in base year 2005 dollars with a 3.1% discount factor) to complete each of the alternatives is as follows:

Alternative 1:	$	0
Alternative 2:	$	160,061
Alternative 3:	$	66,688
Alternative 4:	$	61,650

Table 7-1. Summary of Detailed Analysis of Remedial Alternatives for FBQ

NCP Evaluation Criteria	Alternative 1 No Action	Alternative 2 Limited Action	Alternative 3 Excavation of Soils/Dry Sediments and Offsite Disposal ~ National Guard Trainee Land Use	Alternative 4 Excavation of Soils/Dry Sediments and Offsite Disposal ~ Resident Subsistence Farmer Land Use
1. Overall Protectiveness				
Human Health Protection	Not protective for anticipated OHARNG future land use (National Guard Trainee). Not protective for residential land use.	Protective for anticipated OHARNG future land use (National Guard Trainee). Not applicable for residential land use.	Protective due to removal of impacted media.	Protective due to removal of impacted media.
Environmental Protection	No mitigation of calculated risks to ecological receptors; however, ecological risks are not likely to be high.	No mitigation of calculated risks to ecological receptors; however, ecological risks are not likely to be high.	Remedial actions taken to protect human health also will reduce risks to ecological receptors that occupy or visit this AOC.	Remedial actions taken to protect human health also will reduce risks to ecological receptors that occupy or visit this AOC.
2. Compliance with ARARs				
ARARs	Compliant. No chemical or location-specific ARARs identified.	Compliant. No chemical or location-specific ARARs identified.	Compliant. No chemical or location-specific ARARs identified.	Compliant. No chemical or location-specific ARARs identified.
3. Long-Term Effectiveness and Permanence				
Magnitude of Residual Risk	Residual risk/ hazard exceeds target risk/hazard for restricted and residential land use.	Residual risk/ hazard exceeds target risk/hazard for restricted and residential land use.	Residual risk/ hazard below target for residential land use.	Residual risk/ hazard below target below target for residential land use.
Adequacy and Reliability of Controls	No land use controls.	Land use controls adequate and reliable.	No land use controls required.	No land use controls required.
Long-Term Management	None.	Required since soils/dry sediments would remain onsite in exceedance of residential land-use preliminary cleanup goals.	No long-term management required as residential cleanup goals are achieved.	No long-term management required as residential cleanup goals are achieved.
4. Reduction in Toxicity, Mobility, or Volume through Treatment				
Reduction through Treatment	None (no treatment).	None (no treatment).	None (no treatment).	None (no treatment).

Table 7-1. Summary of Detailed Analysis of Remedial Alternatives for FBQ (continued)

NCP Evaluation Criteria	Alternative 1 No Action	Alternative 2 Limited Action	Alternative 3 Excavation of Soils/Dry Sediments and Offsite Disposal ~ National Guard Trainee Land Use	Alternative 4 Excavation of Soils/Dry Sediments and Offsite Disposal ~ Resident Subsistence Farmer Land Use
5. Short-Term Effectiveness				
Community	No immediate risk to community.	No immediate risk to community.	Slight increase in risk due to construction and transportation activities. Controlled by mitigating measures.	Slight increase in risk due to construction and transportation activities. Controlled by mitigating measures.
Workers	No activities to take place, therefore no risk to workers.	Minimal risk to workers.	Workers may be exposed to impacted soils/dry sediments, as well as heavy equipment hazards. Safety measures would mitigate risk.	Workers may be exposed to impacted soils/dry sediments, as well as heavy equipment hazards. Safety measures would mitigate risk.
Ecological Resources	No ecological impacts beyond existing conditions.	No ecological impacts beyond existing conditions.	Potential short-term environmental impacts minimized by engineering controls.	Potential short-term environmental impacts minimized by engineering controls.
Engineering Controls	None.	None.	Potential releases controlled with management and engineering practices.	Potential releases controlled with management and engineering practices.
Time to Complete	0 years	0 years	1 month	1 month
O&M Period	0 years	30 years (estimated)	0 years	0 years
6. Implementability				
Technical Feasibility	Not applicable.	Feasible.	Feasible.	Feasible.
Administrative Feasibility	Not applicable.	Relatively easy. Land use controls already in place.	Relatively easy.	Relatively easy.
7. Cost				
Estimated Cost	$0	$160,061	$66,688	$61,650

AOC = Area of concern.

ARAR = Applicable and relevant or appropriate requirements.

NCP = National Contingency Plan.

O&M = Operation and maintenance.

OHARNG = Ohio Army National Guard.

Table 7-2. Summary of Comparative Analysis of Remedial Alternatives for FBQ

NCP Evaluation Criteria	Alternative 1 No Action	Alternative 2 Limited Action	Alternative 3 Excavation of Soils/Dry Sediments and Offsite Disposal ~ National Guard Trainee Land Use	Alternative 4 Excavation of Soils/Dry Sediments and Offsite Disposal ~ Resident Subsistence Farmer Land Use
1. Overall Protectiveness	Not protective	Protective	Protective	Protective
2. Compliance with ARARs	Compliant	Compliant	Compliant	Compliant
3. Long-Term Effectiveness and Permanence	Low	Medium	High	High
4. Reduction of Toxicity, Mobility, or Volume through Treatment	Low	Low	Low	Low
5. Short-Term Effectiveness	High	High	Medium	Medium
6. Implementability	High	High	Medium	Medium
7. Cost	High	Low	Medium	Medium
	$0	$160,061	$66,688	$61,650

ARAR = Applicable and Relevant or Appropriate Requirements

8.0 AGENCY COORDINATION AND PUBLIC INVOLVEMENT

The US Army is the lead agency under the Defense Environmental Restoration Program responsible for achieving remedy for (or cleanup of) of the six high priority AOCs at RVAAP, including FBQ. This chapter reviews actions that have been conducted and that are planned in the future to ensure regulatory agencies and the public have been provided with appropriate opportunities to stay informed of progress of the six high priority environmental AOCs remediation and to provide meaningful input on the planning effort as well as the final selection of a remedy.

As described in Chapter 7, two of the nine NCP evaluation criteria are known as “modifying criteria.” These are State Acceptance and Community Acceptance. These criteria provide a framework for obtaining the necessary agency coordination and public involvement in the remedy selection process.

8.1 STATE ACCEPTANCE

State acceptance considers comments received from agencies of the state of Ohio on the remedial alternatives being considered. For the process supporting remedy of the six high priority AOCs, including FBQ, Ohio EPA is the lead regulatory agency and this FS has been prepared in consultation with Ohio EPA. Ohio EPA has provided input during the ongoing investigation and report development process to ensure the remedy ultimately selected for the six high priority AOCs, including FBQ, meets the needs of the state of Ohio and fulfills the requirements of the DFFO (Ohio EPA 2004a). Comments will be solicited from Ohio EPA on the FS and on the Proposed Plan. The US Army will obtain Ohio EPA concurrence prior to the final selection of the remedy for FBQ.

8.2 COMMUNITY ACCEPTANCE

Community acceptance considers comments provided by the community on the remedial alternatives being considered. CERCLA 42 U.S.C. 9617(a) emphasizes early, constant, and responsive community relations. The US Army has prepared a Community Relations Plan (USACE 2003b) for this project to ensure the public has convenient access to information regarding project progress. The community relations program interacts with the public through news releases, public meetings, public workshops, and Restoration Advisory Board (RAB) meetings with local officials, interest groups, and the general public. The public also has the opportunity to comment on draft documents submitted to the Administrative Record that support remedy of FBQ, including the previously completed RI Report and this FS.

CERCLA 42 U.S.C. 9617(a) requires that an Administrative Record be established “at or near the facility at issue.” Relevant documents regarding the RVAAP have been made available to the public for review and comment. The ***Administrative Record*** for this project is available at the following location:

Ravenna Army Ammunition Plant
Building 1037 Conference Room
8451 St. Route 5
Ravenna, Ohio 44266-9297

Access to RVAAP is restricted but can be obtained by contacting facility management at (330) 358-7311. In addition, an Information Repository of current information and final documents is available to any interested reader at the following libraries:

Reed Memorial Library
167 East Main Street
Ravenna, Ohio 44266

Newton Falls Public Library
204 South Canals
Newton Falls, Ohio 44444-1694

Also, RVAAP has an online resource for restoration news and information. This website can be viewed at www.rvaap.org.

Similar to state agencies, comments will be received from the community upon issuance of the FS and the Proposed Plan. The US Army will request public comments on the Proposed Plan for FBQ, as required by the CERCLA regulatory process and the RVAAP Community Relations Plan. These comments will be considered in the final selection of a remedy for FBQ. Responses to these comments will be addressed in the responsiveness summary of the ROD.

9.0 CONCLUSIONS

The primary purpose of this FS is to develop, screen, and evaluate remedial alternatives for FBQ using data collected during previous investigations. This FS examined the history of FBQ and previous investigations, developed media-specific preliminary cleanup goals and RAOs for the AOC, and screened a range of technologies potentially applicable for meeting these preliminary cleanup goals.

Chemical-specific preliminary cleanup goals were established for restricted and residential land use. Preliminary cleanup goals for restricted land use were established for a representative receptor (National Guard Trainee) for likely future land use by OHARNG. The preliminary cleanup goals for the representative receptor are protective of other potential receptors with equal or lesser exposure assumptions than the representative receptor and; therefore, serve as surrogates for these other possible receptors (e.g., preliminary cleanup goals for the National Guard Trainee are also protective of a hunter or a security guard). The potential for the representative receptor to be protective of a trespasser also is addressed. In addition to the National Guard Trainee, preliminary cleanup goals were established for a Resident Subsistence Farmer (adult and child) to provide a baseline for evaluating whether this AOC may be eligible for unrestricted release. FBQ will be transferred to OHARNG. The suspected presence of MEC will be addressed in a subsequent investigation under the MMRP. The suspected presence of MEC requires land use controls until the MMRP is complete when a final evaluation of the need for land use controls will be made.

This FS establishes an RAO and evaluates a range of remedial actions to reduce risks to the environment to obtain remedy for (or cleanup of) of FBQ with respect to soils/dry sediments. The RAO analysis identified COCs in impacted soils/dry sediments at FBQ requiring further evaluation of potential remedial alternatives for both National Guard Trainee and residential land use scenarios. The RAO analysis indicated current National Guard Trainee land use is protective with respect to impacted soils/dry sediments. Therefore, technologies were screened and the following potential remedial alternatives were developed:

- Alternative 1: No Action;
- Alternative 2: Limited Action;
- Alternative 3: Excavation of Soils/Dry Sediments with Offsite Disposal ~ National Guard Trainee Land Use; and
- Alternative 4: Excavation of Soils/Dry Sediments with Offsite Disposal ~ Resident Subsistence Farmer Land Use.

These alternatives were assessed and compared against one another to provide information of sufficient quality and quantity to justify the selection of a remedy.

The next step in the CERCLA process is to prepare a Proposed Plan to solicit public input on the remedial alternatives. The Proposed Plan will present alternatives evaluated in the FS together with the preferred alternative for FBQ.

The ROD will document the final remedy for FBQ. Comments on the Proposed Plan received from state and federal agencies and the public will be considered in drafting the ROD for FBQ. The ROD will provide a brief summary of the history, characteristics, risks, and selected remedy. The ROD also will include a responsiveness summary, addressing comments received on the Proposed Plan.

9.1 RECOMMENDED ALTERNATIVE

The recommended alternative for FBQ is Alternative 3 (Excavation of Soils/Dry Sediments with Offsite Disposal ~ National Guard Trainee Land Use). This alternative involves the removal of dry sediment in the Ditch aggregate at FBQ that exceeds preliminary cleanup goals for the National Guard Trainee. This alternative is protective for the anticipated future land use (National Guard Trainee). Alternative 3 also achieves preliminary cleanup goals for the Resident Subsistence Farmer. Alternative 3 is cost effective (estimated $66,688 for removal), and can be performed in a timely manner. Because the alternative attaines preliminary cleanup goals for a Resident Subsistence Farmer, O&M and CERCLA 5-year reviews with respect to chemical contamination in soil will not be required. However, the US Army and OHARNG will implement land use controls with respect to MEC issues.

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Appendix 2A
Risk Characterization for Trespasser Scenario

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2A.0 RISK CHARACTERIZATION FOR TRESPASSER SCENARIO

2A.1 INTRODUCTION

The baseline HHRA provided in the RI Report for FBQ evaluates the potential health risks to humans resulting from exposure to contamination at FBQ. The HHRA presented in the RI Report is based on the methods outlined in the RVAAP FWHHRAM (USACE 2004), which addresses five receptors to be evaluated at RVAAP [National Guard Trainee, National Guard Dust/Fire Control Worker, Security Guard/Maintenance Worker, Hunter/Trapper/Fisher, and Resident Subsistence Farmer (adult and child)].

An additional receptor (trespasser scenario) was added in an addendum to the FWHHRAM (USACE 2005c). The Trespasser (Juvenile and Adult) is evaluated in this FS to supplement the baseline HHRA provided in the RI Report and to comply with the revised FWHHRAM. This supplemental risk characterization is organized into the same six major sections used in the baseline HHRA:

- Data evaluation and COPCs are discussed in Section 2A.2;
- Exposure assessment is presented in Section 2A.3;
- Toxicity assessment is summarized in Section 2A.4;
- Results of the risk characterization are presented in Section 2A.5;
- The uncertainty analysis is presented in Section 2A.6; and
- The conclusions of the HHRA are summarized in Section 2A.7.

2A.2 DATA EVALUATION

A data evaluation and COPC screening was conducted as part of the baseline HHRA in the Phase I/Phase II RI Report for FBQ (USACE 2005b).

Under this scenario, the Trespasser (Juvenile and Adult) may be exposed to COPCs in shallow surface soil (0-1 ft BGS), sediment, and surface water. This receptor is not exposed to COPCs in subsurface soil or groundwater. A summary of the exposure media evaluated for the Trespasser (Juvenile and Adult) scenario is provided in Table 2A-1.

Table 2A-1. Exposure Media Evaluated for the Trespasser (Juvenile and Adult) Scenario

AOC	Exposure Media		
	Shallow Surface Soil[a]	**Sediment**	**Surface Water**
FBQ	1 EU	3 EUs (Ditch, Quarry Ponds, Settling Basins)	3 EUs (Ditch, Quarry Ponds, Settling Basins)

[a]Shallow surface soil defined as 0-1 ft BGS for the Trespasser scenario.
AOC = area of concern.
EU = exposure unit.
FBQ = Fuze and Booster Quarry Landfill/Ponds
No COPCs = no constituents of potential concern (COPCs) identified for this exposure medium in the Remedial Investigation (RI) Report.

A summary of the COPCs identified for each medium in the baseline HHRA at FBQ is provided in Table 2A-2.

Table 2A-2. COPCs for each Exposure Medium

COPC	Shallow Surface Soil (0-1 ft BGS)	Sediment	Surface Water
Quantitative COPCs[a]			
Inorganics			
Aluminum		X	
Antimony	X	X	
Arsenic	X	X	X
Barium	X	X	
Cadmium	X	X	
Chromium[b]	X	X	
Chromium, hexavalent		X	
Copper	X	X	
Lead[c]	X	X	X
Manganese	X	X	X
Mercury		X	
Vanadium	X	X	
Zinc		X	
Organics			
2,4,6-Trinitrotoluene	X		
2,6-Dinitrotoluene	X		
Benz(a)anthracene		X	
Benzo(a)pyrene	X	X	
Benzo(b)fluoranthene		X	
bis(2-Ethylhexyl)phthalate			X
Indeno(1,2,3-cd)pyrene		X	
Methylene chloride			X
Perchlorate			X
Qualitative COPCs[d]			
Organics			
2-Amino-4,6-dinitrotoluene	X	X	X
4-Amino-2,6-dinitrotoluene	X	X	X
Acenaphthylene		X	
Benzo(g,h,i)perylene		X	
Nitrocellulose	X	X	X
Nitroglycerin		X	
Phenanthrene		X	

[a]Quantitative COPCs have approved toxicity values that allow for further quantitative evaluation in the human health risk assessment.
[b]Total chromium is conservatively evaluated with the toxicity values for trivalent chromium, while measured hexavalent chromium is evaluated with the toxicity values for hexavalent chromium.
[c]Although lead does not have toxicity values for which to quantify risks and/or hazards, it can be evaluated quantitatively with blood lead models from the United States Environmental Protection Agency.
[d]Qualitative COPCs do not have approved toxicity values that allow for further quantitative evaluation in the human health risk assessment.
BGS = Below ground surface.
COPC = Constituent of potential concern.
X = Chemical is a COPC for this medium.

2A.3 EXPOSURE ASSESSMENT

One receptor [Trespasser (Juvenile and Adult)] is evaluated in this supplemental HHRA. RVAAP is a controlled access facility (it is fenced, gated, and patrolled by security guards); however, a trespasser could enter the property and be exposed to contaminants in shallow surface soil (0-1 ft BGS), sediment, and surface water at FBQ. The Juvenile Trespasser is assumed to visit the AOC approximately once per week (i.e., 50 days/year) between the ages of 8 and 18. The Adult Trespasser is assumed to visit the AOC slightly more often (75 days/year) for as long as he lives in the area (i.e., 30 years). In reality, the most likely adult trespassers are hunters or National Guard trainees entering unauthorized areas with a much lower frequency than the Hunter/Fisher/Trapper and National Guard Trainee receptors that are included in the baseline HHRA. A Juvenile Trespasser (ages 8 to 18) and Adult Trespasser are evaluated quantitatively for exposure to contaminated surface soil and sediment via incidental ingestion, inhalation of VOCs and particulates, and dermal contact. The Trespasser (Juvenile and Adult) is also evaluated for exposure to contaminated surface water via incidental ingestion and dermal contact.

Exposure equations for each of these pathways are provided in the FWHHRAM (USACE 2004). Exposure parameters used to calculate potential chemical intakes by the Trespasser (Juvenile and Adult) are from Table 5 of the FWHHRAM Amendment 1 (USACE 2005c) and are provided in Table 2A-3. Chemical-specific exposure parameters are provided for all COPCs in Table 2A-4 at the end of this appendix.

Table 2A-3. Exposure Parameters for Trespasser (Juvenile and Adult) Scenario[a]

Exposure Pathway and Parameter	Units	Value
Surface Soil[b]		
Incidental Ingestion		
Soil ingestion rate (Adult/Juvenile)	kg/day	0.0001 / 0.0002
Exposure time	hours/day	2
Exposure frequency (Adult/Juvenile)	days/year	75 / 50
Exposure duration (Adult/Juvenile)	years	30 / 10
Body weight (Adult/Juvenile)	kg	70 / 45
Carcinogen averaging time	days	25,550
Non-carcinogen averaging time (Adult/Juvenile)	days	10,950 / 3,650
Fraction ingested	unitless	1
Conversion factor	days/hour	0.042
Dermal Contact		
Skin area (Adult/Juvenile)	m^2/event	0.57 / 0.815
Adherence factor (Adult/Juvenile)	mg/cm^2	0.4 / 0.2
Absorption fraction	unitless	Chemical Specific – Table 2A-4
Exposure frequency (Adult/Juvenile)	events/year	75 / 50
Exposure duration (Adult/Juvenile)	years	30 / 10
Body weight (Adult/Juvenile)	kg	70 / 45
Carcinogen averaging time	days	25,550

Table 2A-3. Exposure Parameters for Trespasser (Juvenile and Adult) Scenario[a] (continued)

Exposure Pathway and Parameter	Units	Value
Non-carcinogen averaging time (Adult/Juvenile)	days	10,950 / 3,650
Conversion factor	(kg-cm^2)/(mg-m^2)	0.01
Inhalation of VOCs and Dust		
Inhalation rate	m^3/day	20
Exposure time	hours/day	2
Exposure frequency (Adult/Juvenile)	days/year	75 / 50
Exposure duration (Adult/Juvenile)	years	30 / 10
Body weight (Adult/Juvenile)	kg	70 / 45
Volatilization factor	m^3/kg	Chemical Specific – Table 2A-4
Particulate emission factor	m^3/kg	9.24E+08
Carcinogen averaging time	days	25,550
Non-carcinogen averaging time (Adult/Juvenile)	days	10,950 / 3,650
Conversion factor	days/hour	0.042
Sediment		
Incidental Ingestion		
Soil ingestion rate (Adult/Juvenile)	kg/day	0.0001 / 0.0002
Exposure time	hours/day	2
Exposure frequency (Adult/Juvenile)	days/year	75 / 50
Exposure duration (Adult/Juvenile)	years	30 / 10
Body weight (Adult/Juvenile)	kg	70 / 45
Carcinogen averaging time	days	25,550
Non-carcinogen averaging time (Adult/Juvenile)	days	10,950 / 3,650
Fraction ingested	unitless	1
Conversion factor	days/hour	0.042
Dermal Contact		
Skin area (Adult/Juvenile)	m^2/event	0.57 / 0.815
Adherence factor (Adult/Juvenile)	mg/cm^2	0.4 / 0.2
Absorption fraction	unitless	Chemical Specific – Table 2A-4
Exposure frequency (Adult/Juvenile)	events/year	75 / 50
Exposure duration (Adult/Juvenile)	years	30 / 10
Body weight (Adult/Juvenile)	kg	70 / 45
Carcinogen averaging time	days	25,550
Non-carcinogen averaging time (Adult/Juvenile)	days	10,950 / 3,650
Conversion factor	(kg-cm^2)/(mg-m^2)	0.01
Inhalation of VOCs and Dust		
Inhalation rate	m^3/day	20
Exposure time	hours/day	2
Exposure frequency (Adult/Juvenile)	days/year	75 / 50
Exposure duration (Adult/Juvenile)	years	30 / 10
Body weight (Adult/Juvenile)	kg	70 / 45

Table 2A-3. Exposure Parameters for Trespasser (Juvenile and Adult) Scenario[a] (continued)

Exposure Pathway and Parameter	Units	Value
Volatilization factor	m^3/kg	Chemical Specific – Table 2A-4
Particulate emission factor	m^3/kg	9.24E+08
Carcinogen averaging time	days	25,550
Non-carcinogen averaging time (Adult/Juvenile)	days	10,950 / 3,650
Conversion factor	days/hour	0.042
Surface Water		
Incidental Ingestion		
Incidental water ingestion rate	L/day	0.1
Exposure frequency (Adult/Juvenile)	days/year	75 / 50
Exposure duration (Adult/Juvenile)	years	30 / 10
Body weight (Adult/Juvenile)	kg	70 / 45
Carcinogen averaging time	days	25,550
Non-carcinogen averaging time (Adult/Juvenile)	days	10,950 / 3,650
Dermal Contact		
Skin area (Adult/Juvenile)	m^2	0.57 / 0.815
Exposure time	hours/day	2
Exposure frequency (Adult/Juvenile)	days/year	75 / 50
Exposure duration (Adult/Juvenile)	years	30 / 10
Body weight (Adult/Juvenile)	kg	70 / 45
Carcinogen averaging time	days	25,550
Non-carcinogen averaging time (Adult/Juvenile)	days	10,950 / 3,650
Conversion factor	$(m/cm)(L/m^3)$	10

[a]Exposure parameters are from Table 5 of the Facility Wide Human Health Risk Assessor's Manual Amendment 1 (USACE 2005c).
[b]Surface soil is defined as 0-1 ft BGS (shallow surface soil).
VOC = Volatile organic compound.

EPCs were calculated for each exposure medium in the baseline HHRA as detailed in the RI Report. These EPCs are provided in Tables 2A-13 through 2A-24 at the end of this appendix.

2A.4 TOXICITY ASSESSMENT

Toxicity factors from USEPA sources are provided in Table 2A-5 [non-cancer reference doses (RfDs)] and Table 2A-6 [cancer slope factors (CSFs)] at the end of this appendix. These are the same toxicity factor values used to evaluate the five receptors evaluated in the baseline HHRA for FBQ.

Chronic RfDs are developed for protection from long-term exposure to a chemical (from 7 years to a lifetime); subchronic RfDs are used to evaluate short-term exposure (from 2 weeks to 7 years) (USEPA 1989). The Juvenile Trespasser scenario assumes an exposure duration of 10 years and the Adult Trespasser assumes an exposure duration of 30 years; therefore, only chronic RfDs are used in this supplemental HHRA.

Reference air concentrations (RfCs) and inhalation unit risks were converted to RfDs and CSFs using default adult inhalation rate and body weight [i.e., (RfC × 20 m3/day)/70 kg = RfD, Unit Risk × 70 kg × 1,000 μg/mg)/20 m3/day = CSF] (USEPA 1989).

Dermal RfDs and CSFs are estimated from oral toxicity values using chemical-specific gastrointestinal absorption factors (GAFs) to calculate total absorbed dose as recommended by USEPA (2004). The GAF values used and resulting dermal toxicity values are listed in Tables 2A-5 and 2A-6 at the end of this appendix.

Separate analyses were conducted for total chromium and hexavalent chromium at FBQ; therefore, total chromium is evaluated using toxicity values for trivalent chromium and hexavalent chromium is evaluated using the toxicity values for hexavalent chromium at this AOC.

Per the FWHHRAM (USACE 2004b) toxicity equivalence factors (TEFs) are applied to carcinogenic polycyclic aromatic hydrocarbons (cPAHs) to convert the cPAHs to an equivalent concentration of benzo(a)pyrene.

No RfDs or CSFs are available for some COPCs because the non-carcinogenic and/or carcinogenic effects of these chemicals have not yet been determined. Although these chemicals may contribute to health effects from exposure to contaminated media, their effects cannot be quantified at the present time. COPCs without RfDs and CSFs are 2-amino-4,6-DNT; 4-amino-2,6-DNT; nitrocellulose; nitroglycerin; acenaphthylene; benzo(g,h,i)perylene; and phenanthrene.

No RfDs or CSFs are available for lead. USEPA (1999b) recommends the use of the interim adult lead model (ALM) to support its goal of limiting risk of elevated fetal blood lead concentrations due to lead exposures to women of child-bearing age. This model is used to estimate the probability that the fetal blood lead level will exceed 10 μg/dL as a result of maternal exposure. Complete documentation of the model is available at: http://www.epa.gov/superfund/programs/lead/products/adultpb.pdf (USEPA 2003). The model-supplied default values were used for all parameters, with the exception of the AOC - specific media concentration and exposure frequency. Input parameters and results of this model are provided in Tables 2A-7 through 2A-12 at the end of this appendix. The Integrated Exposure Uptake Biokinetic (IEUBK) model for lead in children (available at: http://www.epa.gov/superfund/programs/lead/ieubk.htm) was not used to evaluate the Juvenile Trespasser because this receptor is assumed to be age 8 to 18 years and the IEUBK model applies to children age 0 to 6 years.

2A.5 RISK CHARACTERIZATION FOR TRESPASSER AT FBQ

Risk characterization integrates the findings of the exposure and toxicity assessments to estimate the potential for receptors to experience adverse effects as a result of exposure to contaminated media. Risk characterization for the Trespasser (Juvenile and Adult) in this supplemental HHRA follows the same methodology used for risk characterization for the other receptors evaluated in the baseline HHRA for FBQ.

Risk characterization results, including identification of COCs, are presented in the following subsections. COCs are defined as COPCs having an ILCR greater than 1.0E-06 and/or an HI greater than 1.

2A.5.1 FBQ Surface Soil (0-1 ft BGS)

Detailed hazard and risk results for direct contact with COPCs in shallow surface soil (0-1 ft BGS) are presented in Tables 2A-13 and 2A-14 (Juvenile Trespasser) and 2A-15 and 2A-16 (Adult Trespasser) at the end of this appendix. Direct contact includes incidental ingestion of soil, inhalation of VOCs and particulates (i.e., dust) from soil, and dermal contact with soil.

The total HIs for the Juvenile Trespasser and Adult Trespasser exposed to shallow surface soil are 0.018 and 0.021, respectively, which are below the threshold of 1.0; thus, no non-carcinogenic shallow surface soil COCs are identified at FBQ for either receptor.

The total risk across all COPCs for the Juvenile Trespasser exposed to shallow surface soil is 6.0E-07, which is below the threshold of 1.0E-06; thus, no carcinogenic shallow surface soil COCs are identified at FBQ for this receptor. The total risk across all COPCs for the Adult Trespasser exposed to shallow surface soil is 2.1E-06, which is above the threshold of 1.0E-06. Arsenic is identified as a carcinogenic COC for the Adult Trespasser exposed to shallow surface soil at FBQ; however, the arsenic risk (1.8E-06) is not in excess of Ohio EPA's level of concern of 1E-05 (Ohio EPA 2005b).

Lead was identified as a surface soil COPC at FBQ. Lead model results for the Juvenile Trespasser and Adult Trespasser are provided in Tables 2A-7 and 2A-8, respectively, at the end of this appendix. The estimated probability of fetal blood lead concentrations exceeding acceptable levels is less than 1% for both a Juvenile Trespasser and an Adult Trespasser exposed to shallow surface soil at FBQ; therefore, lead is not a COC.

2A.5.2 FBQ Sediment

Detailed hazard and risk results for contact with COPCs in sediment are presented in Tables 2A-17 and 2A-18 (Juvenile Trespasser) and Tables 2A-19 and 2A-20 (Adult Trespasser) at the end of this appendix. Direct contact includes incidental ingestion of sediment, inhalation of VOCs and particulates (i.e., dust) from sediment, and dermal contact with sediment. Three sediment EUs are evaluated: Ditch, Quarry Ponds, and Settling Basins.

Total HIs for the Juvenile Trespasser exposed to sediment range from 0.005 to 0.061 for the three EUs, while total HIs for the Adult Trespasser exposed to sediment range from 0.0049 to 0.058 for the three EUs. These HIs are below the threshold of 1.0; thus, no non-carcinogenic sediment COCs are identified at FBQ for either receptor.

The total risk across all COPCs for the Juvenile Trespasser exposed to sediment range from 8.0E-08 to 1.4E-06 for the three EUs. Because all individual chemicals have risks that are below the threshold of

1.0E-06, no carcinogenic sediment COCs are identified at FBQ for this receptor. The total risk across all COPCs for the Adult Trespasser exposed to sediment range from 3.1E-07 to 4.8E-06 for the three EUs. Arsenic (risks of 3.0E-06 and 2.8E-06 at the Ditch and Quarry Ponds, respectively) and benzo(a)pyrene (risk of 1.5E-06 at both the Ditch and Quarry Ponds) are identified as carcinogenic COCs; however, neither chemical has risk in excess of Ohio EPA's level of concern of 1E-05.

Lead was identified as a sediment COPC for two EUs at FBQ: the Quarry Ponds and the Settling Basins. Lead model results for the Juvenile Trespasser and Adult Trespasser are provided in Tables 2A-9 and 2A-10, respectively, at the end of this Appendix. The estimated probability of fetal blood lead concentrations exceeding acceptable levels is 2.3% or less for a Juvenile Trespasser and 1.7% or less for an Adult Trespasser exposed to sediment at FBQ; therefore, lead is not a COC.

2A.5.3 FBQ Surface Water

Detailed hazard and risk results for contact with COPCs in surface water are presented in Tables 2A-21 and 2A-22 (Juvenile Trespasser) and 2A-23 and 2A-24 (Adult Trespasser) at the end of this appendix. Direct contact includes incidental ingestion of surface water and dermal contact with surface water. Three surface water EUs are evaluated: Ditch, Quarry Ponds, and Settling Basins.

Total HIs for the Juvenile Trespasser exposed to surface water range from 0.000041 to 0.45 for the three EUs, while total HIs for the Adult Trespasser exposed to surface water range from 0.000035 to 0.33 for the three EUs. These HIs are below the threshold of 1.0; thus, no non-carcinogenic surface water COCs are identified at FBQ for either receptor.

No carcinogenic COPCs were identified for surface water at the Ditch. The total risks across all COPCs for the Juvenile Trespasser and Adult Trespasser exposed to surface water at the Quarry Ponds is 2.6E-09 and 6.7E-09, respectively, which are below the threshold of 1.0E-06; thus, no carcinogenic surface water COCs are identified for the Ditch or Quarry Ponds at FBQ for either receptor.

The total risk across all COPCs for the Juvenile Trespasser exposed to surface water at the Settling Basins is 1.7E-06, coming predominantly from arsenic. All risks for individual COPCs are less than 1.0E-06; therefore, no carcinogenic surface water COCs are identified at the Quarry Ponds for this receptor. The total risk across all COPCs for the Adult Trespasser exposed to surface water at the Settling Basins is 3.9E-06. Arsenic (risk of 2.1E-06) and bis(2-ethylhexyl)phthalate (risk of 1.8E-06) are identified as carcinogenic COCs at this EU; however, neither chemical has risk in excess of Ohio EPA's level of concern of 1E-05.

Lead was identified as a surface water COPC for the Settling Basins at FBQ. Lead model results for the Juvenile Trespasser and Adult Trespasser are provided in Tables 2A-11 and 2A-12, respectively, at the end of this appendix. The estimated probability of fetal blood lead concentrations exceeding acceptable levels is less than 1% for both a Juvenile Trespasser and an Adult Trespasser exposed to surface water at FBQ; therefore, lead is not a COC.

2A.5.4 Summary of Risk Characterization Results for Trespasser at FBQ

Risks, hazards, and COCs are summarized in Table 2A-25 for the Trespasser (Juvenile and Adult) exposed to shallow surface soil (0-1 ft BGS), sediment, and surface water at FBQ.

Table 2A-25. Summary of Risks and Hazards for Trespasser at FBQ

Exposure Medium	Total HI	Non-carcinogenic COCs	Total ILCR	Carcinogenic COCs
Juvenile Trespasser				
Shallow Surface Soil (0-1 ft BGS)	0.018	None	6.0E-07	None
Sediment				
Ditch	0.034	None	1.4E-06	None
Quarry Ponds	0.061	None	1.3E-06	None
Settling Basins	0.005	None	8.0E-08	None
Surface Water				
Ditch	0.45	None	NA	None
Quarry Ponds	0.000041	None	2.6E-09	None
Settling Basins	0.12	None	1.7E-06	None
Adult Trespasser				
Shallow Surface Soil (0-1 ft BGS)	0.021	None	2.1E-06	arsenic
Sediment				
Ditch	0.037	None	4.8E-06	arsenic, benzo(a)pyrene
Quarry Ponds	0.058	None	4.7E-06	arsenic, benzo(a)pyrene
Settling Basins	0.0049	None	3.1E-07	None
Surface Water				
Ditch	0.33	None	NA	None
Quarry Ponds	0.000035	None	6.7E-09	None
Settling Basins	0.090	None	3.9E-06	arsenic, bis(2-ethylhexyl)phthalate

COC = Constituent of concern.
HI = Hazard index.
ILCR = Incremental lifetime cancer risk.
NA = Not applicable, no carcinogenic constituents of concern (COPCs) identified at this exposure unit (EU).

2A.6 UNCERTAINTY ANALYSIS

Uncertainties associated with each step of the risk assessment process (i.e., data evaluation, exposure assessment, toxicity assessment, and risk characterization) are described in the baseline HHRA for FBQ.

While anticipated future land use has been identified for the RTLS (USACE 2005b), and OHARNG will manage the property, there is uncertainty surrounding land use. To address uncertainty regarding unauthorized access to RVAAP, a Trespasser (Juvenile and Adult) is evaluated in this supplemental risk assessment.

2A.7 SUMMARY AND CONCLUSIONS

This supplemental HHRA was conducted to evaluate risks and hazards associated with impacted media at FBQ for a Trespasser (Juvenile and Adult) scenario. The following steps were used to generate conclusions regarding human health risks and hazards:

- Identification of COPCs (in the baseline HHRA included in the RI Report for FBQ);
- Calculation of risks and hazards; and
- Identification of COCs.

All HIs for the Trespasser (Juvenile and Adult) at FBQ are below the threshold value of 1.0. Therefore, no non-carcinogenic COCs are identified for either receptor.

For the Juvenile Trespasser the total ILCRs are below the threshold value of 1E-06 for shallow surface soil (0-1 ft BGS), for sediment at the Settling Basins, and for surface water at the Ditch and Quarry Ponds. The total ILCRs exceed 1.0E-06, but are below Ohio EPA's level of concern of 1E-05 and no individual chemicals have ILCRs that exceed 1.0E-06 for sediment exposures at the Ditch and Quarry Ponds and for surface water exposures at the Settling Basins. Therefore, no carcinogenic COCs are identified for the Juvenile Trespasser.

For the Adult Trespasser the total ILCRs are below the threshold value of 1.0E-06 for sediment at the Settling Basins and for surface water at the Ditch and Quarry Ponds; therefore, no carcinogenic COCs are identified for the Adult Trespasser for these medium/EU combinations. The total ILCRs exceed 1.0E-06 at all other medium/EU combinations, but are below Ohio EPA's level of concern of 1E-05 and no individual chemicals have ILCRs that exceed Ohio EPA's level of concern of 1E-05. Arsenic is identified as a carcinogenic COC in shallow surface soil (0-1 ft BGS), sediment (Ditch and Quarry Ponds), and surface water (Settling Basins); benzo(a)pyrene is identified as a carcinogenic COC in sediment (Ditch and Quarry Ponds); and bis(2-ethylhexyl)phthalate is identified as a carcinogenic COC in surface water (Settling Basins).

Table 2A-4. Chemical-Specific Exposure Parameters

COPC	Dermal Absorption Factor[a] (unitless)	Permeability Constant[b] (cm/hr)	Volatilization Factor[c] (m^3/kg)
Inorganics			
Aluminum	1.0E-03	2.1E-03	--
Antimony	1.0E-03	1.1E-03	--
Arsenic	3.0E-02	1.9E-03	--
Barium	1.0E-03	4.0E-04	--
Cadmium	1.0E-03	3.5E-04	--
Chromium (as Chromium III)	1.0E-03	1.0E-03	--
Chromium, hexavalent	1.0E-03	1.0E-03	--
Copper	1.0E-03	3.1E-04	--
Manganese	1.0E-03	1.3E-03	--
Mercury	1.0E-03	2.9E-05	--
Vanadium	1.0E-03	1.4E-03	--
Zinc	1.0E-03	3.4E-04	--
Organics			
2,4,6-Trinitrotoluene	1.0E-01	1.1E-03	--
2,6-Dinitrotoluene	1.0E-01	4.6E-03	--
Benz(a)anthracene	1.3E-01	9.5E-01	--
Benzo(a)pyrene	1.3E-01	1.2E+00	--
Benzo(b)fluoranthene	1.3E-01	7.0E-01	--
Bis(2-ethylhexyl)phthalate	1.0E-02	2.0E+00	--
Indeno(1,2,3-cd)pyrene	1.3E-01	2.2E+00	--
Methylene chloride	1.0E-02	4.5E-03	3.5E+03
Perchlorate	1.0E-03	3.8E-07	--

[a] Chemical-specific absorption factor values from USEPA, 2004. When chemical-specific values are not available the following default values are used for soil and sediment only: SVOCs = 0.1, VOCs = 0.01, inorganics = 0.001 per USEPA Region 4 Supplemental Guidance to RAGS.
[b] From Risk Assessment Information System (RAIS) *http://risk.lsd.ornl.gov/tox/tox_values.shtml* for surface water.
[c] Volatilization factors (VFs) calculated using the 1996 USEPA Soil Screening Guidance Methodology, using site-specific parameter values for Cleveland, Ohio. Only used for soil and sediment VOCs.
COPC = Constituent of potential concern.
RAGS = Risk Assessment Guidance for Superfund.
SVOC = semivolatile organic compound.
USEPA = United States Environmental Protection Agency.
VOC = Volatile organic compound.
-- = No value available.

Table 2A-5. Non-carcinogenic Reference Doses for COPCs

COPC	Oral Chronic RfD (mg/kg-day)	Confidence Level	% GI absorption[a]	Dermal Chronic RfD (mg/kg-day)	Inhalation Chronic RfD (mg/kg-day)	RfD Basis (vehicle)	Critical Effect	Uncertainty/ Modifying Factor
Inorganics								
Aluminum	1.0E+00	NA	1	1.0E+00	1.4E-03	NA	NA	(O) UF=10
Antimony	4.0E-04	Low	0.15	6.0E-05	--	Oral, oral-water	Gastrointestinal, liver, cardiovascular, and developmental toxicity	(O) UF=1000
Arsenic	3.0E-04	Medium (O)	0.95	3.0E-04	--	Oral, oral-water	Hyperpigmentation and keritosis and possible vascular complication	(O) UF=3
Barium	7.0E-02	Medium (O)	0.07	4.9E-03	1.4E-04	Oral, oral-water, inhalation	(O) increased blood pressure (human) (I) baritosis (human)	(O) UF=3 (I) UF=1000
Cadmium (soil/food)	1.0E-03	High	0.025	2.5E-05	--	Oral, oral-water	Renal toxicity, osteomalacia, osteoporosis, and significant proteinuria	(O) UF=1000
Cadmium (water)	5.0E-04	High	0.05	2.5E-05	--	Oral, oral-water	Renal toxicity, osteomalacia, osteoporosis, and significant proteinuria	(O) UF=1000
Chromium (as Cr III)	1.5E+00	Low (O)	0.013	2.0E-02	--	Oral (rat)	NA	(O) UF=100
Chromium, hexavalent	3.0E-03	Low	0.025	7.5E-05	2.9E-05	Oral (rat)	NA	(O) MF=3 (O) UF=300
Copper	4.0E-02	NA	1	4.0E-02	--	NA	NA	
Manganese (food)	1.4E-01	Medium (O)	0.04	5.6E-03	1.4E-05	Oral	(O) lethargy, tremors, mental disturbance, muscle tonus, and central nervous system effects	(O) UF=1 (O) MF=1
Manganese (soil/water)	4.6E-02	Medium (O)	0.04	1.8E-03	1.4E-05	Oral: water, inhalation	(O) lethargy, tremors, mental disturbance, muscle tonus, and central nervous system effects	(O) UF=1 (O) MF=1 (I) UF=1000
Mercury	3.0E-04	Medium (I)	0.07	2.1E-05	--	Human occupational inhalation studies	Hand tremor, increases in memory disturbance; slight subjective and objective evidence of autonomic dysfunction	(I) UF=30
Vanadium	7.0E-03	Low	0.026	1.8E-04	--	Oral (rat)	Decreased hair cystine	UF=100

Table 2A-5. Non-carcinogenic Reference Doses for COPCs (continued)

COPC	Oral Chronic RfD (mg/kg-day)	Confidence Level	% GI absorption[a]	Dermal Chronic RfD (mg/kg-day)	Inhalation Chronic RfD (mg/kg-day)	RfD Basis (vehicle)	Critical Effect	Uncertainty/ Modifying Factor
Zinc	3.0E-01	Medium	0.3	9.0E-02	--	Oral	(O) copper deficiency & hypochromic microcytic anemia (human) (I) pulmonary & gastrointestinal effects (human)	UF=3
Organics								
2,4,6-Trinitrotoluene	5.0E-04	Medium	1	5.0E-04	--	Oral (dog)	Liver effects	UF=1000
2,6-Dinitrotoluene	1.0E-03	Medium	1	1.0E-03	--	Oral (dog)	Neurological, hematological, and liver histopathology	UF=3000
Bis (2-ethylhexyl)phthalate	2.0E-02	Medium	1	2.0E-02	--	Oral	Liver effects with increased relative weight	(O) MF=1 (O) UF=1000
Methylene chloride	6.0E-02	Medium	1	6.0E-02	8.6E-01	Oral (mice), inhalation (mice)	Adenomas, carcinomas, nodules	UF=100
Perchlorate	7.0E-04	NA	1	7.0E-04	--	NA	NA	NA

[a] % GI absorption values from USEPA 2004.
(O) indicates oral, (I) indicates inhalation.
RfD = Reference dose.
USEPA = United States Environmental Protection Agency.
MF = Modifying factor (the default modifying factor is 1).
UF = Uncertainty factor.
NA = Not available.
-- = No value available.
GI = Gastrointestinal.
COPC = constituent of potential concern.

Table 2A-6. Cancer Slope Factors for COPCs

COPC	Oral Slope Factor $(mg/kg\text{-}day)^{-1}$	% GI absorption[a]	Dermal Slope Factor $(mg/kg\text{-}day)^{-1}$	Inhalation Slope Factor $(mg/kg\text{-}day)^{-1}$	USEPA Class	TEF	Type of Cancer
Inorganics							
Arsenic	1.5E+00	0.95	1.5E+00	1.5E+01	A	--	Respiratory system tumors
Cadmium (soil/food)	--	0.025	--	6.3E+00	B1	--	Respiratory tract and lung tumors
Cadmium (water)	--	0.05	--	6.3E+00	B1	--	Respiratory tract and lung tumors
Chromium, hexavalent	--	0.025	--	4.2E+01	A	--	Lung tumors
Organics							
2,4,6-Trinitrotoluene	3.0E-02	1	3.0E-02	--	C	--	Bladder transitional cell papilloma
2,6-Dinitrotoluene	6.8E-01	1	6.8E-01	--	B2	--	Liver carcinoma, mammary adenomas, fibromas (mouse)
Benz(a)anthracene	7.3E-01	0.58	7.3E-01	3.1E-01	B2	0.1	Stomach tumors (mouse)
Benzo(a)pyrene	7.3E+00	0.58	7.3E+00	3.1E+00	B2	1	Stomach, nasal cavity, larynx, trachea, and pharynx
Benzo(b)fluoranthene	7.3E-01	0.58	7.3E-01	3.1E-01	B2	0.1	Tumors
Bis(2-ethylhexyl)phthalate	1.4E-02	1	1.4E-02	--	B2	--	Liver neoplastic nodule and nepatocellular carcinoma (mouse)
Indeno(1,2,3-cd)pyrene	7.3E-01	0.58	7.3E-01	3.1E-01	B2	0.1	Tumors
Methylene chloride	7.5E-03	1	7.5E-03	1.7E-03	B2	--	Hepatocellular carcinoma, adinomas (mouse)

[a] % gastrointestinal (GI) absorption values from United States Environmental Protection Agency (USEPA) 2004.
TEF = Toxicity Equivalency Factor is based on the relative potency of each carcinogenic polycyclic aromatic hydrocarbon (PAH) relative to that of benzo(a)pyrene.
-- = No value available.
COPC = Constituent of potential concern.

Table 2A-7. FBQ Shallow Surface Soil (0-1 ft BGS) Calculations of Blood Lead Concentrations for Juvenile Trespasser

Exposure Variable	PbB Equation[1]		Description of Exposure Variable	Units	Juvenile Trespasser	
	1*	2*			GSDi = 1.8	GSDi = 2.1
PbS	X	X	Soil lead concentration	ug/g or mg/kg	82.7	82.7
$R_{fetal/maternal}$	X	X	Fetal/maternal PbB ratio	--	0.9	0.9
BKSF	X	X	Biokinetic Slope Factor	ug/dL per ug/day	0.4	0.4
GSD_i	X	X	Geometric standard deviation PbB	--	1.8	2.1
PbB_0	X	X	Baseline PbB	ug/dL	2.2	1.7
IR_S	X		Soil ingestion rate (including soil-derived indoor dust)	g/day	0.2	0.2
IR_{S+D}		X	Total ingestion rate of outdoor soil and indoor dust	g/day	0.2	0.2
W_S		X	Weighting factor; fraction of IR_{S+D} ingested as outdoor soil	--	--	--
K_{SD}		X	Mass fraction of soil in dust	--	--	--
$AF_{S, D}$	X	X	Absorption fraction (same for soil and dust)	--	0.12	0.12
$EF_{S, D}$	X	X	Exposure frequency (same for soil and dust)	days/yr	50	50
$AT_{S, D}$	X	X	Averaging time (same for soil and dust)	days/yr	365	365
PbB_{adult}	**PbB of adult receptor, geometric mean**			**ug/dL**	**2.3**	**1.8**
$PbB_{fetal, 0.95}$	**95th percentile PbB among fetuses of adult workers**			**ug/dL**	**5.5**	**5.5**
PbB_t	**Target PbB level of concern (e.g., 10 ug/dL)**			**ug/dL**	**10.0**	**10.0**
$P(PbB > PbB_t)$	**Probability that PbB > PbB_t, assuming lognormal distribution**			**%**	**0.4%**	**0.7%**

[1] Equation 1 does not apportion exposure between soil and dust ingestion (excludes W_S, K_{SD}). When IRS = IR_{S+D} and WS = 1.0, the equations yield the same $PbB_{fetal,0.95}$.
* Equation 1, based on Eq. 1, 2 in United States Environmental Protection Agency (USEPA) 2003. USEPA Technical Review Workgroup for Lead, Adult Lead Committee.
$PbB_{adult} = (PbS * BKSF * IR_{S+D} * AF_{S,D} * EF_{S,D} / AT_{S,D}) + PbB_0$.
$PbB_{fetal, 0.95} = PbB_{adult} * (GSD_i^{1.645} * R)$.

Table A-8. FBQ Shallow Surface Soil (0-1 ft BGS) Calculations of Blood Lead Concentrations for Adult Trespasser

Exposure Variable	PbB Equation[1] 1*	2*	Description of Exposure Variable	Units	Adult Trespasser GSDi = 1.8	GSDi = 2.1
PbS	X	X	Soil lead concentration	ug/g or mg/kg	82.7	82.7
$R_{fetal/maternal}$	X	X	Fetal/maternal PbB ratio	--	0.9	0.9
BKSF	X	X	Biokinetic Slope Factor	ug/dL per ug/day	0.4	0.4
GSD_i	X	X	Geometric standard deviation PbB	--	1.8	2.1
PbB_0	X	X	Baseline PbB	ug/dL	2.2	1.7
IR_S	X		Soil ingestion rate (including soil-derived indoor dust)	g/day	0.1	0.1
IR_{S+D}		X	Total ingestion rate of outdoor soil and indoor dust	g/day	0.1	0.1
W_S		X	Weighting factor; fraction of IR_{S+D} ingested as outdoor soil	--	--	--
K_{SD}		X	Mass fraction of soil in dust	--	--	--
$AF_{S,D}$	X	X	Absorption fraction (same for soil and dust)	--	0.12	0.12
$EF_{S,D}$	X	X	Exposure frequency (same for soil and dust)	days/yr	75	75
$AT_{S,D}$	X	X	Averaging time (same for soil and dust)	days/yr	365	365
PbB_{adult}	**PbB of adult receptor, geometric mean**			**ug/dL**	**2.3**	**1.8**
$PbB_{fetal,0.95}$	**95^{th} percentile PbB among fetuses of adult workers**			**ug/dL**	**5.4**	**5.4**
PbB_t	**Target PbB level of concern (e.g., 10 ug/dL)**			**ug/dL**	**10.0**	**10.0**
$P(PbB > PbB_t)$	**Probability that PbB > PbB_t, assuming lognormal distribution**			**%**	**0.4%**	**0.7%**

[1] Equation 1 does not apportion exposure between soil and dust ingestion (excludes W_S, K_{SD}). When $IR_S = IR_{S+D}$ and $W_S = 1.0$, the equations yield the same $PbB_{fetal,0.95}$.

* Equation 1, based on Eq. 1, 2 in United States Environmental Protection Agency (USEPA) 2003. USEPA Technical Review Workgroup for Lead, Adult Lead Committee.

$PbB_{adult} = (PbS * BKSF * IR_{S+D} * AF_{S,D} * EF_{S,D} / AT_{S,D}) + PbB_0$.

$PbB_{fetal,0.95} = PbB_{adult} * (GSD_i^{1.645} * Rfetal/maternal)$.

Table A-9. FBQ Sediment Calculations of Blood Lead Concentrations for Juvenile Trespasser

Exposure Variable	PbB Equation[1] 1*	PbB Equation[1] 2*	Description of Exposure Variable	Units	Juvenile Trespasser: Quarry Ponds GSDi = 1.8	Quarry Ponds GSDi = 2.1	Settling Basins GSDi = 1.8	Settling Basins GSDi = 2.1
PbS	X	X	Soil lead concentration	ug/g or mg/kg	621	621	114	114
$R_{fetal/maternal}$	X	X	Fetal/maternal PbB ratio	--	0.9	0.9	0.9	0.9
BKSF	X	X	Biokinetic Slope Factor	ug/dL per ug/day	0.4	0.4	0.4	0.4
GSD_i	X	X	Geometric standard deviation PbB	--	1.8	2.1	1.8	2.1
PbB_0	X	X	Baseline PbB	ug/dL	2.2	1.7	2.2	1.7
IR_S	X		Soil ingestion rate (including soil-derived indoor dust)	g/day	0.2	0.2	0.2	0.2
IR_{S+D}		X	Total ingestion rate of outdoor soil and indoor dust	g/day	0.2	0.2	0.2	0.2
W_S		X	Weighting factor; fraction of IR_{S+D} ingested as outdoor soil	--	--	--	--	--
K_{SD}		X	Mass fraction of soil in dust	--	--	--	--	--
$AF_{S, D}$	X	X	Absorption fraction (same for soil and dust)	--	0.12	0.12	0.12	0.12
$EF_{S, D}$	X	X	Exposure frequency (same for soil and dust)	days/yr	50	50	50	50
$AT_{S, D}$	X	X	Averaging time (same for soil and dust)	days/yr	365	365	365	365
PbB_{adult}	**PbB of adult receptor, geometric mean**			**ug/dL**	**3.0**	**2.5**	**2.3**	**1.8**
$PbB_{fetal, 0.95}$	**95th percentile PbB among fetuses of adult workers**			**ug/dL**	**7.1**	**7.7**	**5.6**	**5.6**
PbB_t	**Target PbB level of concern (e.g., 10 ug/dL)**			**ug/dL**	**10.0**	**10.0**	**10.0**	**10.0**
$P(PbB > PbB_t)$	**Probability that PbB > PbB_t, assuming lognormal distribution**			**%**	**1.3%**	**2.3%**	**0.4%**	**0.8%**

Equation 1 does not apportion exposure between soil and dust ingestion (excludes W_S, K_{SD}). When IRS = IR_{S+D} and WS = 1.0, the equations yield the same $PbB_{fetal,0.95}$.
* Equation 1, based on Eq. 1, 2 in United States Environmental Protection Agency (USEPA) 2003. USEPA Technical Review Workgroup for Lead, Adult Lead Committee.
$PbB_{adult} = (PbS * BKSF * IR_{S+D} * AF_{S,D} * EF_{S,D} / AT_{S,D}) + PbB_0$.
$PbB_{fetal, 0.95} = PbB_{adult} * (GSD_i^{1.645} * R)$.

Table 2A-10. FBQ Sediment Calculations of Blood Lead Concentrations for Adult Trespasser

Exposure Variable	PbB Equation[1]		Description of Exposure Variable	Units	Quarry Ponds		Small Basins	
	1*	2*			GSDi = 1.8	GSDi = 2.1	GSDi = 1.8	GSDi = 2.1
PbS	X	X	Soil lead concentration	ug/g or mg/kg	621	621	114	114
$R_{fetal/maternal}$	X	X	Fetal/maternal PbB ratio	--	0.9	0.9	0.9	0.9
BKSF	X	X	Biokinetic Slope Factor	ug/dL per ug/day	0.4	0.4	0.4	0.4
GSD_i	X	X	Geometric standard deviation PbB	--	1.8	2.1	1.8	2.1
PbB_0	X	X	Baseline PbB	ug/dL	2.2	1.7	2.2	1.7
IR_S	X		Soil ingestion rate (including soil-derived indoor dust)	g/day	0.1	0.1	0.1	0.1
IR_{S+D}		X	Total ingestion rate of outdoor soil and indoor dust	g/day	0.1	0.1	0.1	0.1
W_S		X	Weighting factor; fraction of IR_{S+D} ingested as outdoor soil	--	--	--	--	--
K_{SD}		X	Mass fraction of soil in dust	--	--	--	--	--
$AF_{S, D}$	X	X	Absorption fraction (same for soil and dust)	--	0.12	0.12	0.12	0.12
$EF_{S, D}$	X	X	Exposure frequency (same for soil and dust)	days/yr	75	75	75	75
$AT_{S, D}$	X	X	Averaging time (same for soil and dust)	days/yr	365	365	365	365
PbB_{adult}	**PbB of adult receptor, geometric mean**			**ug/dL**	**2.8**	**2.3**	**2.3**	**1.8**
$PbB_{fetal, 0.95}$	**95th percentile PbB among fetuses of adult workers**			**ug/dL**	**6.7**	**7.1**	**5.5**	**5.5**
PbB_t	**Target PbB level of concern (e.g., 10 ug/dL)**			**ug/dL**	**10.0**	**10.0**	**10.0**	**10.0**
$P(PbB > PbB_t)$	**Probability that PbB > PbB_t, assuming lognormal distribution**			**%**	**1.0%**	**1.7%**	**0.4%**	**0.7%**

[1] Equation 1 does not apportion exposure between soil and dust ingestion (excludes W_S, K_{SD}). When $IR_S = IR_{S+D}$ and $W_S = 1.0$, the equations yield the same $PbB_{fetal,0.95}$.
* Equation 1, based on Eq. 1, 2 in United States Environmental Protection Agency (USEPA) 2003. USEPA Technical Review Workgroup for Lead, Adult Lead Committee.
$PbB_{adult} = (PbS * BKSF * IR_{S+D} * AF_{S,D} * EF_{S,D} / AT_{S,D}) + PbB_0.$
$PbB_{fetal, 0.95} = PbB_{adult} * (GSD_i^{1.645} * Rfetal/maternal).$

Table 2A-11. FBQ Surface Water Calculations of Blood Lead Concentrations for Juvenile Trespasser

Exposure Variable	PbB Equation[1]		Description of Exposure Variable	Units	Juvenile Trespasser Settling Basins	
	1*	2*			GSDi = 1.8	GSDi = 2.1
PbW	X	X	Water lead concentration	ug/L	8.57	8.57
$R_{fetal/maternal}$	X	X	Fetal/maternal PbB ratio	--	0.9	0.9
BKSF	X	X	Biokinetic Slope Factor	ug/dL per ug/day	0.4	0.4
GSD_i	X	X	Geometric standard deviation PbB	--	1.8	2.1
PbB_0	X	X	Baseline PbB	ug/dL	2.2	1.7
IR_W	X		Water ingestion rate	L/day	0.1	0.1
AF_W	X	X	Absorption fraction	--	0.12	0.12
EF_W	X	X	Exposure frequency	days/yr	50	50
AT_W	X	X	Averaging time	days/yr	365	365
PbB_{adult}	**PbB of adult receptor, geometric mean**			**ug/dL**	**2.2**	**1.7**
$PbB_{fetal, 0.95}$	**95^{th} percentile PbB among fetuses of adult workers**			**ug/dL**	**5.2**	**5.2**
PbB_t	**Target PbB level of concern (e.g., 10 ug/dL)**			**ug/dL**	**10.0**	**10.0**
$P(PbB > PbB_t)$	**Probability that PbB > PbB_t, assuming lognormal distribution**			**%**	**0.3%**	**0.6%**

* Equation 1, based on Eq. 1, 2 in United States Environmental Protection Agency (USEPA) 2003. USEPA Technical Review Workgroup for Lead, Adult Lead Committee.
$PbB_{adult} = (PbW * BKSF * IR_W * AF_W * EF_W / AT_W) + PbB_0$.
$PbB_{fetal, 0.95} = PbB_{adult} * (GSD_i^{1.645} * R)$.

Table 2A-12. FBQ Surface Water Calculations of Blood Lead Concentrations for Adult Trespasser

Exposure Variable	PbB Equation*	Description of Exposure Variable	Units	Settling Basins	
				GSDi = 1.8	GSDi = 2.1
PbW	X	Water lead concentration	ug/L	8.57	8.57
$R_{fetal/maternal}$	X	Fetal/maternal PbB ratio	--	0.9	0.9
BKSF	X	Biokinetic Slope Factor	ug/dL per ug/day	0.4	0.4
GSD_i	X	Geometric standard deviation PbB	--	1.8	2.1
PbB_0	X	Baseline PbB	ug/dL	2.2	1.7
IR_W	X	Water ingestion rate	L/day	0.1	0.1
AF_W	X	Absorption fraction	--	0.12	0.12
EF_W	X	Exposure frequency	days/yr	75	75
AT_W	X	Averaging time	days/yr	365	365
PbB_{adult}	**PbB of adult receptor, geometric mean**		**ug/dL**	**2.2**	**1.7**
$PbB_{fetal, 0.95}$	**95^{th} percentile PbB among fetuses of adult workers**		**ug/dL**	**5.2**	**5.2**
PbB_t	**Target PbB level of concern (e.g., 10 ug/dL)**		**ug/dL**	**10.0**	**10.0**
P(PbB > PbB_t)	**Probability that PbB > PbB_t, assuming lognormal distribution**		**%**	**0.3%**	**0.6%**

* Equation based on Eq. 1, 2 in United States Environmental Protection Agency (USEPA) 2003. USEPA Technical Review Workgroup for Lead, Adult Lead Committee.
$PbB_{adult} = (PbS * BKSF * IR_{S+D} * AF_{S,D} * EF_{S,D} / AT_{S,D}) + PbB_0$.
$PbB_{fetal, 0.95} = PbB_{adult} * (GSD_i^{1.645} * Rfetal/maternal)$.

Table 2A-13. Juvenile Trespasser Shallow Surface Soil (0-1 ft BGS) Non-Carcinogenic Hazards - Direct Contact

COPC	EPC (mg/kg)	Daily Intake (mg/kg-d)			Hazard Quotient (HQ)			Total HI Across All Pathways	COC[a]
		Ingestion	Dermal	Inhalation	Ingestion	Dermal	Inhalation		
FBQ									
Antimony	4.1E+00	2.1E-07	2.0E-08	2.3E-11	5.2E-04	3.4E-04		8.6E-04	
Arsenic	1.2E+01	6.2E-07	1.8E-06	6.7E-11	2.1E-03	6.1E-03		8.1E-03	
Barium	1.2E+02	5.9E-06	5.8E-07	6.4E-10	8.4E-05	1.2E-04	4.5E-06	2.1E-04	
Cadmium	3.4E-01	1.7E-08	1.7E-09	1.9E-12	1.7E-05	6.7E-05		8.4E-05	
Chromium	2.0E+01	1.0E-06	9.9E-08	1.1E-10	6.8E-07	5.1E-06		5.8E-06	
Copper	4.1E+01	2.1E-06	2.0E-07	2.3E-10	5.2E-05	5.1E-06		5.8E-05	
Manganese	7.4E+02	3.7E-05	3.7E-06	4.1E-09	8.1E-04	2.0E-03	2.8E-04	3.1E-03	
Vanadium	2.2E+01	1.1E-06	1.1E-07	1.2E-10	1.6E-04	6.1E-04		7.7E-04	
Inorganics Pathway Total					3.7E-03	9.2E-03	2.9E-04	1.3E-02	
2,4,6-Trinitrotoluene	4.6E+00	2.3E-07	2.3E-06	2.5E-11	4.7E-04	4.6E-03		5.0E-03	
2,6-Dinitrotoluene	1.1E-01	5.4E-09	5.3E-08	5.8E-13	5.4E-06	5.3E-05		5.8E-05	
Benzo(a)pyrene	8.4E-02	4.3E-09	5.4E-08	4.6E-13					
Organics Pathway Total					4.7E-04	4.6E-03		5.1E-03	
Pathway Total - Chemicals					4.2E-03	1.4E-02	2.9E-04	1.8E-02	

[a] COPCs are identified as constituents of concern (COCs) if the total HI across all pathways is > 1 (H).
COPC = Constituent of potential concern.
EPC = Exposure point concentration.
FBQ = Fuze and Booster Quarry Landfill/Ponds.
HI = Hazard index.

Table 2A-14. Juvenile Trespasser Shallow Surface Soil (0-1 ft BGS) Carcinogenic Risks - Direct Contact

COPC	EPC (mg/kg)	Daily Intake (mg/kg-d)			Risk			Total Risk Across All Pathways	COC[a]
		Ingestion	Dermal	Inhalation	Ingestion	Dermal	Inhalation		
FBQ									
Antimony	4.1E+00	3.0E-08	2.9E-09	3.2E-12					
Arsenic	1.2E+01	8.8E-08	2.6E-07	9.6E-12	1.3E-07	3.9E-07	1.4E-10	5.2E-07	
Barium	1.2E+02	8.4E-07	8.2E-08	9.1E-11					
Cadmium	3.4E-01	2.5E-09	2.4E-10	2.7E-13			1.7E-12	1.7E-12	
Chromium	2.0E+01	1.4E-07	1.4E-08	1.6E-11					
Copper	4.1E+01	3.0E-07	2.9E-08	3.2E-11					
Manganese	7.4E+02	5.3E-06	5.2E-07	5.8E-10					
Vanadium	2.2E+01	1.6E-07	1.6E-08	1.7E-11					
Inorganics Pathway Total					1.3E-07	3.9E-07	1.5E-10	5.2E-07	
2,4,6-Trinitrotoluene	4.6E+00	3.3E-08	3.3E-07	3.6E-12	1.0E-09	9.8E-09		1.1E-08	
2,6-Dinitrotoluene	1.1E-01	7.7E-10	7.5E-09	8.3E-14	5.2E-10	5.1E-09		5.6E-09	
Benzo(a)pyrene	8.4E-02	6.1E-10	7.7E-09	6.6E-14	4.4E-09	5.7E-08	2.0E-13	6.1E-08	
Organics Pathway Total					6.0E-09	7.1E-08	2.0E-13	7.7E-08	
Pathway Total - Chemicals					1.4E-07	4.6E-07	1.5E-10	6.0E-07	

[a] COPCs are identified as constituents of concern (COCs) if the total ILCR across all pathways is > 1E-06 (R).
COPC = Constituent of potential concern.
EPC = Exposure Point poncentration.
FBQ = Fuze and Booster Quarry Landfill/Ponds.
ILCR = Incremental lifetime cancer risk.

Table 2A-15. Adult Trespasser Shallow Surface Soil (0-1 ft BGS) Non-carcinogenic Hazards - Direct Contact

COPC	EPC (mg/kg)	Daily Intake (mg/kg-d)			Hazard Quotient (HQ)			Total HI Across All Pathways	COC[a]
		Ingestion	Dermal	Inhalation	Ingestion	Dermal	Inhalation		
FBQ									
Antimony	4.1E+00	1.0E-07	2.8E-08	2.2E-11	2.5E-04	4.6E-04		7.1E-04	
Arsenic	1.2E+01	3.0E-07	2.4E-06	6.5E-11	9.9E-04	8.2E-03		9.2E-03	
Barium	1.2E+02	2.8E-06	7.8E-07	6.1E-10	4.1E-05	1.6E-04	4.3E-06	2.0E-04	
Cadmium	3.4E-01	8.3E-09	2.3E-09	1.8E-12	8.3E-06	9.1E-05		9.9E-05	
Chromium	2.0E+01	4.9E-07	1.3E-07	1.1E-10	3.3E-07	6.9E-06		7.2E-06	
Copper	4.1E+01	1.0E-06	2.8E-07	2.2E-10	2.5E-05	6.9E-06		3.2E-05	
Manganese	7.4E+02	1.8E-05	4.9E-06	3.9E-09	3.9E-04	2.7E-03	2.7E-04	3.4E-03	
Vanadium	2.2E+01	5.4E-07	1.5E-07	1.2E-10	7.8E-05	8.2E-04		8.9E-04	
Inorganics Pathway Total					1.8E-03	1.2E-02	2.8E-04	1.4E-02	
2,4,6-Trinitrotoluene	4.6E+00	1.1E-07	3.1E-06	2.4E-11	2.3E-04	6.2E-03		6.4E-03	
2,6-Dinitrotoluene	1.1E-01	2.6E-09	7.1E-08	5.6E-13	2.6E-06	7.1E-05		7.4E-05	
Benzo(a)pyrene	8.4E-02	2.1E-09	7.3E-08	4.4E-13					
Organics Pathway Total					2.3E-04	6.2E-03		6.5E-03	
Pathway Total - Chemicals					2.0E-03	1.9E-02	2.8E-04	2.1E-02	

[a] COPCs are identified as constituents of concern (COCs) if the total HI across all pathways is > 1 (H).
COPC = Constituent of potential concern.
EPC = Exposure point concentration.
HI = Hazard index

Table 2A-16. Adult Trespasser Shallow Surface Soil (0-1 ft BGS) Carcinogenic Risks - Direct Contact

COPC	EPC (mg/kg)	Daily Intake (mg/kg-d)			Risk			Total Risk Across All Pathways	COC[a]
		Ingestion	Dermal	Inhalation	Ingestion	Dermal	Inhalation		
FBQ									
Antimony	4.1E+00	4.3E-08	1.2E-08	9.3E-12					
Arsenic	1.2E+01	1.3E-07	1.0E-06	2.8E-11	1.9E-07	1.6E-06	4.2E-10	1.8E-06	R
Barium	1.2E+02	1.2E-06	3.3E-07	2.6E-10					
Cadmium	3.4E-01	3.6E-09	9.7E-10	7.7E-13			4.8E-12	4.8E-12	
Chromium	2.0E+01	2.1E-07	5.7E-08	4.5E-11					
Copper	4.1E+01	4.3E-07	1.2E-07	9.4E-11					
Manganese	7.4E+02	7.7E-06	2.1E-06	1.7E-09					
Vanadium	2.2E+01	2.3E-07	6.4E-08	5.0E-11					
Inorganics Pathway Total					1.9E-07	1.6E-06	4.2E-10	1.8E-06	
2,4,6-Trinitrotoluene	4.6E+00	4.8E-08	1.3E-06	1.0E-11	1.4E-09	4.0E-08		4.1E-08	
2,6-Dinitrotoluene	1.1E-01	1.1E-09	3.0E-08	2.4E-13	7.6E-10	2.1E-08		2.1E-08	
Benzo(a)pyrene	8.4E-02	8.8E-10	3.1E-08	1.9E-13	6.4E-09	2.3E-07	5.9E-13	2.4E-07	
Organics Pathway Total					8.6E-09	2.9E-07	5.9E-13	3.0E-07	
Pathway Total - Chemicals					2.0E-07	1.9E-06	4.2E-10	2.1E-06	

[a] COPCs are identified as constituents of concern (COCs) if the total ILCR across all pathways is > 1E-06 (R).
COPC = Constituent of potential concern.
EPC = Exposure point concentration.

Table 2A-17. Juvenile Trespasser Sediment Non-carcinogenic Hazards - Direct Contact

COPC	EPC (mg/kg)	Daily Intake (mg/kg-d)			Hazard Quotient (HQ)			Total HI Across All Pathways	COC[a]
		Ingestion	Dermal	Inhalation	Ingestion	Dermal	Inhalation		
FBQ									
Ditch									
Aluminum	1.6E+04	7.9E-04	7.7E-05	8.6E-08	7.9E-04	7.7E-05	6.0E-05	9.3E-04	
Antimony	5.5E+00	2.8E-07	2.7E-08	3.0E-11	7.0E-04	4.6E-04		1.2E-03	
Arsenic	2.1E+01	1.0E-06	3.1E-06	1.1E-10	3.5E-03	1.0E-02		1.4E-02	
Manganese	4.1E+03	2.1E-04	2.0E-05	2.3E-08	4.5E-03	1.1E-02	1.6E-03	1.7E-02	
Vanadium	2.8E+01	1.4E-06	1.4E-07	1.5E-10	2.0E-04	7.7E-04		9.7E-04	
Inorganics Pathway Total					9.7E-03	2.3E-02	1.6E-03	3.4E-02	
Benz(a)anthracene	6.4E-01	3.2E-08	4.1E-07	3.5E-12					
Benzo(a)pyrene	5.3E-01	2.7E-08	3.4E-07	2.9E-12					
Benzo(b)fluoranthene	6.0E-01	3.0E-08	3.8E-07	3.3E-12					
Organics Pathway Total									
Pathway Total - Chemicals					9.7E-03	2.3E-02	1.6E-03	3.4E-02	
Quarry Ponds									
Aluminum	1.3E+04	6.6E-04	6.5E-05	7.1E-08	6.6E-04	6.5E-05	5.0E-05	7.7E-04	
Antimony	1.3E+02	6.5E-06	6.4E-07	7.0E-10	1.6E-02	1.1E-02		2.7E-02	
Arsenic	1.9E+01	9.7E-07	2.9E-06	1.1E-10	3.2E-03	9.5E-03		1.3E-02	
Barium	2.9E+02	1.5E-05	1.4E-06	1.6E-09	2.1E-04	2.9E-04	1.1E-05	5.1E-04	
Cadmium	1.9E+01	9.6E-07	9.4E-08	1.0E-10	9.6E-04	3.8E-03		4.7E-03	
Chromium	5.7E+01	2.9E-06	2.8E-07	3.1E-10	1.9E-06	1.5E-05		1.6E-05	
Chromium, hexavalent	2.0E+01	9.9E-07	9.7E-08	1.1E-10	3.3E-04	1.3E-03	3.7E-06	1.6E-03	
Copper	2.0E+02	1.0E-05	1.0E-06	1.1E-09	2.6E-04	2.5E-05		2.8E-04	
Mercury	3.0E+01	1.5E-06	1.5E-07	1.6E-10	5.1E-03	7.1E-03		1.2E-02	
Vanadium	2.4E+01	1.2E-06	1.2E-07	1.3E-10	1.7E-04	6.4E-04		8.1E-04	
Zinc	1.4E+03	7.2E-05	7.0E-06	7.7E-09	2.4E-04	7.8E-05		3.2E-04	

Table 2A-17. Juvenile Trespasser Sediment Non-carcinogenic Hazards - Direct Contact (continued)

COPC	EPC (mg/kg)	Daily Intake (mg/kg-d)			Hazard Quotient (HQ)			Total HI Across All pathways	COC[a]
		Ingestion	Dermal	Inhalation	Ingestion	Dermal	Inhalation		
Inorganics Pathway Total					2.7E-02	3.3E-02	6.5E-05	6.1E-02	
Benz(a)anthracene	5.4E-01	2.7E-08	3.5E-07	2.9E-12					
Benzo(a)pyrene	5.2E-01	2.6E-08	3.4E-07	2.9E-12					
Benzo(b)fluoranthene	5.8E-01	2.9E-08	3.7E-07	3.2E-12					
Indeno(1,2,3-cd)pyrene	3.7E-01	1.9E-08	2.4E-07	2.0E-12					
Organics Pathway Total									
Pathway Total - Chemicals					2.7E-02	3.3E-02	6.5E-05	6.1E-02	
Settling Basins									
Aluminum	1.9E+04	9.4E-04	9.2E-05	1.0E-07	9.4E-04	9.2E-05	7.1E-05	1.1E-03	
Chromium	2.1E+02	1.1E-05	1.1E-06	1.2E-09	7.2E-06	5.4E-05		6.2E-05	
Manganese	6.5E+02	3.3E-05	3.2E-06	3.5E-09	7.1E-04	1.7E-03	2.5E-04	2.7E-03	
Vanadium	3.2E+01	1.6E-06	1.6E-07	1.8E-10	2.3E-04	8.7E-04		1.1E-03	
Inorganics Pathway Total					1.9E-03	2.8E-03	3.2E-04	5.0E-03	
Benzo(a)pyrene	1.1E-01	5.6E-09	7.1E-08	6.0E-13					
Organics Pathway Total									
Pathway Total - Chemicals					1.9E-03	2.8E-03	3.2E-04	5.0E-03	

[a] COPCs are identified as constituents of concern (COCs) if the total HI across all pathways is > 1 (H).
COPC = Constituent of potential concern.
EPC = Exposure point concentration.
HI = Hazard index.

Table 2A-18. Juvenile Trespasser Sediment Carcinogenic Risks - Direct Contact

COPC	EPC (mg/kg)	Daily Intake (mg/kg-d)			Risk			Total Risk across all pathways	COC[a]
		Ingestion	Dermal	Inhalation	Ingestion	Dermal	Inhalation		
				FBQ					
				Ditch					
Aluminum	1.6E+04	1.1E-04	1.1E-05	1.2E-08					
Antimony	5.5E+00	4.0E-08	3.9E-09	4.3E-12					
Arsenic	2.1E+01	1.5E-07	4.4E-07	1.6E-11	2.2E-07	6.6E-07	2.4E-10	8.8E-07	
Manganese	4.1E+03	3.0E-05	2.9E-06	3.2E-09					
Vanadium	2.8E+01	2.0E-07	2.0E-08	2.2E-11					
Inorganics Pathway Total					2.2E-07	6.6E-07	2.4E-10	8.8E-07	
Benz(a)anthracene	6.4E-01	4.6E-09	5.9E-08	5.0E-13	3.4E-09	4.3E-08	1.6E-13	4.6E-08	
Benzo(a)pyrene	5.3E-01	3.8E-09	4.9E-08	4.2E-13	2.8E-08	3.6E-07	1.3E-12	3.8E-07	
Benzo(b)fluoranthene	6.0E-01	4.3E-09	5.5E-08	4.7E-13	3.2E-09	4.0E-08	1.4E-13	4.3E-08	
Organics Pathway Total					3.5E-08	4.4E-07	1.6E-12	4.7E-07	
Pathway Total - Chemicals					2.6E-07	1.1E-06	2.4E-10	1.4E-06	
				Quarry Ponds					
Aluminum	1.3E+04	9.4E-05	9.2E-06	1.0E-08					
Antimony	1.3E+02	9.3E-07	9.1E-08	1.0E-10					
Arsenic	1.9E+01	1.4E-07	4.1E-07	1.5E-11	2.1E-07	6.1E-07	2.3E-10	8.2E-07	
Barium	2.9E+02	2.1E-06	2.0E-07	2.3E-10					
Cadmium	1.9E+01	1.4E-07	1.3E-08	1.5E-11			9.3E-11	9.3E-11	
Chromium	5.7E+01	4.1E-07	4.0E-08	4.5E-11					
Chromium, hexavalent	2.0E+01	1.4E-07	1.4E-08	1.5E-11			6.4E-10	6.4E-10	
Copper	2.0E+02	1.5E-06	1.4E-07	1.6E-10					
Mercury	3.0E+01	2.2E-07	2.1E-08	2.3E-11					
Vanadium	2.4E+01	1.7E-07	1.7E-08	1.8E-11					
Zinc	1.4E+03	1.0E-05	1.0E-06	1.1E-09					
Inorganics Pathway Total					2.1E-07	6.1E-07	9.6E-10	8.2E-07	

Table 2A-18. Juvenile Trespasser Sediment Carcinogenic Risks - Direct Contact (continued)

COPC	EPC (mg/kg)	Daily Intake (mg/kg-d)			Risk			Total Risk Across All Pathways	COC[a]
		Ingestion	Dermal	Inhalation	Ingestion	Dermal	Inhalation		
Benz(a)anthracene	5.4E-01	3.9E-09	4.9E-08	4.2E-13	2.8E-09	3.6E-08	1.3E-13	3.9E-08	
Benzo(a)pyrene	5.2E-01	3.8E-09	4.8E-08	4.1E-13	2.8E-08	3.5E-07	1.3E-12	3.8E-07	
Benzo(b)fluoranthene	5.8E-01	4.2E-09	5.3E-08	4.5E-13	3.1E-09	3.9E-08	1.4E-13	4.2E-08	
Indeno(1,2,3-cd)pyrene	3.7E-01	2.7E-09	3.4E-08	2.9E-13	2.0E-09	2.5E-08	9.0E-14	2.7E-08	
Organics Pathway Total					3.5E-08	4.5E-07	1.6E-12	4.9E-07	
Pathway Total - Chemicals					2.4E-07	1.1E-06	9.6E-10	1.3E-06	
Settling Basins									
Aluminum	1.9E+04	1.3E-04	1.3E-05	1.5E-08					
Chromium	2.1E+02	1.6E-06	1.5E-07	1.7E-10					
Manganese	6.5E+02	4.7E-06	4.6E-07	5.1E-10					
Vanadium	3.2E+01	2.3E-07	2.3E-08	2.5E-11					
Inorganics Pathway Total									
Benzo(a)pyrene	1.1E-01	8.0E-10	1.0E-08	8.6E-14	5.8E-09	7.4E-08	2.7E-13	8.0E-08	
Organics Pathway Total					5.8E-09	7.4E-08	2.7E-13	8.0E-08	
Pathway Total - Chemicals					5.8E-09	7.4E-08	2.7E-13	8.0E-08	

[a] COPCs are identified as constituents of concern (COCs) if the total ILCR across all pathways is > 1E-06 (R).
COPC = Constituent of potential concern.
EPC = Exposure point concentration.
FBQ = Fuze and Booster Quarry Landfill/Ponds.
ILCR = Incremental lifetime cancer risk.

Table 2A-19. Adult Trespasser Sediment Non-carcinogenic Hazards - Direct Contact

COPC	EPC (mg/kg)	Daily Intake (mg/kg-d)			Hazard Quotient (HQ)			Total HI Across All Pathways	COC[a]
		Ingestion	Dermal	Inhalation	Ingestion	Dermal	Inhalation		
FBQ									
Ditch									
Aluminum	1.6E+04	3.8E-04	1.0E-04	8.3E-08	3.8E-04	1.0E-04	5.8E-05	5.4E-04	
Antimony	5.5E+00	1.3E-07	3.7E-08	2.9E-11	3.4E-04	6.1E-04		9.5E-04	
Arsenic	2.1E+01	5.0E-07	4.1E-06	1.1E-10	1.7E-03	1.4E-02		1.5E-02	
Manganese	4.1E+03	1.0E-04	2.7E-05	2.2E-08	2.2E-03	1.5E-02	1.5E-03	1.9E-02	
Vanadium	2.8E+01	6.9E-07	1.9E-07	1.5E-10	9.8E-05	1.0E-03		1.1E-03	
Inorganics Pathway Total					4.7E-03	3.0E-02	1.6E-03	3.7E-02	
Benz(a)anthracene	6.4E-01	1.6E-08	5.6E-07	3.4E-12					
Benzo(a)pyrene	5.3E-01	1.3E-08	4.6E-07	2.8E-12					
Benzo(b)fluoranthene	6.0E-01	1.5E-08	5.2E-07	3.2E-12					
Organics Pathway Total									
Pathway Total - Chemicals					4.7E-03	3.0E-02	1.6E-03	3.7E-02	
Quarry Ponds									
Aluminum	1.3E+04	3.2E-04	8.7E-05	6.9E-08	3.2E-04	8.7E-05	4.8E-05	4.5E-04	
Antimony	1.3E+02	3.1E-06	8.6E-07	6.8E-10	7.8E-03	1.4E-02		2.2E-02	
Arsenic	1.9E+01	4.7E-07	3.9E-06	1.0E-10	1.6E-03	1.3E-02		1.4E-02	
Barium	2.9E+02	7.0E-06	1.9E-06	1.5E-09	1.0E-04	3.9E-04	1.1E-05	5.0E-04	
Cadmium	1.9E+01	4.6E-07	1.3E-07	1.0E-10	4.6E-04	5.1E-03		5.5E-03	
Chromium	5.7E+01	1.4E-06	3.8E-07	3.0E-10	9.3E-07	2.0E-05		2.1E-05	
Chromium, hexavalent	2.0E+01	4.8E-07	1.3E-07	1.0E-10	1.6E-04	1.7E-03	3.6E-06	1.9E-03	
Copper	2.0E+02	4.9E-06	1.4E-06	1.1E-09	1.2E-04	3.4E-05		1.6E-04	
Mercury	3.0E+01	7.3E-07	2.0E-07	1.6E-10	2.4E-03	9.5E-03		1.2E-02	
Vanadium	2.4E+01	5.7E-07	1.6E-07	1.2E-10	8.2E-05	8.6E-04		9.5E-04	
Zinc	1.4E+03	3.4E-05	9.4E-06	7.5E-09	1.1E-04	1.0E-04		2.2E-04	

Table 2A-19. Adult Trespasser Sediment Non-carcinogenic Hazards - Direct Contact (continued)

COPC	EPC (mg/kg)	Daily Intake (mg/kg-d)			Hazard Quotient (HQ)			Total HI Across All Pathways	COC[a]
		Ingestion	Dermal	Inhalation	Ingestion	Dermal	Inhalation		
Inorganics Pathway Total					1.3E-02	4.5E-02	6.2E-05	5.8E-02	
Benz(a)anthracene	5.4E-01	1.3E-08	4.7E-07	2.8E-12					
Benzo(a)pyrene	5.2E-01	1.3E-08	4.5E-07	2.8E-12					
Benzo(b)fluoranthene	5.8E-01	1.4E-08	5.0E-07	3.1E-12					
Indeno(1,2,3-cd)pyrene	3.7E-01	9.1E-09	3.2E-07	2.0E-12					
Organics Pathway Total									
Pathway Total - Chemicals					1.3E-02	4.5E-02	6.2E-05	5.8E-02	
Settling Basins									
Aluminum	1.9E+04	4.5E-04	1.2E-04	9.8E-08	4.5E-04	1.2E-04	6.9E-05	6.4E-04	
Chromium	2.1E+02	5.2E-06	1.4E-06	1.1E-09	3.5E-06	7.3E-05		7.7E-05	
Manganese	6.5E+02	1.6E-05	4.3E-06	3.4E-09	3.4E-04	2.3E-03	2.4E-04	2.9E-03	
Vanadium	3.2E+01	7.8E-07	2.1E-07	1.7E-10	1.1E-04	1.2E-03		1.3E-03	
Inorganics Pathway Total					9.1E-04	3.7E-03	3.1E-04	4.9E-03	
Benzo(a)pyrene	1.1E-01	2.7E-09	9.6E-08	5.8E-13					
Organics Pathway Total									
Pathway Total - Chemicals					9.1E-04	3.7E-03	3.1E-04	4.9E-03	

[a]COPCs are identified as constituents of concern (COCs) if the total HI across all pathways is > 1 (H).
COPC = Constituent of potential concern.
EPC = Exposure point concentration.
FBQ = Fuze and Booster Quarry Landfill/Ponds.
ILCR = Incremental lifetime cancer risk.

Table 2A-20. Adult Trespasser Sediment Carcinogenic Risks - Direct Contact

COPC	EPC (mg/kg)	Daily Intake (mg/kg-d)			Risk			Total Risk Across All Pathways	COC[a]
		Ingestion	Dermal	Inhalation	Ingestion	Dermal	Inhalation		
FBQ									
Ditch									
Aluminum	1.6E+04	1.6E-04	4.5E-05	3.5E-08					
Antimony	5.5E+00	5.8E-08	1.6E-08	1.3E-11					
Arsenic	2.1E+01	2.2E-07	1.8E-06	4.7E-11	3.2E-07	2.7E-06	7.0E-10	3.0E-06	R
Manganese	4.1E+03	4.3E-05	1.2E-05	9.3E-09					
Vanadium	2.8E+01	2.9E-07	8.1E-08	6.4E-11					
Inorganics Pathway Total					3.2E-07	2.7E-06	7.0E-10	3.0E-06	
Benz(a)anthracene	6.4E-01	6.7E-09	2.4E-07	1.5E-12	4.9E-09	1.7E-07	4.5E-13	1.8E-07	
Benzo(a)pyrene	5.3E-01	5.5E-09	2.0E-07	1.2E-12	4.0E-08	1.4E-06	3.7E-12	1.5E-06	R
Benzo(b)fluoranthene	6.0E-01	6.2E-09	2.2E-07	1.4E-12	4.6E-09	1.6E-07	4.2E-13	1.7E-07	
Organics Pathway Total					5.0E-08	1.8E-06	4.6E-12	1.8E-06	
Pathway Total - Chemicals					3.7E-07	4.4E-06	7.1E-10	4.8E-06	
Quarry Ponds									
Aluminum	1.3E+04	1.4E-04	3.7E-05	3.0E-08					
Antimony	1.3E+02	1.3E-06	3.7E-07	2.9E-10					
Arsenic	1.9E+01	2.0E-07	1.7E-06	4.4E-11	3.0E-07	2.5E-06	6.6E-10	2.8E-06	R
Barium	2.9E+02	3.0E-06	8.3E-07	6.5E-10					
Cadmium	1.9E+01	2.0E-07	5.4E-08	4.3E-11			2.7E-10	2.7E-10	
Chromium	5.7E+01	6.0E-07	1.6E-07	1.3E-10					
Chromium, hexavalent	2.0E+01	2.0E-07	5.6E-08	4.4E-11			1.9E-09	1.9E-09	
Copper	2.0E+02	2.1E-06	5.8E-07	4.6E-10					
Mercury	3.0E+01	3.1E-07	8.6E-08	6.8E-11					
Vanadium	2.4E+01	2.5E-07	6.7E-08	5.3E-11					
Zinc	1.4E+03	1.5E-05	4.0E-06	3.2E-09					

Table 2A-20. Adult Trespasser Sediment Carcinogenic Risks - Direct Contact (continued)

COPC	EPC (mg/kg)	Daily Intake (mg/kg-d) Ingestion	Daily Intake (mg/kg-d) Dermal	Daily Intake (mg/kg-d) Inhalation	Risk Ingestion	Risk Dermal	Risk Inhalation	Total Risk Across All Pathways	COC[a]
Inorganics Pathway Total					3.0E-07	2.5E-06	2.8E-09	2.8E-06	
Benz(a)anthracene	5.4E-01	5.6E-09	2.0E-07	1.2E-12	4.1E-09	1.5E-07	3.8E-13	1.5E-07	
Benzo(a)pyrene	5.2E-01	5.5E-09	1.9E-07	1.2E-12	4.0E-08	1.4E-06	3.7E-12	1.5E-06	R
Benzo(b)fluoranthene	5.8E-01	6.1E-09	2.2E-07	1.3E-12	4.4E-09	1.6E-07	4.1E-13	1.6E-07	
Indeno(1,2,3-cd)pyrene	3.7E-01	3.9E-09	1.4E-07	8.4E-13	2.8E-09	1.0E-07	2.6E-13	1.0E-07	
Organics Pathway Total					5.1E-08	1.8E-06	4.7E-12	1.9E-06	
Pathway Total - Chemicals					3.5E-07	4.3E-06	2.8E-09	4.7E-06	
Settling Basins									
Aluminum	1.9E+04	1.9E-04	5.3E-05	4.2E-08					
Chromium	2.1E+02	2.2E-06	6.1E-07	4.9E-10					
Manganese	6.5E+02	6.8E-06	1.9E-06	1.5E-09					
Vanadium	3.2E+01	3.3E-07	9.1E-08	7.2E-11					
Inorganics Pathway Total									
Benzo(a)pyrene	1.1E-01	1.2E-09	4.1E-08	2.5E-13	8.4E-09	3.0E-07	7.7E-13	3.1E-07	
Organics Pathway Total					8.4E-09	3.0E-07	7.7E-13	3.1E-07	
Pathway Total - Chemicals					8.4E-09	3.0E-07	7.7E-13	3.1E-07	

[a] COPCs are identified as constituents of concern (COCs) if the total ILCR across all pathways is > 1E-06 (R).
COPC = Constituent of potential concern.
EPC = Exposure point concentration.
FBQ = Fuze and Booster Quarry Landfill/Ponds.
ILCR = Incremental lifetime cancer risk.

Table 2A-21. Juvenile Trespasser Surface Water Non-Carcinogenic Hazards - Direct Contact

COPC	EPC (mg/L)	Daily Intake (mg/kg-d)		Hazard Quotient (HQ)		Total HI Across All Pathways	COC[a]
		Ingestion	Dermal	Ingestion	Dermal		
FBQ							
Ditch							
Manganese	1.1E+01	3.3E-03	7.0E-04	7.3E-02	3.8E-01	4.5E-01	
Inorganics Pathway Total				7.3E-02	3.8E-01	4.5E-01	
Pathway Total - Chemicals				7.3E-02	3.8E-01	4.5E-01	
Quarry Ponds							
Methylene chloride	4.7E-03	1.4E-06	1.0E-06	2.4E-05	1.7E-05	4.1E-05	
Organics Pathway Total				2.4E-05	1.7E-05	4.1E-05	
Pathway Total - Chemicals				2.4E-05	1.7E-05	4.1E-05	
Settling Basins							
Arsenic	9.0E-03	2.7E-06	8.6E-07	9.2E-03	2.9E-03	1.2E-02	
Manganese	2.0E+00	6.1E-04	1.3E-04	1.3E-02	6.9E-02	8.2E-02	
Inorganics Pathway Total				2.2E-02	7.2E-02	9.4E-02	
Bis(2-ethylhexyl)phthalate	4.5E-03	1.4E-06	4.4E-04	6.9E-05	2.2E-02	2.2E-02	
Perchlorate	1.2E-02	3.6E-06	2.2E-10	5.1E-03	3.2E-07	5.1E-03	
Organics Pathway Total				5.2E-03	2.2E-02	2.7E-02	
Pathway Total - Chemicals				2.8E-02	9.4E-02	1.2E-01	

[a] COPCs are identified as constituents of concern (COCs) if the total HI across all pathways is > 1 (H).
COPC = Constituent of potential concern.
EPC = Exposure point concentration.
FBQ = Fuze and Booster Quarry Landfill/Ponds.
HI = Hazard index.

Table 2A-22. Juvenile Trespasser Surface Water Carcinogenic Risks - Direct Contact

COPC	EPC (mg/L)	Daily Intake (mg/kg-d)		Risk		Total Risk Across All Pathways	COC[a]
		Ingestion	Dermal	Ingestion	Dermal		
FBQ							
Ditch							
Manganese	1.1E+01	4.8E-04	1.0E-04				
Inorganics Pathway Total							
Pathway Total - Chemicals							
Quarry Ponds							
Methylene chloride	4.7E-03	2.0E-07	1.5E-07	1.5E-09	1.1E-09	2.6E-09	
Organics Pathway Total				1.5E-09	1.1E-09	2.6E-09	
Pathway Total - Chemicals				1.5E-09	1.1E-09	2.6E-09	
Settling Basins							
Arsenic	9.0E-03	3.9E-07	1.2E-07	5.9E-07	1.9E-07	7.7E-07	
Manganese	2.0E+00	8.7E-05	1.8E-05				
Inorganics Pathway Total				5.9E-07	1.9E-07	7.7E-07	
Bis(2-ethylhexyl)phthalate	4.5E-03	2.0E-07	6.3E-05	2.8E-09	8.9E-07	8.9E-07	
Perchlorate	1.2E-02	5.1E-07	3.2E-11				
Organics Pathway Total				2.8E-09	8.9E-07	8.9E-07	
Pathway Total - Chemicals				5.9E-07	1.1E-06	1.7E-06	

[a] COPCs are identified as constituents of concern (COCs) if the total ILCR across all pathways is > 1E-06 (R).
COPC = Constituent of potential concern.
EPC = Exposure point concentration.
FBQ = Fuze and Booster Quarry Landfill/Ponds.
ILCR = Incremental lifetime cancer risk.

Table 2A-23. Adult Trespasser Surface Water Non-carcinogenic Hazards - Direct Contact

COPC	EPC (mg/L)	Daily Intake (mg/kg-d) Ingestion	Daily Intake (mg/kg-d) Dermal	Hazard Quotient Ingestion	Hazard Quotient Dermal	Total HI Across All Pathways	COC[a]
FBQ							
Ditch							
Manganese	1.1E+01	3.2E-03	4.7E-04	7.0E-02	2.6E-01	3.3E-01	
Inorganics Pathway Total				7.0E-02	2.6E-01	3.3E-01	
Pathway Total - Chemicals				7.0E-02	2.6E-01	3.3E-01	
Quarry Ponds							
Methylene chloride	4.7E-03	1.4E-06	7.0E-07	2.3E-05	1.2E-05	3.5E-05	
Organics Pathway Total				2.3E-05	1.2E-05	3.5E-05	
Pathway Total - Chemicals				2.3E-05	1.2E-05	3.5E-05	
Settling Basins							
Arsenic	9.0E-03	2.6E-06	5.8E-07	8.8E-03	1.9E-03	1.1E-02	
Manganese	2.0E+00	5.9E-04	8.6E-05	1.3E-02	4.7E-02	5.9E-02	
Inorganics Pathway Total				2.2E-02	4.9E-02	7.0E-02	
Bis(2-ethylhexyl)phthalate	4.5E-03	1.3E-06	3.0E-04	6.6E-05	1.5E-02	1.5E-02	
Perchlorate	1.2E-02	3.5E-06	1.5E-10	4.9E-03	2.2E-07	4.9E-03	
Organics Pathway Total				5.0E-03	1.5E-02	2.0E-02	
Pathway Total - Chemicals				2.7E-02	6.3E-02	9.0E-02	

[a] COPCs are identified as constituents of concern (COCs) if the total HI across all pathways is > 1 (H).
COPC = Constituent of potential concern.
EPC = Exposure point concentration.
FBQ = Fuze and Booster Quarry Landfill/Ponds.
HI = Hazard index.

Table 2A-24. Adult Trespasser Surface Water Carcinogenic Risks - Direct Contact

COPC	EPC (mg/L)	Daily Intake (mg/kg-d) Ingestion	Daily Intake (mg/kg-d) Dermal	Risk Ingestion	Risk Dermal	Total Risk Across All Pathways	COC[a]
FBQ							
Ditch							
Manganese	1.1E+01	1.4E-03	2.0E-04				
Inorganics Pathway Total							
Pathway Total - Chemicals							
Quarry Ponds							
Methylene chloride	4.7E-03	5.9E-07	3.0E-07	4.4E-09	2.3E-09	6.7E-09	
Organics Pathway Total				4.4E-09	2.3E-09	6.7E-09	
Pathway Total - Chemicals				4.4E-09	2.3E-09	6.7E-09	
Settling Basins							
Arsenic	9.0E-03	1.1E-06	2.5E-07	1.7E-06	3.7E-07	2.1E-06	R
Manganese	2.0E+00	2.5E-04	3.7E-05				
Inorganics Pathway Total				1.7E-06	3.7E-07	2.1E-06	
Bis(2-ethylhexyl)phthalate	4.5E-03	5.7E-07	1.3E-04	8.0E-09	1.8E-06	1.8E-06	R
Perchlorate	1.2E-02	1.5E-06	6.5E-11				
Organics Pathway Total				8.0E-09	1.8E-06	1.8E-06	
Pathway Total - Chemicals				1.7E-06	2.2E-06	3.9E-06	

[a] COPCs are identified as constituents of concern (COCs) if the total ILCR across all pathways is > 1E-06 (R).
COPC = Constituent of potential concern.
EPC = Exposure point concentration.
FBQ = Fuze and Booster Quarry Landfill/Ponds.
ILCR = Incremental lifetime cancer risk.

Appendix 2B
Supplemental Phase II RI Sampling Results

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2B.0 SUPPLEMENTAL PHASE II RI FOR FBQ

2B.1 INTRODUCTION

This appendix addresses the results of the Supplemental Phase II RI of FBQ at RVAAP, Ravenna, Ohio. This Supplemental Phase II RI investigation was conducted under the DoD IRP by SAIC, under contract number GS-10F-0076J, Delivery Order No. W912QR-05-F-003, with the USACE, Louisville District. The Phase I/II RI, completed in 2005 (USACE 2005c), and the supplemental investigation presented in this report, were conducted in compliance with the CERCLA of 1980 following work plans reviewed and commented on by the Ohio EPA.

This document summarizes the results of the Supplemental Phase II RI field activities conducted in November 2005 at FBQ. These activities were conducted in accordance with the *Final Sampling and Analysis Plan Addendum No. 1 Supplemental Phase II Remedial Investigations for Open Demolition Area #2 (RVAAP-02), Fuze and Booster Quarry Landfill/Ponds (RVAAP-16), and Central Burn Pits (RVAAP-49)* (Supplemental Phase II RI Sampling and Analysis Plan [SAP]) issued November 10, 2005 and approved by Ohio EPA (SAIC 2005). This Supplemental Phase II RI Report addresses only the findings of the investigation at FBQ. Supplemental Phase II RI reports for Open Demolition Area #2 and Central Burn Pits are issued separately.

2B.1.1 Purpose and Objectives

The purpose of the field investigation performed in the Supplemental RI was to fill additional data needs regarding the extent of contamination in affected soil media following the Phase I/II RI. The primary objective of the Supplemental RI field investigation was to provide an updated assessment of the nature and extent of soil contamination, and potential risks to receptors at FBQ at RVAAP.

The objectives of the Supplemental Phase II sampling at FBQ are to define the nature and extent of explosive and inorganic compounds detected during the previous Phase I/II RI and to evaluate potential risks to receptors in support of the FS.

2B.1.2 Phase I/II RI Summary

Phase I/Phase II field activities were conducted in October, November, and December 2003, and July 2004 at FBQ. Environmental media (soil, surface water, and groundwater) were sampled and submitted for laboratory analysis. These activities and subsequent findings and data are presented in the *Phase I/Phase II Remedial Investigation Report for Fuze and Booster Quarry Landfill/Pond (RVAAP-16)* (USACE 2005c).

Inorganics, explosive/propellant compounds, VOCs, SVOCs, and pesticides were detected in some or all of the soil samples collected during the Phase I/Phase II RIs. All detections except antimony, arsenic, manganese, iron, and lead were below PRGs (residential). Antimony, lead, and manganese exceeded the PRG (residential).

Explosives/propellants, perchlorate, and SVOCs were detected in surface water at FBQ. Perchlorate was detected in surface water samples collected in 2003; however, perchlorate was not detected at these same sample locations in 2004. Explosives/propellants were detected in five of the six groundwater monitoring wells. SVOCs, inorganics (copper, lead, cobalt, manganese, aluminum, nickel, silver, and cadmium) also were detected in groundwater. Pesticides and PCBs were not detected in either surface water or groundwater.

2B.1.3 Report Organization

This Supplemental RI Report is organized to meet Ohio EPA requirements in accordance with USEPA CERCLA Superfund and USACE guidance. This Supplemental Phase II RI Report consists of Sections 2B.1 through 2B.6, and supporting attachments.

- Section 2B.1 describes the purpose, objectives, and organization of this report.
- Section 2B.2 presents the study area field investigation and the methodologies used for data collection.
- Section 2B.3 describes the updated nature and extent of soil contamination at FBQ.
- Section 2B.4 presents the qualitative risk evaluation.
- Section 2B.5 presents the summary and conclusions of the report.
- Section 2B.6 provides a list of referenced documents used to support this Supplemental RI.

Attachments (A through G) contain supporting data collected during the Supplemental Phase II RI field activities. These attachments consist of:

- Attachment A: Soil Sampling Logs;
- Attachment B: Investigation Derived Waste (IDW) Summary Report;
- Attachment C: Project Quality Assurance Summary Report;
- Attachment D: Data Quality Control Summary Report;
- Attachment E: the Laboratory Analytical Results and chain-of-custody forms;
- Attachment F: the Topographic Survey Report; and
- Attachment G: and the MEC Avoidance Survey Report.

2B.2 STUDY AREA INVESTIGATION

The scope of the Supplemental Phase II RI field investigation at FBQ included sampling surface (0-1 ft BGS) and subsurface soils (1-3 ft BGS). This section presents information on locations of and rationale for samples collected during the field effort and provides a synopsis of the sampling methods employed during the investigation. Information regarding standard field decontamination procedures, sample container types, preservation techniques, sample labeling, chain-of-custody, and packaging and shipping requirements implemented during the field investigation may be found in the Facility-Wide SAP (USACE 2001) and the Supplemental Phase II RI SAP (SAIC 2005).

2B.2.1 Surface and Subsurface Soil Characterization

Soil samples for chemical analyses were collected from a total of six stations located throughout the FBQ AOC. Figure 2B-1 illustrates the locations for surface soil (0-1 ft BGS) and subsurface soil (1-3 ft BGS) sampling. Table 2B-1 provides a detailed listing of the soil samples collected during the Supplemental Phase II RI field effort. Both surface and subsurface samples were collected at all of the stations. Soil sampling logs are presented in Attachment A.

2B.2.1.1 Rationale

Soil samples were collected primarily from outside of the area previously sampled to further define the nature and extent of explosive and inorganic compounds detected during the previous Phase I/Phase II RI in the upper northeast corner and southern portion of FBQ. Sample locations were selected on the basis of analytical results from the Phase I/II RI to characterize contaminant nature and extent (i.e., where explosives were detected or inorganic contamination was not defined).

Table 2B-1. Soil Sample List and Rationales, FBQ Supplemental Phase II RI

Area Description	Station ID	Sample Location Rationale	Sample ID	Depth (ft)	Sample Collected (Yes/No)	Comments
FBQ	FBQ-193	Site Boundary	FBQss-193-0500-SO	0 to 1	Yes	
	FBQ-193	Site Boundary	FBQso-193-0501-SO	1 to 3	Yes	
	FBQ-194	Site Boundary	FBQss-194-0502-SO	0 to 1	Yes	
	FBQ-194	Site Boundary	FBQso-194-0503-SO	1 to 3	Yes	Auger refusal at 2.3 feet
	FBQ-195	Site Boundary	FBQss-195-0504-SO	0 to 1	Yes	
	FBQ-195	Site Boundary	FBQso-195-0505-SO	1 to 3	Yes	Auger refusal at 2.3 feet
	FBQ-196	Site Boundary	FBQss-196-0506-SO	0 to 1	Yes	
	FBQ-196	Site Boundary	FBQso-196-0507-SO	1 to 3	Yes	Auger refusal at 2.8 feet
	FBQ-197	Site Boundary	FBQss-197-0508-SO	0 to 1	Yes	
	FBQ-197	Site Boundary	FBQso-197-0509-SO	1 to 3	Yes	Auger refusal at 2.9 feet
	FBQ-198	Site Boundary	FBQso-198-0510-SO	0 to 1	Yes	
	FBQ-198	Site Boundary	FBQso-198-0510-SO	1 to 3	Yes	

Six discrete surface and subsurface soil samples were collected at FBQ (Figure 2B-1). The final sample locations were determined in the field based on site conditions, access considerations, visual survey of the area, and MEC considerations. The six discrete surface and subsurface soil locations are as follows:

- Three surface and subsurface soil samples were collected along the northeastern edge of FBQ. These samples encompass the explosive detections at Phase II sample locations FBQ-032 and FBQ-048, as well as the manganese detection that exceeded the background value of 1,450 mg/kg at location FBQ-051.

- One surface and subsurface soil sample was collected south of FBQ-002. This location bounds FBQ-002, which has a manganese concentration in excess of background (1,450 mg/kg).

- Two surface and subsurface soil samples were collected at the southern end of FBQ to attempt to bound sample locations FBQ-003, FBQ-005, and FBQ-060. Explosives were detected at these locations in previous Phase I/II RI sampling activities.

Surface soil (0-1 ft BGS) samples were collected from six sampling stations at FBQ as planned in the Supplemental Phase II RI SAP (Table 2B-1). Corresponding subsurface (1-3 ft BGS) samples were also planned at these locations and were collected as planned.

2B.2.1.2 <u>Surface and Subsurface Soil Field Sampling Methods</u>

Surface Soil Sampling Methods

A decontaminated bucket hand auger was used to collect surface soil samples at each station. The target depth interval for surface soil samples was 0-1 ft BGS. Composite samples were collected for all surface soil samples. Because of the physical characteristics of explosives and propellant compounds (e.g., flakes, particles, and pellets) and the nature of demolition operations, the distribution of these types of compounds can be erratic and highly variable. Composite sampling has been shown to reduce statistical sampling error in surface soil at sites with a history of explosives contamination in surface soil (Jenkins et al. 1996) and to increase the likelihood of capturing detectable levels of explosives compounds over a given area. Composite sampling data are considered acceptable to the Ohio EPA for use in risk assessment where concentrations are expected to vary spatially.

To collect composite samples for surface soil, three borings were hand augured in an equilateral triangle pattern measuring approximately 3 ft on a side. Equal portions of soil from the three subsamples were placed into a large, decontaminated stainless-steel bowl and labeled with the Sample ID. Field descriptions and classifications for the soil samples were performed and the results recorded in the project logbooks in accordance with Section 4.4.2.3 of the Facility-Wide SAP, as specified in the Supplemental Phase II RI SAP, with the exception that headspace gases were not screened in the field for organic vapors. Organic vapor measurements were made in the breathing zone during sampling and the results recorded on the field sample logs.

The samples were homogenized by MKM Engineers using the procedure utilized during the 14 Sites AOC field effort (MKM 2005). The combined sub-samples collected in the field were brought back to Building 1036 and logged for processing to ensure chain-of-custody was maintained. The soil was spread and allowed to air dry overnight or up to two days. The air-dried soil was prepared for sieving by crushing and removing rocks and organic materials. The soil was then sieved using a #10 and #4 stainless-steel sieve. Any materials not passing through the sieve was considered IDW. The remaining air-dried, sieved material was then ground using a decontaminated coffee grinder. The ground soil was incrementally placed into sample jars and submitted to the fixed-base laboratory for analysis.

Following preparation of the sample, excess soil was designated as IDW and placed in lined 55-gallon open top drums staged at Building 1036. IDW is discussed in Attachment B. Hand-auger borings were backfilled to the ground surface with dry bentonite chips.

Subsurface Soil Sampling Methods

To collect subsurface (1-3 ft BGS) samples for chemical analyses, a decontaminated auger bucket was used to deepen one of the three surface soil borings at each sample location over the required depth interval. Soil from the subsurface interval was placed into a stainless-steel pan or bowl and labeled with the Sample ID. Field descriptions and classification of the soils were performed and the results recorded in the project logbooks in accordance with Section 4.4.2.3 of the Facility-Wide SAP, as specified in the Supplemental Phase II RI SAP, with the exception that headspace gases were not screened in the field for organic vapors. Organic vapor measurements were made in the breathing zone during sampling and at the top of the boring and recorded in the field logbooks.

The samples were homogenized by MKM Engineers using the procedure utilized during the 14 Sites AOC field effort (MKM 2005). The samples collected in the field were brought back to Building 1036 and logged for processing to ensure chain-of-custody was maintained. The soil was spread and allowed to air dry overnight or up to two days. The air-dried soil was prepared for sieving by crushing and removing rocks and organic materials. The soil was then sieved using a #10 and #4 stainless-steel sieve. Any materials not passing through the sieve was considered IDW. The remaining air-dried, sieved material was then ground using a decontaminated coffee grinder. The ground soil was incrementally placed into sample jars and submitted to the fixed-base laboratory for analysis.

Following preparation of the samples, excess soil was designated as IDW and placed in a lined, open-top 55-gallon drum staged at Building 1036. IDW practices for all media are discussed in Attachment B. Hand-auger borings were backfilled to the ground surface with dry bentonite chips.

2B.2.2 Analytical Program Overview

2B.2.2.1 <u>Laboratory Analyses</u>

All analytical procedures were completed in accordance with applicable professional standards, USEPA requirements, government regulations and guidelines, USACE Louisville District analytical quality assurance (QA) guidelines, and specific project goals and requirements. The sampling and analysis program conducted during the Supplemental Phase II RI for FBQ involved the collection and analysis of surface soil and subsurface soil. Specified samples were analyzed by an independent quality control (QC) split analytical laboratory under contract with the USACE Louisville District. Samples were collected and analyzed according to the Facility-Wide SAP and the Supplemental Phase II RI SAP.

Samples collected during the investigation were analyzed by GPL Laboratories, Gaithersburg, Maryland, a USACE Center of Excellence certified laboratory. The specified QC split samples were analyzed by USACE-contracted laboratory, Severn Trent Laboratories, located in North Canton, Ohio. Laboratories supporting this work have statements of qualifications including organizational structures, QA manuals, and standard operating procedures, which are available upon request.

Data Quality Objectives (DQOs) for this project included analytical precision, accuracy, representativeness, completeness, comparability, and sensitivity for the measurement data. Attachment C presents an assessment of those objectives as they apply to the analytical program.

QA/QC samples for this project included field blanks, QA field duplicates, laboratory method blanks, laboratory control samples, laboratory duplicates, matrix spike/matrix spike duplicate (MS/MSD) samples, and QC field split samples (submitted to the independent USACE-contracted laboratory). Field blanks, consisting of potable and de-ionized water used in the decontamination process and equipment rinsate blanks were submitted for analysis along with field duplicate samples to provide a means to assess the quality of the data resulting from the field sampling program. The QC field split samples provide independent verification of the accuracy and precision of the principal analytical laboratory. Evaluation of these QC measures and of their contribution to documenting the project data quality is provided in Attachment D, Data Quality Summary Report (DQSR).

SAIC is the custodian of the project file and will maintain the contents of the file for this investigation, including all relevant records, reports, logs, field notebooks, pictures, subcontractor reports, correspondence, and chain-of-custody forms. These files will remain in a secure area under the custody of the SAIC Program Manager until they are transferred to the USACE Louisville District and RVAAP. Analytical data reports from GPL Laboratories have been forwarded to the USACE Louisville District laboratory data validation contractor (Lab Data Consultants, Inc.) for validation review and QA comparison. GPL Laboratories will retain all original raw data information (both hard copy and electronic) in a secure area under the custody of the laboratory project manager.

2B.2.2.2 Data Review, Validation, and Quality Assessment

Samples were properly packaged for shipment and dispatched to GPL Laboratories for analysis. A separate signed custody record with sample numbers and locations listed was enclosed with each shipment. When transferring the possession of samples, the individuals who relinquished and received the samples signed, dated, and noted the time on the record. All shipments were in compliance with applicable DOT regulations for environmental samples.

Data were produced, reviewed, and reported by the laboratory in accordance with specifications outlined in the Supplemental Phase II RI Quality Assurance Project Plan (QAPP) Addendum, the USACE Louisville District analytical QA guidelines, and the laboratory's QA manual. Laboratory reports included documentation verifying analytical holding time compliance.

GPL Laboratories performed in-house analytical data reduction under the direction of the laboratory project manager and QA officer. These individuals were responsible for assessing data quality and informing SAIC of any data that are considered "unacceptable" or that require caution on the part of the data user in terms of its reliability. Data were reduced, reviewed, and reported as described in the laboratory QA manual and standard operating procedures. Data reduction, review, and reporting by the laboratory were conducted as follows:

- Raw data produced by the analyst were turned over to the respective area supervisor.

- The area supervisor reviewed the data for attainment of QC criteria as outlined in the established methods and for overall reasonableness.

- Upon acceptance of the raw data by the area supervisor, a report was generated and sent to the laboratory project manager.

- The laboratory project manager completed a thorough review of all reports.

- The laboratory project manager executed the final reports.

Data were then delivered to SAIC for data verification. GPL Laboratories prepared and retained full analytical and QC documentation for the project in both paper copy and electronic storage media (e.g., magnetic tape), as directed by the analytical methodologies employed. GPL Laboratories provided the following information to SAIC 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 continuing calibration verifications of standards and blanks, method blanks, and laboratory control sample information.

A systematic process for data verification was performed by SAIC to ensure that the precision and accuracy of the analytical data were adequate for their intended use. This verification also attempted 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 was consistent with DQOs for the project and with the analytical methods, and was appropriate for determining contaminants of concern and calculating risk. Analytical data were verified through the review process outlined in the SAP and are presented in Attachment E. Following data verification, all data packages were forwarded to the USACE independent data validation contractor.

Independent data validation was performed by Lab Data Consultants, Inc. under a separate task with the USACE Louisville District. This review constitutes comprehensive validation of 10% of the primary data set, comprehensive validation of the QA split sample data set, and a comparison of primary sample, field duplicate sample, and field QA split sample information.

2B.2.3 Munitions and Explosives of Concern Avoidance

MEC avoidance subcontractor support staff was present during all field operations. The MEC Team Leader led an initial safety briefing on MEC to train all field personnel to recognize and avoid MEC. Daily tailgate safety briefings included reminders regarding MEC avoidance. Site visitors were briefed on MEC avoidance before they were allowed access to the AOC. Prior to beginning sampling activities, access routes into areas from which samples were to be collected were assessed for potential MEC using visual surveys and hand-held magnetometers. The MEC Team Leader, Ohio EPA technical representative, and SAIC project manager located proposed sampling stations within the AOC using pin flags or wooden stakes marked with the sample station identification number. The pin flag or stake was placed at a point approved by the MEC technician. An MEC technician remained with the sampling crews as work progressed. Prior to collection of subsurface soil samples (1-3 ft BGS), a magnetometer was lowered into the borehole to screen for subsurface magnetic anomalies at the top of the subsurface interval. Attachment G presents the MEC Survey Report.

2B.3 UPDATED NATURE AND EXTENT

This section presents results of the Supplemental Phase II RI. Constituents that are deemed to be related to AOC operations are classified as SRCs. These SRCs are then evaluated to determine their occurrence and distribution in surface (0-1 ft BGS) and subsurface (1-3 ft BGS) soil at FBQ. Section 2B.3.1 presents the statistical methods and screening criteria used to reduce and display data and to distinguish naturally occurring constituents from SRCs indicative of historical site operations. Section 2B.3.2 presents the nature and extent of identified SRCs in surface and subsurface soil.

2B.3.1 Data Evaluation Methods

For the purposes of this Supplemental Phase II RI Report, the evaluation and screening of data were performed using the established RVAAP processes employed in the FBQ Phase I/Phase II RI Report (USACE, 2005c) and other RIs for the facility, including: (1) defining data aggregates, (2) data reduction and screening, and (3) data presentation.

2B.3.1.1 Data Aggregates

The FBQ Supplemental Phase II RI data were grouped (aggregated) by environmental media (soil) and then further aggregated on the basis of depth: surface soil from 0 to 0.3 m (0 to 1 ft) and subsurface soil greater than a depth of 1 ft. For the nature and extent section, only the Supplemental Phase II data are discussed. For the qualitative risk evaluation Phase II RI and Supplemental Phase II RI data were evaluated together, as well as evaluating the Supplemental Phase II RI data separately.

2B.3.1.2 Data Reduction and Screening

Data reduction and screening steps to identify SRCs included the following: screening of inorganics against facility-wide background values and screening of essential human nutrients. A frequency of detection screen is not applicable because only six samples were collected. Detailed descriptions of these screening processes may be found in Section 4.1.3 of the Phase I/II RI Report (USACE 2005c). The screening steps are summarized below.

- Facility-wide background values for inorganic constituents in soil, sediment, surface water, and groundwater (bedrock and unconsolidated zones) were developed as part of a previous Phase II RI at the Winklepeck Burning Grounds at RVAAP (USACE 1999). Any inorganic chemical exceeding its facility-wide background criterion for soil was considered to be an SRC. For inorganics not detected in the background data set, the background value is considered to be zero; thus, any detected value for these inorganics is considered to be above background.

- Chemicals considered to be essential nutrients (calcium, chloride, iodine, iron, magnesium, potassium, phosphorus, and sodium) are not generally addressed as SRCs in the contaminant nature and extent evaluation and the HHRA (USEPA 1989 and 1996) unless they are grossly elevated relative to background values. For the FBQ investigation, analyses were conducted for calcium, iron, magnesium, potassium, and sodium. These five constituents were eliminated as SRCs for the nature and extent evaluation and HHRA.

2B.3.1.3 Data Presentation

Data summary statistics and screening results for groundwater data are presented in Tables 2B-2 and 2B-3. Analytical results for selected SRCs are presented on maps to depict spatial distribution. Analytical results by sample location for classes of SRCs (e.g., explosive compounds or inorganics) are presented in Tables 2B-4 through 2B-7. Complete analytical results are contained in Attachment E.

Table 2B-2. Summary Statistics and Determination of Supplemental Phase II RI SRCs in FBQ Surface Soil (0-1 ft BGS)

Analyte	CAS Number	Units	Results >Detection Limit	Average Result	Minimum Detect	Maximum Detect	95% UCL of Mean	Exposure Concentration	Background Criteria	Max. > Bkg.?	Site Related?
Inorganics											
Aluminum	7429905	mg/kg	6/6	15900	13200	17800	17200	17200	17700	Yes	Yes
Antimony	7440360	mg/kg	6/6	0.608	0.4	1	0.879	0.879	0.96	Yes	Yes
Arsenic	7440382	mg/kg	6/6	11.5	9.9	15.8	13.5	13.5	15.4	Yes	Yes
Barium	7440393	mg/kg	6/6	80.5	53.2	114	98.8	98.8	88.4	Yes	Yes
Beryllium	7440417	mg/kg	6/6	0.752	0.59	0.91	0.857	0.857	0.88	Yes	Yes
Calcium	7440702	mg/kg	6/6	447	253	710	684	684	15800	No	No
Chromium	7440473	mg/kg	6/6	25.7	22.2	28.9	27.9	27.9	17.4	Yes	Yes
Cobalt	7440484	mg/kg	6/6	11.6	8.3	14.9	13.4	13.4	10.4	Yes	Yes
Copper	7440508	mg/kg	6/6	13.1	10.2	19.5	15.7	15.7	17.7	Yes	Yes
Iron	7439896	mg/kg	6/6	23500	20200	26200	25200	25200	23100	Yes	No
Lead	7439921	mg/kg	6/6	41.4	18.2	122	127	122	26.1	Yes	Yes
Magnesium	7439954	mg/kg	6/6	2600	2320	3030	2860	2860	3030	No	No
Manganese	7439965	mg/kg	6/6	899	244	1490	1300	1300	1450	Yes	Yes
Mercury	7439976	mg/kg	6/6	0.0533	0.04	0.08	0.0668	0.0668	0.036	Yes	Yes
Nickel	7440020	mg/kg	6/6	19.1	16.2	22	21.5	21.5	21.1	Yes	Yes
Potassium	7440097	mg/kg	6/6	1360	1200	1520	1450	1450	927	Yes	No
Selenium	7782492	mg/kg	6/6	0.638	0.37	0.94	0.972	0.94	1.4	No	No
Sodium	7440235	mg/kg	6/6	59.6	50.1	68.4	66	66	123	No	No
Thallium	7440280	mg/kg	4/6	0.517	0.49	0.84	0.789	0.789	0	Yes	Yes
Vanadium	7440622	mg/kg	6/6	31.4	27.4	36.6	34.9	34.9	31.1	Yes	Yes
Zinc	7440666	mg/kg	6/6	59.2	49	71.6	67.2	67.2	61.8	Yes	Yes
Organics-Explosives											
Nitrobenzene	98953	mg/kg	6/6	0.035	0.02	0.06	0.0525	0.0525	--	--	Yes

CAS = Chemical Abstracts Service.
UCL = Upper confidence limit.

Table 2B-3. Summary Statistics and Determination of Supplemental Phase II RI SRCs in FBQ Subsurface Soil (1-3 ft BGS)

Analyte	CAS Number	Units	Results >Detection Limit	Average Result	Minimum Detect	Maximum Detect	95% UCL of Mean	Exposure Concentration	Background Criteria	Max. > Bkg.?	Site Related?
Inorganics											
Aluminum	7429905	mg/kg	6/6	18800	5870	25200	24600	24600	19500	Yes	Yes
Antimony	7440360	mg/kg	6/6	0.52	0.36	0.67	0.617	0.617	0.96	No	No
Arsenic	7440382	mg/kg	6/6	13.8	13.2	15.8	14.6	14.6	19.8	No	No
Barium	7440393	mg/kg	6/6	108	41	168	230	168	124	Yes	Yes
Beryllium	7440417	mg/kg	6/6	0.968	0.39	1.4	1.29	1.29	0.88	Yes	Yes
Calcium	7440702	mg/kg	6/6	3590	357	13400	191000	13400	35500	No	No
Chromium	7440473	mg/kg	6/6	29.2	18.4	33.1	33.8	33.1	27.2	Yes	Yes
Cobalt	7440484	mg/kg	6/6	14.6	6.9	24.4	26.3	24.4	23.2	Yes	Yes
Copper	7440508	mg/kg	6/6	22.5	17.1	27.7	27.8	27.7	32.3	No	No
Iron	7439896	mg/kg	6/6	31000	17500	36800	37100	36800	35200	Yes	No
Lead	7439921	mg/kg	6/6	15.9	12.7	17.9	17.5	17.5	19.1	No	No
Magnesium	7439954	mg/kg	6/6	4690	1430	7510	6630	6630	8790	No	No
Manganese	7439965	mg/kg	6/6	402	287	471	461	461	3030	No	No
Mercury	7439976	mg/kg	6/6	0.0267	0.02	0.04	0.0334	0.0334	0.044	No	No
Nickel	7440020	mg/kg	6/6	31	18.6	45.1	40.5	40.5	60.7	No	No
Potassium	7440097	mg/kg	6/6	2380	904	3390	3190	3190	3350	Yes	No
Selenium	7782492	mg/kg	6/6	0.445	0.26	0.73	0.723	0.723	1.5	No	No
Sodium	7440235	mg/kg	6/6	86	56.9	126	108	108	145	No	No
Thallium	7440280	mg/kg	6/6	0.69	0.38	0.85	0.867	0.85	0.91	No	No
Vanadium	7440622	mg/kg	6/6	33.8	13.1	43.2	42.8	42.8	37.6	Yes	Yes
Zinc	7440666	mg/kg	6/6	62.6	51.7	73.2	72.5	72.5	93.3	No	No
Organics-Explosives											
Nitrobenzene	98953	mg/kg	6/6	0.0617	0.03	0.08	0.0758	0.0758	--	--	Yes

CAS = Chemical Abstracts Service.
UCL = Upper confidence limit.

2B.3.2 Nature and Extent of SRCs in Surface and Subsurface Soil

Surface (0-1 ft BGS) and subsurface (1-3 ft BGS) soil samples were collected from six locations at FBQ to further define the nature and extent of explosive and inorganic contamination. All discrete samples were analyzed for explosives and target analyte list metals. Data summary statistics and screening results to identify SRCs are presented in Tables 2B-2 and 2B-3.

2B.3.2.1 <u>Surface Soil (0-1 ft BGS)</u>

Explosives

One explosive, nitrobenzene, was detected in the FBQ discrete surface soil samples at all six locations (Table 2B-4). Nitrobenzene was previously detected in 4 of 60 surface soil samples collected during the Phase II RI at a maximum detection of 0.083. The Supplemental Phase II results are all below the Phase II maximum detection and are all below reporting limits. Figure 2B-2 presents the detections spatially. No other explosives were detected in surface soil at FBQ. The extent of explosives compounds at FBQ has been defined to below reporting limits with the additional Supplemental Phase II data collected.

Table 2B-4. Explosive SRCs Detected in Surface Soil (0-1 ft BGS) at FBQ

Analyte (mg/kg)	Station					
	FBQ-193	FBQ-194	FBQ-195	FBQ-196	FBQ-197	FBQ-198
Nitrobenzene	0.03 J	0.02 J	0.04 J	0.03 J	0.03 J	0.06 J

J = Estimated value less than reporting limits.

Inorganics

Twenty-one inorganic compounds were detected in surface soil samples (0-1 ft BGS) collected during the Supplemental Phase II RI (Table 2B-2). Seventeen inorganic compounds were detected above background, fifteen were identified as SRCs (Table 2B-5). Potassium and iron were eliminated because they are essential nutrients. Chromium and Mercury were detected above background in all six surface soil samples collected.

FBQ-196, and FBQ-197 were collected to define the extent of manganese in the southwestern portion of the site. FBQ-195 was collected to define the extent of manganese in the northeast portion of the site to bound the manganese detection above background at FBQ-051. Results for manganese in all three of these locations were below background, thus defining the extent of manganese contamination. No other inorganic surface soil samples (0-1 ft BGS) were collected specifically to define the extent of inorganic constituents at FBQ. Figure 2B-3 illustrates results for inorganic SRCs in surface soil. It is noted that miscellaneous inorganics are present above background concentrations in the Supplemental Phase II samples collected; however, no substantial data gaps have been identified.

Table 2B-5. Inorganic SRCs Detected in Surface Soil (0-1 ft BGS) at FBQ

Analyte (mg/kg)	Background	Station					
		FBQ-193	FBQ-194	FBQ-195	FBQ-196	FBQ-197	FBQ-198
Aluminum	17700	17800 =#	15500 =	16000 =	13200 =	17400 =	15200 =
Antimony	0.96	1 J#	0.73 J	0.51 J	0.55 J	0.46 J	0.4 J
Arsenic	15.4	10.9 =	9.9 =	10.2 =	15.8 =#	11.7 =	10.6 =
Barium	88.4	114 J#	83.7 J	87.5 J	53.2 J	86.7 J	57.7 J
Beryllium	0.88	0.87 =	0.78 =	0.73 =	0.63 =	0.91 =#	0.59 =
Chromium	17.4	28.9 =#	28.1 =#	22.2 =#	23.1 =#	26.1 D=#	25.7 =#
Cobalt	10.4	14.9 =#	12.2 =#	11.2 =#	8.3 =	12.4 =#	10.4 =
Copper	17.7	12.5 =	12.3 =	11.6 =	19.5 =#	10.2 =	12.2 =
Lead	26.1	122 =#	41.7 =#	21.6 =	19.3 =	25.8 =	18.2 =
Manganese	1450	1490 =#	881 =	801 =	244 =	1410 =	568 =
Mercury	0.036	0.06 =#	0.06 =#	0.04 J#	0.04 =#	0.08 =#	0.04 J#
Nickel	21.1	20.3 =	21.3 =#	17.6 =	22 =#	17.2 =	16.2 =
Thallium	0	0.67 U	0.63 J#	0.84 J#	0.49 J#	0.61 U	0.5 J#
Vanadium	31.1	34.6 J#	28.9 J	29.6 J	27.4 J	36.6 J#	31.4 J#
Zinc	61.8	71.6 =#	61.7 =	56.3 =	53.4 =	63.4 =#	49 =

J - Estimated value less than reporting limits.
U - Not detected.
= - Analyte present and concentration accurate.
- Value above Facility-Wide background.

2B.3.2.2 Subsurface Soil (1-3 ft BGS)

Explosives

One explosive, nitrobenzene was detected in the FBQ discrete subsurface soil samples at all six locations (Table 2B-6). The detections of nitrobenzene at the Supplemental Phase II samples were all below reporting limits. No other explosives were detected. Figure 2B-4 illustrates the detections of explosives in subsurface soil spatially. The extent of explosives compounds at FBQ has been defined to below reporting limits with the additional Supplemental Phase II data collected.

Table 2B-6. Explosive SRCs Detected in Subsurface Soil (1-3 ft BGS) at FBQ

Analyte (mg/kg)	Station					
	FBQ-193	FBQ-194	FBQ-195	FBQ-196	FBQ-197	FBQ-198
Nitrobenzene	0.08 J	0.06 J	0.07 J	0.03 J	0.06 J	0.07 J

J - estimated value less than reporting limits.

Inorganics

Twenty-one inorganic compounds were detected in subsurface soil samples (1-3 ft BGS) collected during the Supplemental Phase II RI (Table 2B-3). Eight inorganic compounds were detected above background, six (aluminum, barium, beryllium, chromium, cobalt, and vanadium) were identified as SRCs (Table 2B-7). Iron and potassium were eliminated as SRCs because they are essential nutrients. FBQ-193 had the most detections of inorganics SRCs above background (6). The other five locations ranged from none (FBQ-196) to five (FBQ 195). Figure 2B-5 illustrates the results for inorganic SRCs in subsurface soil.

Table 2B-7. Inorganic SRCs Detected in Subsurface Soil (1-3 ft BGS) at FBQ

Analyte (mg/kg)	Background	Station					
		FBQ-193	**FBQ-194**	**FBQ-195**	**FBQ-196**	**FBQ-197**	**FBQ-198**
Aluminum	19500	25200 =#	16700 =	23000 =#	5870 =	20600 =#	21700 =#
Barium	124	132 J#	67.8 J	159 J#	41 J	77.4 J	168 J#
Beryllium	0.88	1.4 =#	0.74 =	1.3 =#	0.39 =	0.78 =	1.2 =#
Chromium	27.2	33.1 =#	27.7 =#	32.7 =#	18.4 =	31.2 =#	31.8 =#
Cobalt	23.2	24.4 =#	9 =	17.6 =	6.9 =	11.6 =	18.1 =
Vanadium	37.6	39.7 J#	31.1 J	38.6 J#	13.1 J	43.2 J#	37.3 J

J - Estimated value less than reporting limits.
= - Analyte present and concentration accurate.
- Value above Facility-Wide background.

2B.4 QUALITATIVE RISK EVALUATION

This qualitative risk evaluation analyzes the impact of the Supplemental Phase II soil data on the conclusions of the HHRA and SERA presented in the *Phase I/Phase II Remedial Investigation Report for Fuze and Booster Quarry Landfill/Pond* (USACE 2005c).

Tables 2B-8 through 2B-10 provide summary statistics and identification of SRCs and COPCs for (1) the soil data sets used in the RI Report, and (2) revised soil data sets including both the original RI data and the Supplemental Phase II data collected in November 2005. The impact of including the supplemental data on the conclusions of the HHRA and SERA are summarized below. The impact of inclusion of the supplemental data falls into three categories:

1. Chemicals that are essentially unchanged by the addition of the new data;

2. SRCs/COPCs that differ between the original RI Report data set and the combined RI Report and supplemental data set; and

3. New chemicals detected in the supplemental data but not detected in the RI Report data set.

Chemicals in each of these three categories are summarized below for shallow surface soil (0-1 ft BGS), deep surface soil (0-3 ft BGS), and subsurface soil (1-3 ft BGS).

2B.4.1 Shallow Surface Soil (0-1 ft BGS)

Summary statistics for shallow surface soil (0-1 ft BGS) data are provided in Table 2B-8. The impact of inclusion of the supplemental data on the conclusions of the HHRA and SERA is summarized in the following sections.

2B.4.1.1 Chemicals Essentially Unchanged

Forty-five chemicals were detected in surface soil data in the RI Report. For 44 of these chemicals, the identification of SRCs and COPCs does not change as a result of adding the Supplemental Phase II data. For these 44 chemicals the EPC (95% upper confidence level [UCL] or MDC) reported in the RI Report is the same or slightly larger than the EPC calculated with the supplemental data included (i.e., using two significant figures, the ratios of the revised EPC/original EPC range from 0.91 to 1.0). Chemicals with EPCs that decrease and stay the same are listed below:

- The EPCs for 10 chemicals (antimony; cadmium; calcium; copper; silver; zinc; 1,3,5-trinitrobenzene; 2,4,6-TNT; 2-amino-4,6-DNT; and 4-amino-2,6-DNT) are slightly lower with the supplemental data included (revised EPC/original EPC range from 0.91 to 0.95). Six of these chemicals were identified as COPCs (antimony; cadmium; copper; 2,4,6-TNT; 2-amino-4,6-DNT; and 4-amino-2,6-DNT) and the maximum HQ (0.14) and maximum ILCR (2.7E-07) calculated for these 6 chemicals were below acceptable levels using the old (higher) EPC; therefore, this reduction in the EPC does not change the conclusions of the HHRA.

- The EPCs for the remaining 34 chemicals are unchanged (revised EPC/original EPC = 1.0).

The conclusions of the HHRA and SERA would be unchanged for these 44 chemicals.

2B.4.1.2 SRCs/COPCs that Differ

Results for one chemical differ between the surface soil data included in the RI Report and the supplemental data.

Aluminum: The MDC of aluminum reported in the RI Report (17,200 mg/kg) was just below the background criterion (17,700 mg/kg); therefore, aluminum was not considered an SRC or a COPC. The MDC of aluminum reported in the supplemental data (17,800 mg/kg) is just above the background criterion and above 1/10th the PRG (7600 mg/kg); therefore, inclusion of the supplemental data results in aluminum being identified as an SRC and a COPC. The EPC for aluminum (12,200 mg/kg), including the supplemental data, is less than background. Both the EPC and the MDC for aluminum are less than 1/10th the PRG for an industrial worker (92,000 mg/kg). The cleanup goal for aluminum would not be less than the background concentration and the EPC is less than background; therefore, inclusion of aluminum as a COPC would not change the conclusions of the HHRA (i.e., aluminum would not be a COC for evaluation of alternatives). The USEPA recommends that aluminum not be considered an ecological COPC for soils with a pH > 5.5. The soil pH at FBQ is 8.4 (USACE 2005b, Appendix K, attachment 2): therefore, inclusion of the supplemental data would not change the conclusions of the SERA.

The conclusions of the HHRA and SERA are unchanged for aluminum.

2B.4.1.3 New chemicals detected in the Supplemental Data Only

One chemical, thallium, was detected in the supplemental data but not in the original RI data.

> **Thallium:** This metal was not detected in the RI Report data but was detected in 4 of 6 supplemental surface soil samples. No background concentration is available for thallium in surface soil. The MDC (0.84 mg/kg) exceeds 1/10th the PRG (0.52 mg/kg); therefore, thallium is identified as both an SRC and a COPC. The EPC for thallium (0.45 mg/kg) is less than 1/10th the Region 9 residential PRG. Both the EPC and the MDC for thallium are less than the 1/10th the Region 9 PRG for an industrial worker (6.7 mg/kg). Because the EPC is less than 1/10th the Region 9 residential PRG, thallium would not be a risk driver and its detection in the supplemental soil data does not change the conclusions of the HHRA. Because the MDC is less than the ecological screening value (ESV; 1 mg/kg from Efroymson et al. 1997), thallium is not identified as a chemical of potential ecological concern (COPEC) and its detection in the supplemental data does not change the conclusions of the SERA.

The conclusions of the HHRA and SERA are unchanged by inclusion of thallium.

2B.4.1.4 Risk Assessment Conclusions for Supplemental Shallow Surface Soil Data

Based on evaluation of the original and revised data sets, inclusion of the supplemental data would not change the conclusions of the HHRA or SERA for shallow surface soil (0-1 ft BGS) at FBQ.

2B.4.2 Deep Surface Soil (0-3 ft BGS)

Summary statistics for deep surface soil (0-3 ft BGS) data are provided in Table 2B-9. The impact of inclusion of the supplemental data on the conclusions of the HHRA is summarized in the following sections. The deep surface soil aggregate is not evaluated in the SERA.

2B.4.2.1 Chemicals that are Essentially Unchanged

Forty-five chemicals were detected in deep surface soil (0-3 ft BGS) data in the RI Report. For all 45 of these chemicals, the identification of SRCs and COPCs does not change as a result of adding the Supplemental Phase II data. For these 45 chemicals the EPC (95% UCL or MDC) reported in the RI Report is very similar to the EPC calculated with the supplemental data included in the data set (i.e., the ratio of the revised EPC/original EPC range from 0.89 to 1.1). Chemicals with EPCs that increase, decrease, and stay the same are listed below:

- The EPCs for 12 chemicals (antimony; cadmium; calcium; copper; lead; mercury; selenium; silver; 1,3,5-trinitrobenzene; 2,4,6-TNT; 2-amino-4,6-DNT; and 4-amino-2,6-DNT) are slightly lower with the supplemental data included (revised EPC/original EPC range from 0.87 to 0.95). Seven of these chemicals were identified as COPCs (antimony; cadmium; copper; lead; 2,4,6-TNT; 2-amino-4,6-DNT; and 4-amino-2,6-DNT) and the maximum HQ

(0.0017) and maximum ILCR (2.1E-08) for these 7 COPCs were below acceptable levels using the old (higher) EPC; therefore, this reduction in the EPC does not change the conclusions of the HHRA.

- The EPCs for two chemicals (potassium and vanadium) are slightly larger with the supplemental data included (revised EPC/original EPC = 1.1). Potassium is an essential nutrient and is not a COPC. The maximum HQ (0.0007) for vanadium was below acceptable levels using the old (smaller) EPC. Therefore, the increase in the EPCs for these two chemicals does not change the conclusions of the HHRA.

- The EPCs for the remaining 31 chemicals are unchanged (revised EPC/original EPC = 1.0).

The conclusions of the HHRA would be unchanged for these 45 chemicals.

2B.4.2.2 SRCs/COPCs that Differ

As noted above, no new SRCs/COPCs were identified among the 45 chemicals detected in the original RI Report data set.

2B.4.2.3 New chemicals detected in the Supplemental Data Only

One chemical, thallium, was detected in the supplemental data but not in the original RI data.

Thallium: This metal was not detected in the RI Report data but was detected in the supplemental data. The MDC (0.85 mg/kg) is less than the background criterion (0.91 mg/kg) for subsurface soil which is included in the deep surface soil interval (no surface soil background value is available); therefore, thallium is not identified as an SRC.

The conclusions of the HHRA are unchanged by inclusion of thallium.

2B.4.2.4 Risk Assessment Conclusions for Supplemental Deep Surface Soil Data

Based on evaluation of the original and revised data sets, inclusion of the supplemental data would not change the conclusions of the HHRA for deep surface soil (0-3 ft BGS) at FBQ. Deep surface soil is not evaluated in the SERA.

2B.4.3 Subsurface Soil (1-3 ft BGS)

Summary statistics for subsurface soil (1-3 ft BGS) data are provided in Table 2B-10. The impact of inclusion of the supplemental data on the conclusions of the HHRA and SERA is summarized in the following sections.

2B.4.3.1 Chemicals Essentially Unchanged

Twenty-seven chemicals were detected in subsurface soil data in the RI Report. For 26 of these chemicals, the identification of SRCs and COPCs does not change as a result of adding the Supplemental Phase II data. For these 25 chemicals the EPC (95% UCL or MDC) reported in the RI Report is very similar to the EPC calculated with the supplemental data included in the data set (i.e., the ratio of the revised EPC/original EPC range from 0.87 to 1.1). Chemicals with EPCs that increase, decrease, and stay the same are listed below:

- The EPCs for four chemicals (cadmium, calcium, mercury, and selenium) are slightly lower with the supplemental data included (revised EPC/original EPC range from 0.87 to 0.93). These chemicals were not COPCs in the RI Report (and still are not COPCs after including the November 2005 data); thus, no HQs or ILCRs were quantified for these chemicals and the conclusions of the HHRA do not change.

- The EPCs for five chemicals (aluminum, antimony, barium, potassium, and vanadium) are slightly larger with the supplemental data included (revised EPC/original EPC = 1.1). Two of these metals (aluminum and vanadium) were human health COPCs with maximum HQs (for the child resident) of 0.20 and 0.052 respectively; therefore, this slight increase in EPC does not change the conclusions of the HHRA. Aluminum is not a COPEC because the soil pH is >5.5 and, in fact is 8.4 as explained in Section 2B.4.1.2 about aluminum. The MDCs of antimony (1.9 mg/kg) and barium (168 mg/kg) with the supplemental data included are less than their ESVs (5 mg/kg and 283 mg/kg respectively). Therefore, antimony and barium are not identified as COPECs in subsurface soil. Potassium is an essential nutrient and has no ESV. Vanadium was retained as a COPEC in the RI Report; therefore, there is no change in the conclusions of the SERA nor of the weight-of-evidence assessment in the FS.

- The EPCs for the remaining 17 chemicals are unchanged (revised EPC/original EPC = 1.0).

The conclusions of the HHRA and SERA would be unchanged for these 26 chemicals.

2B.4.3.2 SRCs/COPCs that Differ

Results for one chemical differ between the subsurface soil data included in the RI Report and the supplemental data.

Cobalt: The MDC of cobalt reported in the RI Report (22.5 mg/kg) was just below the background criterion (23.2 mg/kg); therefore, cobalt was not considered an SRC or a COPC. The MDC of cobalt reported in the supplemental data (24.4 mg/kg) is just above the background criterion; therefore, inclusion of the supplemental data results in cobalt being identified as an SRC. The MDC remains below $1/10^{th}$ the PRG (140 mg/kg); therefore, cobalt is not a human health COPC in the original or supplemental data. The EPC for cobalt (13.3 mg/kg) including the supplemental data is less than background. The cleanup goal for cobalt would not be less than the background concentration and the EPC is less than background; therefore, inclusion of cobalt as an SRC would not change the conclusions of the FS. Because the MDC is greater than the ESV (20 mg/kg), cobalt is identified as a new COPEC in subsurface soil. However, cobalt was a COPEC in shallow surface soil and, therefore, there is no new COPEC in the weight-of-evidence assessment in the FS for soil.

The conclusions of the HHRA and SERA are unchanged for cobalt.

2B.4.3.3 New chemicals detected in the Supplemental Data Only

One chemical, thallium, was detected in the supplemental subsurface soil data but not in the original RI Report data.

Thallium: This metal was not detected in the RI Report data but was detected in the supplemental data. The MDC (0.85 mg/kg) in subsurface soil is less than the background criterion for subsurface soil (0.91 mg/kg); therefore, thallium is not identified as an SRC.

The conclusions of the HHRA and SERA are unchanged by inclusion of thallium.

2B.4.3.4 Risk Assessment Conclusions for Supplemental Subsurface Soil Data

Based on evaluation of the original and revised data sets, inclusion of the supplemental data would not change the conclusions of the HHRA or SERA for subsurface soil (1-3 ft BGS) at FBQ.

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Table 2B-8. Summary of RI Report and Supplemental Phase II Shallow Surface Soil (0-1 ft BGS) Data: Fuze and Booster Quarry Landfill/Ponds

				Data included in Phase I/Phase II RI Report (USACE 2005a)								Data included in RI report Plus Supplemental Data collected Nov 2005								Revised
					Measured Concentration								Measured Concentration							
Chemical	CAS Number	Site Background Criteria[a]	Region 9 Res PRG[b]	Freq of Detect	Min	Ave	Max	95% UCL	EPC	SRC[c]?	COPC[d]?	Freq of Detect	Min	Ave	Max	95% UCL	EPC	SRC[c]?	COPC[d]?	EPC/ RIR EPC
Inorganics																				
Aluminum	7429905	17700	7600	60 / 60	723	10900	17200	11800	11800	No	No	66/ 66	723	11300	17800	12200	12200	Yes	Yes	1.0
Antimony	7440360	0.96	3.1	15 / 60	0.91	2.0	74	4.1	4.1	Yes	Yes	21/ 66	0.4	1.91	74.4	3.79	3.79	Yes	Yes	0.92
Arsenic	7440382	15.4	0.39	60 / 60	1.1	11	27	12	12	Yes	Yes	66/ 66	1.1	11.3	27.1	12.1	12.1	Yes	Yes	1.0
Barium	7440393	88.4	540	60 / 60	11	87	1070	116	116	Yes	Yes	66/ 66	10.7	86.3	1070	113	113	Yes	Yes	1.0
Beryllium	7440417	0.88	15	60 / 60	0.21	0.71	1.5	0.75	0.75	Yes	No	66/ 66	0.21	0.713	1.5	0.753	0.753	Yes	No	1.0
Cadmium	7440439	0	3.7	31 / 60	0.10	0.22	4.0	0.34	0.34	Yes	Yes	31/ 66	0.1	0.202	4	0.309	0.309	Yes	Yes	0.91
Calcium	7440702	15800	NA	60 / 60	108	2620	39800	4120	4120	No	No	66/ 66	108	2420	39800	3790	3790	No	No	0.92
Chromium	7440473	17.4	22	60 / 60	2.7	18	89	20	20	Yes	Yes	66/ 66	2.7	18.4	88.9	20.6	20.6	Yes	Yes	1.0
Chromium, hexavalent	18540299	0	22	7 / 8	1.3	3.7E+00	6.8	7.2	6.8	Yes	No	7/ 8	1.3	3.72	6.8	7.15	6.8	Yes	No	1.0
Cobalt	7440484	10.4	140	60 / 60	1.1	11	37	12	12	Yes	No	66/ 66	1.1	10.6	36.8	11.5	11.5	Yes	No	1.0
Copper	7440508	17.7	310	60 / 60	2.1	26	559	41	41	Yes	Yes	66/ 66	2.1	24.9	559	38.8	38.8	Yes	Yes	0.94
Iron	7439896	23100	2300	60 / 60	4250	25900	110000	28700	28700	No	No	66/ 66	4250	25700	110000	28300	28300	No	No	1.0
Lead	7439921	26.1	400	60 / 60	5.8	57	887	83	83	Yes	Yes	66/ 66	5.8	55.2	887	79	79	Yes	Yes	1.0
Magnesium	7439954	3030	NA	60 / 60	143	2390	9850	2740	2740	No	No	66/ 66	143	2400	9850	2730	2730	No	No	1.0
Manganese	7439965	1450	180	60 / 60	218	657	2310	738	738	Yes	Yes	66/ 66	218	679	2310	765	765	Yes	Yes	1.0
Mercury	7439976	0.036	2.3	12 / 60	0.054	0.063	1.2	0.10	0.10	Yes	No	18/ 66	0.04	0.0616	1.2	0.0963	0.0963	Yes	No	1.0
Nickel	7440020	21.1	160	60 / 60	2.9	18	85	21	21	Yes	No	66/ 66	2.9	18.4	85.4	20.4	20.4	Yes	No	1.0
Potassium	7440097	927	NA	60 / 60	122	1070	2660	1180	1180	No	No	66/ 66	122	1100	2660	1190	1190	No	No	1.0
Selenium	7782492	1.4	39	34 / 60	1.1	1.2	7.9	1.4	1.4	Yes	No	40/ 66	0.37	1.14	7.9	1.36	1.36	Yes	No	1.0
Silver	7440224	0	39	1 / 60	0.26	0.063	0.26	0.076	0.08	No	No	1/ 66	0.26	0.0604	0.26	0.0722	0.0722	No	No	0.95
Sodium	7440235	123	NA	55 / 60	61	103	687	121	121	No	No	61/ 66	50.1	99.5	687	116	116	No	No	1.0
Thallium	7440280	0	0.52	0 / 60	NA	NA	NA	NA	NA	No	No	4/ 66	0.49	0.376	0.84	0.451	0.451	Yes	Yes	NA
Vanadium	7440622	31.1	7.8	60 / 60	3.0	21	36	22	22	Yes	Yes	66/ 66	3	21.7	36.6	23.2	23.2	Yes	Yes	1.0
Zinc	7440666	61.8	2300	60 / 60	15	99	1330	136	136	Yes	No	66/ 66	15.3	95.6	1330	129	129	Yes	No	0.95
Organic Explosives																				
1,3,5-Trinitrobenzene	99354	NA	180	6 / 60	0.062	0.090	1.7	0.14	0.14	Yes	No	6/ 66	0.062	0.0864	1.7	0.129	0.129	Yes	No	0.94
2,4,6-Trinitrotoluene	118967	NA	3.1	11 / 60	0.027	1.9	99	4.6	4.6	Yes	Yes	11/ 66	0.027	1.69	99	4.19	4.19	Yes	Yes	0.91
2,4-Dinitrotoluene	121142	NA	0.72	4 / 60	0.038	0.058	0.40	0.069	0.069	Yes	No	4/ 66	0.038	0.0575	0.4	0.0669	0.0669	Yes	No	1.0
2,6-Dinitrotoluene	606202	NA	0.72	2 / 60	0.070	0.071	1.3	0.11	0.11	Yes	Yes	2/ 66	0.07	0.0692	1.3	0.101	0.101	Yes	Yes	1.0
2-Amino-4,6-dinitrotoluene	35572782	NA	NA	9 / 60	0.14	0.30	12	0.64	0.64	Yes	Yes	9/ 66	0.14	0.28	12	0.583	0.583	Yes	Yes	0.92
4-Amino-2,6-dinitrotoluene	19406510	NA	NA	9 / 60	0.11	0.26	9.7	0.52	0.52	Yes	Yes	9/ 66	0.11	0.236	9.7	0.481	0.481	Yes	Yes	0.92
Nitrobenzene	98953	NA	2	4 / 60	0.040	0.050	0.083	0.051	0.051	Yes	No	10/ 66	0.02	0.0487	0.083	0.0503	0.0503	Yes	No	1.0
Nitrocellulose	9004700	NA	NA	6 / 8	25	56	150	314	150	Yes	Yes	6/ 8	25	56.3	150	314	150	Yes	Yes	1.0
RDX	121824	NA	4.4	1 / 60	0.33	0.10	0.33	0.11	0.11	Yes	No	1/ 66	0.33	0.103	0.33	0.109	0.109	Yes	No	1.0
Organic Pesticides																				
4,4'-DDE	72559	NA	1.7	2 / 8	0.00018	0.00085	0.00037	0.0011	0.00037	Yes	No	2/ 8	0.00018	0.00085	0.00037	0.00109	0.00037	Yes	No	1.0
Organic Semivolatiles																				
Benz(a)anthracene	56553	NA	0.62	1 / 8	0.19	0.21	0.19	0.21	0.19	Yes	No	1/ 8	0.19	0.206	0.19	0.213	0.19	Yes	No	1.0
Benzo(a)pyrene	50328	NA	0.062	1 / 8	0.084	0.19	0.084	0.22	0.084	Yes	Yes	1/ 8	0.084	0.193	0.084	0.223	0.084	Yes	Yes	1.0
Benzo(b)fluoranthene	205992	NA	0.62	1 / 8	0.26	0.22	0.26	0.23	0.23	Yes	No	1/ 8	0.26	0.215	0.26	0.228	0.228	Yes	No	1.0
Benzo(k)fluoranthene	207089	NA	6.2	1 / 8	0.085	0.19	0.085	0.22	0.085	Yes	No	1/ 8	0.085	0.193	0.085	0.223	0.085	Yes	No	1.0
Chrysene	218019	NA	62	1 / 8	0.37	0.23	0.37	0.27	0.27	Yes	No	1/ 8	0.37	0.229	0.37	0.267	0.267	Yes	No	1.0
Di-n-butyl phthalate	84742	NA	610	1 / 5	0.24	0.22	0.24	0.23	0.23	Yes	No	1/ 5	0.24	0.217	0.24	0.23	0.23	Yes	No	1.0

Table 2B-8. Summary of RI Report and Supplemental Phase II Shallow Surface Soil (0-1 ft BGS) Data: Fuze and Booster Quarry Landfill/Ponds (continued)

				Data included in Phase I/Phase II RI Report (USACE 2005a)								Data included in RI report Plus Supplemental Data collected Nov 2005								Revised
					Measured Concentration								Measured Concentration							
Chemical	CAS Number	Site Background Criteria[a]	Region 9 Res PRG[b]	Freq of Detect	Min	Ave	Max	95% UCL	EPC	SRC[c]?	COPC[d]?	Freq of Detect	Min	Ave	Max	95% UCL	EPC	SRC[c]?	COPC[d]?	EPC/ RIR EPC
Organic Semivolatiles (continued)																				
Fluoranthene	206440	NA	230	2 / 8	0.050	0.27	0.87	0.44	0.44	Yes	No	2/ 8	0.05	0.271	0.87	0.437	0.437	Yes	No	1.0
Pyrene	129000	NA	230	1 / 8	0.64	0.26	0.64	0.37	0.37	Yes	No	1/ 8	0.64	0.263	0.64	0.365	0.365	Yes	No	1.0
Organic Volatiles																				
Acetone	67641	NA	1400	1 / 4	0.0051	0.0050	0.0051	0.0064	0.0051	Yes	No	1/ 4	0.0051	0.00496	0.0051	0.00636	0.0051	Yes	No	1.0
Carbon disulfide	75150	NA	36	1 / 8	0.069	0.011	0.069	0.027	0.027	Yes	No	1/ 8	0.069	0.0114	0.069	0.027	0.027	Yes	No	1.0
Methylene chloride	75092	NA	9.1	1 / 4	0.027	9.8E-03	0.027	0.023	0.023	Yes	No	1/ 4	0.027	0.00983	0.027	0.0233	0.0233	Yes	No	1.0
Trichloroethene	79016	NA	0.053	2 / 8	0.0032	0.0034	0.0049	0.0038	0.0038	Yes	No	2/ 8	0.0032	0.00335	0.0049	0.00378	0.00378	Yes	No	1.0

Chemical was not an SRC or COPC in the original RIR data set but is identified as an SRC and/or COPC with the Supplemental Phase II data included.

Chemical was not detected in the original RIR data set but was detected with the Supplemental Phase II data.

EPC for this chemical was larger in the original RIR data set and is reduced by the inclusion of the Supplemental Phase II data.

All units are mg/kg.
COPC = Constituent of potential concern.
CAS = Chemical Abstracts Service
EPC = Exposure point concentration.
PRG = Preliminary remediation goal.
RDX = hexahydro-1,3,5-trinitro-1,3,5-triazine
RIR = Remedial Investigation Report.
SRC = Site-related contaminant.
DDE = dichlorodiphenyldichloroethylene.
UCL = Upper confidence limit on the mean.
NA = not applicable or no data available.

[a]Background criteria for surface soil from USACE 2001. *Final Phase II Remedial Investigation Report for the Winklepeck Burning Grounds at the Ravenna Army Ammunition Plant, Ravenna, Ohio*.

[b]Residential United States Environmental Protection Agency Region 9 preliminary remediation goal (PRG) corresponding to a carcinogenic risk of 1E-06 or hazard index of 0.1.

[c]Chemicals are identified as SRCs if (1) they are detected in any sample (high explosives) or they are detected in at least 5% of samples (all other chemical classes), and (2) they are not essential nutrients, and (3) the maximum detected concentration (MDC) is greater than background (inorganics).

[d]Chemicals are identified as COPCs if (1) they are SRCs and (2) the MDC is greater than the residential PRG.

Table 2B-9. Summary of RIR and Supplemental Phase II Deep Surface Soil (0-3 ft BGS) Data: Fuze and Booster Quarry Landfill/Ponds

				Data included in Phase I/Phase II RI Report (USACE 2005a)								Data included in RI report Plus Supplemental Data collected Nov 2005								Revised
Chemical	CAS Number	Site Backgrd Criteria[a]	Region 9 Res PRG[b]	Freq of Detect	Measured Concentration Min	Measured Concentration Ave	Measured Concentration Max	95% UCL	EPC	SRC[c]?	COPC[d]?	Freq of Detect	Measured Concentration Min	Measured Concentration Ave	Measured Concentration Max	95% UCL	EPC	SRC[c]?	COPC[d]?	EPC/ RIR EPC
Inorganics																				
Aluminum	7429905	17700	7600	97 / 97	556	12100	20900	12800	12800	Yes	Yes	109/ 109	556	12600	25200	13400	13400	Yes	Yes	1.0
Antimony	7440360	0.96	3.1	17 / 97	0.91	1.4	74	2.7	2.7	Yes	Yes	29/ 109	0.36	1.29	74.4	2.42	2.42	Yes	Yes	0.91
Arsenic	7440382	15	0.39	96 / 97	1.1	13	27	13	13	Yes	Yes	108/ 109	1.1	12.5	27.1	13.2	13.2	Yes	Yes	1.0
Barium	7440393	88	540	97 / 97	11	83	1070	101	101	Yes	Yes	109/ 109	10.7	84	1070	100	100	Yes	Yes	1.0
Beryllium	7440417	0.88	15	97 / 97	0.20	0.73	1.5	0.77	0.77	Yes	No	109/ 109	0.2	0.748	1.5	0.783	0.783	Yes	No	1.0
Cadmium	7440439	0	3.7	41 / 97	0.085	0.16	4.0	0.23	0.23	Yes	Yes	41/ 109	0.085	0.143	4	0.21	0.21	Yes	Yes	0.90
Calcium	7440702	15800	NA	97 / 97	91	3580	39800	5020	5020	No	No	109/ 109	90.6	3410	39800	4710	4710	No	No	0.94
Chromium	7440473	17	22	97 / 97	2.7	21	283	26	26	Yes	Yes	109/ 109	2.7	21.8	283	26.1	26.1	Yes	Yes	1.0
Chromium, hexavalent	18540299	0	22	9 / 13	1.3	3.5	7.9	5.6	5.6	No	No	9/ 13	1.3	3.52	7.9	5.6	5.6	No	No	1.0
Cobalt	7440484	10	140	97 / 97	0.97	11	37	12	12	Yes	No	109/ 109	0.97	11.2	36.8	11.9	11.9	Yes	No	1.0
Copper	7440508	18	310	97 / 97	0.85	24	559	33	33	Yes	Yes	109/ 109	0.85	23.1	559	31.4	31.4	Yes	Yes	0.95
Iron	7439896	23100	2300	97 / 97	4250	26700	110000	28500	28500	No	No	109/ 109	4250	26700	110000	28400	28400	No	No	1.0
Lead	7439921	19	400	97 / 97	2.2	42	887	58	58	Yes	Yes	109/ 109	2.2	40.3	887	54.9	54.9	Yes	Yes	0.94
Magnesium	7439954	3030	NA	97 / 97	96	2850	9850	3170	3170	No	No	109/ 109	95.6	2940	9850	3240	3240	No	No	1.0
Manganese	7439965	1450	180	97 / 97	190	578	2310	627	627	Yes	Yes	109/ 109	190	586	2310	633	633	Yes	Yes	1.0
Mercury	7439976	0.036	2.3	13 / 97	0.054	0.051	1.2	0.077	0.077	Yes	No	25/ 109	0.02	0.0494	1.2	0.0732	0.0732	Yes	No	0.95
Nickel	7440020	21	160	97 / 97	2.3	20	85	22	22	Yes	No	109/ 109	2.3	20.5	85.4	22.1	22.1	Yes	No	1.0
Potassium	7440097	927	NA	97 / 97	118	1210	3120	1310	1310	No	No	109/ 109	118	1290	3390	1390	1390	No	No	1.1
Selenium	7782492	1.4	39	58 / 97	1.0	1.2	7.9	1.4	1.4	Yes	No	70/ 109	0.26	1.13	7.9	1.28	1.28	Yes	No	0.93
Silver	7440224	0	39	1 / 97	0.26	0.054	0.26	0.062	0.062	No	No	1/ 109	0.26	0.0504	0.26	0.0581	0.0581	No	No	0.94
Sodium	7440235	123	NA	91 / 97	61	106	687	117	117	No	No	103/ 109	50.1	102	687	113	113	No	No	1.0
Thallium	7440280	0.91	0.52	0 / 97	NA	NA	NA	NA	NA	No	No	10/ 109	0.38	0.35	0.85	0.399	0.399	No	No	NA
Vanadium	7440622	31	7.8	97 / 97	2.7	22	40	23	23	Yes	Yes	109/ 109	2.7	23.3	43.2	24.6	24.6	Yes	Yes	1.1
Zinc	7440666	62	2300	97 / 97	15	86	1330	108	108	Yes	No	109/ 109	15.3	82.9	1330	103	103	Yes	No	1.0
Organic Explosives																				
1,3,5-Trinitrobenzene	99354	NA	180	6 / 97	0.062	0.075	1.7	0.10	0.10	Yes	No	6/ 109	0.062	0.072	1.7	0.0978	0.0978	Yes	No	0.94
2,4,6-Trinitrotoluene	118967	NA	3.1	11 / 97	0.027	1.2	99	2.9	2.9	Yes	Yes	11/ 109	0.027	1.04	99	2.55	2.55	Yes	Yes	0.89
2,4-Dinitrotoluene	121142	NA	0.72	4 / 97	0.038	0.055	0.40	0.062	0.062	Yes	No	4/ 109	0.038	0.0546	0.4	0.0602	0.0602	Yes	No	1.0
2,6-Dinitrotoluene	606202	NA	0.72	2 / 97	0.070	0.063	1.3	0.085	0.085	Yes	Yes	2/ 109	0.07	0.0617	1.3	0.0807	0.0807	Yes	Yes	1.0
2-Amino-4,6-dinitrotoluene	35572782	NA	NA	9 / 97	0.14	0.21	12	0.41	0.41	Yes	Yes	9/ 109	0.14	0.189	12	0.372	0.372	Yes	Yes	0.90
4-Amino-2,6-dinitrotoluene	19406510	NA	NA	9 / 97	0.11	0.18	9.7	0.34	0.34	Yes	Yes	9/ 109	0.11	0.163	9.7	0.31	0.31	Yes	Yes	0.91
Nitrobenzene	98953	NA	2.0	12 / 97	0.039	0.052	0.10	0.053	0.053	Yes	No	24/ 109	0.02	0.0512	0.1	0.0529	0.0529	Yes	No	1.0
Nitrocellulose	9004700	NA	NA	10 / 13	25	54	150	128	128	Yes	Yes	10/ 13	25	53.5	150	128	128	Yes	Yes	1.0
RDX	121824	NA	4.4	1 / 97	0.33	0.10	0.33	0.11	0.11	Yes	No	1/ 109	0.33	0.102	0.33	0.106	0.106	Yes	No	1.0
Organic Pesticides																				
4,4'-DDE	72559	NA	1.7	2 / 13	0.00018	0.00091	0.00037	0.0011	0.00037	Yes	No	2/ 13	0.00018	0.000908	0.00037	0.00105	0.00037	Yes	No	1.0
Organic Semivolatiles																				
Benz(a)anthracene	56553	NA	0.62	1 / 13	0.19	0.20	0.19	0.21	0.19	Yes	No	1/ 13	0.19	0.203	0.19	0.208	0.19	Yes	No	1.0
Benzo(a)pyrene	50328	NA	0.062	1 / 13	0.084	0.20	0.084	0.21	0.084	Yes	Yes	1/ 13	0.084	0.195	0.084	0.212	0.084	Yes	Yes	1.0
Benzo(b)fluoranthene	205992	NA	0.62	1 / 13	0.26	0.21	0.26	0.22	0.22	Yes	No	1/ 13	0.26	0.209	0.26	0.218	0.218	Yes	No	1.0
Benzo(k)fluoranthene	207089	NA	6.2	1 / 13	0.085	0.20	0.085	0.21	0.085	Yes	No	1/ 13	0.085	0.195	0.085	0.212	0.085	Yes	No	1.0
Chrysene	218019	NA	62	1 / 13	0.37	0.22	0.37	0.24	0.24	Yes	No	1/ 13	0.37	0.217	0.37	0.24	0.24	Yes	No	1.0
Di-n-butyl phthalate	84742	NA	610	1 / 8	0.24	0.21	0.24	0.22	0.22	Yes	No	1/ 8	0.24	0.211	0.24	0.22	0.22	Yes	No	1.0

Table 2B-9. Summary of RIR and Supplemental Phase II Deep Surface Soil (0-3 ft BGS) Data: Fuze and Booster Quarry Landfill/Ponds (continued)

				Data included in Phase I/Phase II RI Report (USACE 2005a)									Data included in RI report Plus Supplemental Data collected Nov 2005									Revised
		Site	Region 9	Freq	Measured Concentration			95%					Freq	Measured Concentration			95%					EPC/
Chemical	CAS Number	Backgrd Criteria[a]	Res PRG[b]	of Detect	Min	Ave	Max	UCL	EPC	SRC[c]?	COPC[d]?		of Detect	Min	Ave	Max	UCL	EPC	SRC[c]?	COPC[d]?		RIR EPC
Organic Semivolatiles (continued)																						
Fluoranthene	206440	NA	230	2 / 13	0.050	0.24	0.87	0.34	0.34	Yes	No		2/ 13	0.05	0.243	0.87	0.339	0.339	Yes	No		1.0
Pyrene	129000	NA	230	1 / 13	0.64	0.24	0.64	0.30	0.30	Yes	No		1/ 13	0.64	0.238	0.64	0.298	0.298	Yes	No		1.0
Organic Volatiles																						
Acetone	67641	NA	1400	1 / 7	0.0051	0.0044	0.0051	0.0052	0.0051	Yes	No		1/ 7	0.0051	0.00441	0.0051	0.00521	0.0051	Yes	No		1.0
Carbon disulfide	75150	NA	36	3 / 13	0.013	0.015	0.087	0.029	0.029	Yes	No		3/ 13	0.013	0.0154	0.087	0.0293	0.0293	Yes	No		1.0
Methylene chloride	75092	NA	9.1	3 / 7	0.017	0.017	0.027	0.027	0.027	Yes	No		3/ 7	0.017	0.0165	0.027	0.0269	0.0269	Yes	No		1.0
Trichloroethene	79016	NA	0.053	3 / 13	0.0028	0.0032	0.0049	0.0035	0.0035	Yes	No		3/ 13	0.0028	0.0032	0.0049	0.00346	0.00346	Yes	No		1.0

Chemical was not detected in the original RIR data set but was detected with the Supplemental Phase II data.

EPC for this chemical was larger in the original RIR data set and is reduced by the inclusion of the Supplemental Phase II data.

EPC for this chemical was smaller in the original RIR data set and is increased by the inclusion of the Supplemental Phase II data.

All units are mg/kg.
EPC = Exposure point concentration.
RIR = Remedial Investigation Report.
UCL = Upper confidence limit on the mean.
COPC = Constituent of potential concern.
PRG = Preliminary remediation goal.
SRC = Site-related contaminant.
NA = Not applicable or no data available.
CAS = Chemical Abstracts Service
RDX = hexahydro-1,3,5-trinitro-1,3,5-triazine
DDE = dichlorodiphenyldichloroethylene

[a]Background criteria are the lesser of the values for surface soil (0-2 ft BGS) or subsurface soil (>2 ft BGS) for RVAAP from USACE 2001 with one exception. Thallium was not detected in background surface soil; therefore, subsurface value is reported.. USACE 2001, *Final Phase II Remedial Investigation Report for the Winklepeck Burning Grounds at the Ravenna Army Ammunition Plant, Ravenna, Ohio*.

[b]Residential United States Environmental Protection Agency Region 9 preliminary remediation goal (PRG) corresponding to a carcinogenic risk of 1E-06 or hazard index of 0.1.

[c]Chemicals are identified as SRCs if (1) they are detected in any sample (high explosives) or they are detected in at least 5% of samples (all other chemical classes), and (2) they are not essential nutrients, and (3) the maximum detected concentration (MDC) is greater than background (inorganics).

[d]Chemicals are identified as COPCs if (1) they are SRCs and (2) the MDC is greater than the PRG.

Table 2B-10. Summary of RIR and Supplemental Phase II Subsurface Soil (1-3 ft BGS) Data: Fuze and Booster Quarry Landfill/Ponds

				Data included in Phase I/Phase II RI Report (USACE 2005a)								Data included in RI report Plus Supplemental Data collected Nov 2005								Revised
Chemical	CAS Number	Site Backgrd Criteria[a]	Region 9 Res PRG[b]	Freq of Detect	Measured Concentration Min	Measured Concentration Ave	Measured Concentration Max	95% UCL	EPC	SRC[c]?	COPC[d]?	Freq of Detect	Measured Concentration Min	Measured Concentration Ave	Measured Concentration Max	95% UCL	EPC	SRC[c]?	COPC[d]?	EPC/ RIR EPC
Inorganics																				
Aluminum	7429905	19500	7600	37 / 37	556	14000	20900	15200	15200	Yes	Yes	43/ 43	556	14700	25200	16000	16000	Yes	Yes	1.1
Antimony	7440360	0.96	3.1	2 / 37	1.1	0.30	1.9	0.38	0.38	Yes	No	8/ 43	0.36	0.326	1.9	0.405	0.405	Yes	No	1.1
Arsenic	7440382	19.8	0.39	36 / 37	7.3	15	25	16	16	Yes	Yes	42/ 43	7.3	14.4	24.6	15.6	15.6	Yes	Yes	1.0
Barium	7440393	124	540	37 / 37	11	76	151	84	84	Yes	No	43/ 43	11	80.5	168	89.4	89.4	Yes	No	1.1
Beryllium	7440417	0.88	15	37 / 37	0.20	0.78	1.2	0.83	0.83	Yes	No	43/ 43	0.2	0.802	1.4	0.865	0.865	Yes	No	1.0
Cadmium	7440439	0	3.7	10 / 37	0.09	0.06	0.72	0.10	0.10	Yes	No	10/ 43	0.085	0.0534	0.72	0.0836	0.0836	Yes	No	0.87
Calcium	7440702	35500	NA	37 / 37	91	5130	35100	8070	8070	No	No	43/ 43	90.6	4920	35100	7480	7480	No	No	0.93
Chromium	7440473	27.2	22	37 / 37	3.0	27	283	39	39	Yes	Yes	43/ 43	3	27	283	37.3	37.3	Yes	Yes	1.0
Chromium, hexavalent	18540299	0	22	2 / 5	3.7	3.2	7.9	5.9	5.9	Yes	No	2/ 5	3.7	3.19	7.9	5.87	5.87	Yes	No	1.0
Cobalt	7440484	23.2	140	37 / 37	1.0	12	23	13	13	No	No	43/ 43	0.97	12.2	24.4	13.3	13.3	Yes	No	1.0
Copper	7440508	32.3	310	37 / 37	0.85	20	28	22	22	No	No	43/ 43	0.85	20.2	28.2	21.7	21.7	No	No	1.0
Iron	7439896	35200	2300	37 / 37	13500	27900	40800	29400	29400	No	No	43/ 43	13500	28300	40800	29800	29800	No	No	1.0
Lead	7439921	19.1	400	37 / 37	2.2	18	116	22	22	Yes	No	43/ 43	2.2	17.3	116	21.3	21.3	Yes	No	1.0
Magnesium	7439954	8790	NA	37 / 37	96	3600	9080	4180	4180	No	No	43/ 43	95.6	3750	9080	4300	4300	No	No	1.0
Manganese	7439965	3030	180	37 / 37	190	450	978	504	504	No	No	43/ 43	190	443	978	489	489	No	No	1.0
Mercury	7439976	0.044	2.3	1 / 37	0.76	0.03	0.76	0.07	0.07	Yes	No	7/ 43	0.02	0.0305	0.76	0.0598	0.0598	Yes	No	0.92
Nickel	7440020	60.7	160	37 / 37	2.3	23	37	25	25	No	No	43/ 43	2.3	23.8	45.1	26	26	No	No	1.0
Potassium	7440097	3350	NA	37 / 37	118	1450	3120	1630	1630	No	No	43/ 43	118	1580	3390	1770	1770	No	No	1.1
Selenium	7782492	1.5	39	24 / 37	1.0	1.2	3.1	1.4	1.4	Yes	No	30/ 43	0.26	1.11	3.1	1.31	1.31	Yes	No	0.91
Sodium	7440235	145	NA	36 / 37	68	110	176	120	120	No	No	42/ 43	56.9	107	176	116	116	No	No	1.0
Thallium	7440280	0.91	0.52	0 / 37	NA	NA	NA	NA	NA	No	No	6/ 43	0.38	0.31	0.85	0.356	0.356	No	No	NA
Vanadium	7440622	37.6	7.8	37 / 37	2.7	25	40	26	26	Yes	Yes	43/ 43	2.7	25.8	43.2	27.9	27.9	Yes	Yes	1.1
Zinc	7440666	93.3	2300	37 / 37	18	63	156	69	69	Yes	No	43/ 43	17.8	63.3	156	68.1	68.1	Yes	No	1.0
Organic Explosives																				
Nitrobenzene	98953	NA	2	8 / 37	0.039	0.054	0.10	0.058	0.058	Yes	No	14/ 43	0.03	0.055	0.1	0.0586	0.0586	Yes	No	1.0
Nitrocellulose	9004700	NA	NA	4 / 5	26	49	110	561	110	Yes	Yes	4/ 5	26	49	110	561	110	Yes	Yes	1.0
Organic Volatiles																				
Carbon disulfide	75150	NA	36	2 / 5	0.013	0.022	0.087	0.057	0.057	Yes	No	2/ 5	0.013	0.0218	0.087	0.0568	0.0568	Yes	No	1.0
Methylene chloride	75092	NA	9.1	2 / 3	0.017	0.026	0.018	0.26	0.018	Yes	No	2/ 3	0.017	0.0255	0.018	0.262	0.018	Yes	No	1.0
Trichloroethene	79016	NA	0.053	1 / 5	0.0028	0.0030	0.0028	0.0031	0.0028	Yes	No	1/ 5	0.0028	0.00295	0.0028	0.00306	0.0028	Yes	No	1.0

Chemical was not an SRC or COPC in the original RIR data set but is identified as an SRC and/or COPC with the Supplemental Phase II data included.

Chemical was not detected in the original RIR data set but was detected with the Supplemental Phase II data.

EPC for this chemical was larger in the original RIR data set and is reduced by the inclusion of the Supplemental Phase II data.

EPC for this chemical was smaller in the original RIR data set and is increased by the inclusion of the Supplemental Phase II data.

All units are mg/kg.
COPC = Constituent of potential concern.
EPC = Exposure point concentration.
PRG = Preliminary remediation goal.
RIR = Remedial investigation report.
SRC = Site-related contaminant.
UCL = Upper confidence limit on the mean.
NA = not applicable or no data available.

[a]Background criteria for subsurface soil (>2 ft BGS) RVAAP from USACE 2001. *Final Phase II Remedial Investigation Report for the Winklepeck Burning Grounds at the Ravenna Army Ammunition Plant, Ravenna, Ohio*.

[b]Residential United States Environmental Protection Agency Region 9 preliminary remediation goal (PRG) corresponding to a carcinogenic risk of 1E-06 or hazard index of 0.1.

[c]Chemicals are identified as SRCs if (1) they are detected in any sample (high explosives) or they are detected in at least 5% of samples (all other chemical classes), and (2) they are not essential nutrients, and (3) the maximum detected concentration (MDC) is greater than background (inorganics).

[d]Chemicals are identified as COPCs if (1) they are SRCs and (2) the MDC is greater than the PRG.

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2B.5 SUMMARY AND CONCLUSIONS

2B.5.1 Summary of Contaminant Nature and Extent

The extent of explosive contamination was defined to below reporting limits in surface and subsurface soils at FBQ. Only one explosive, nitrobenzene was detected in the discrete samples, however all detections of nitrobenzene were below reporting limits.

Detections of manganese not previously bounded by Phase I/II sample locations were bounded in the Supplemental Phase II. Additional characterization of the AOC in not necessary, based on data obtained to date, in order to proceed with the FS phase. It is noted that inorganics are present above background concentrations in the perimeter samples collected; however, no substantial data gaps have been identified following completion of the Supplemental Phase II RI.

2B.5.2 Summary of the Supplemental Human Health and Ecological Risk Assessments

Based on evaluation of the original (as used in the RI Report [USACE 2005b]) and revised (including supplemental Phase II samples) data sets, inclusion of the supplemental data would not change the conclusions of the HHRA or SERA for shallow surface soil (0-1 ft BGS), deep surface soil (0-3 ft BGS), or subsurface soil (1-3 ft BGS) at FBQ.

2B.5.3 Conclusions and Recommendations

Adequate data has been collected to proceed with the Feasibility Study for FBQ.

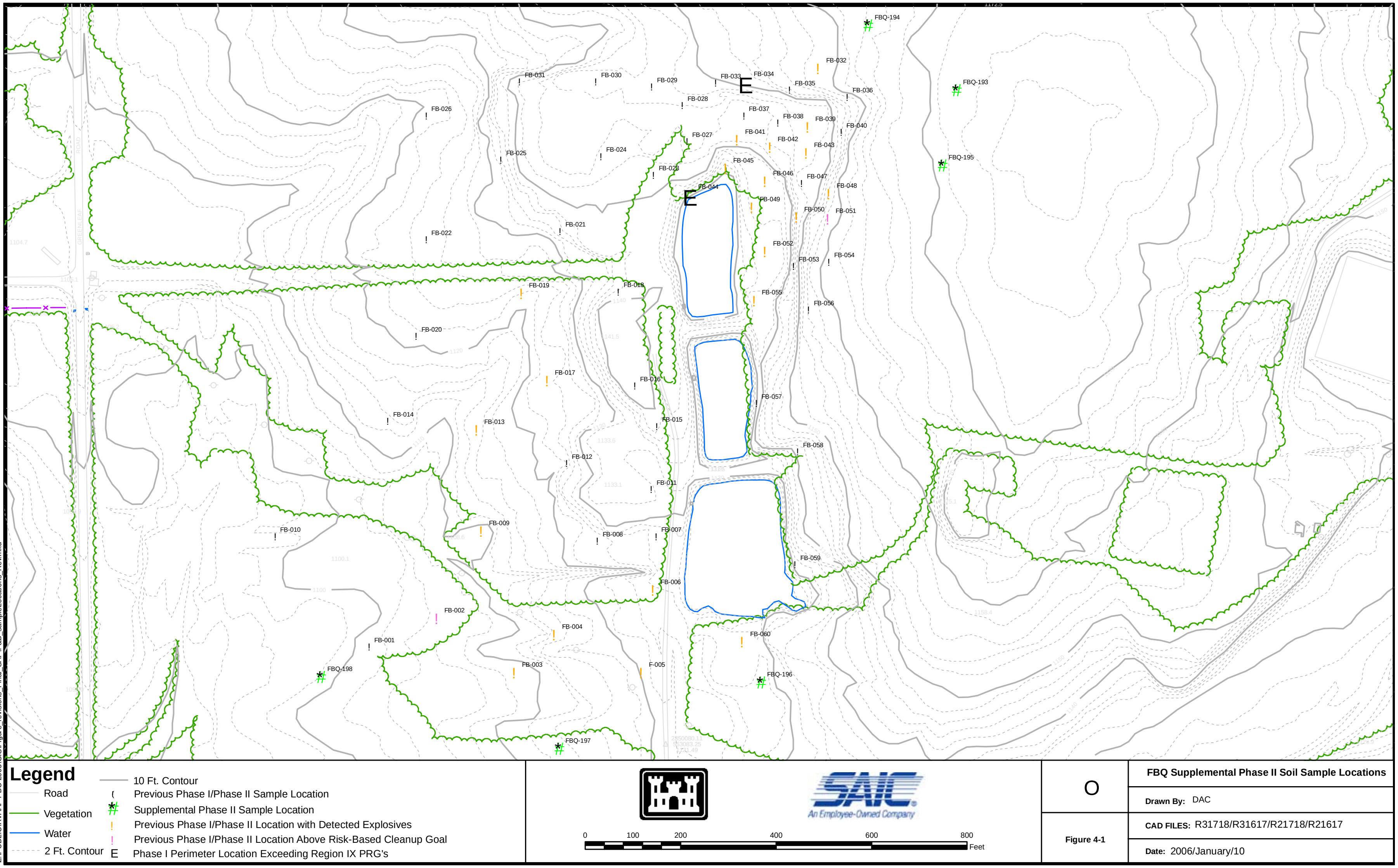

Figure 2B-1. Sample Locations at FBQ

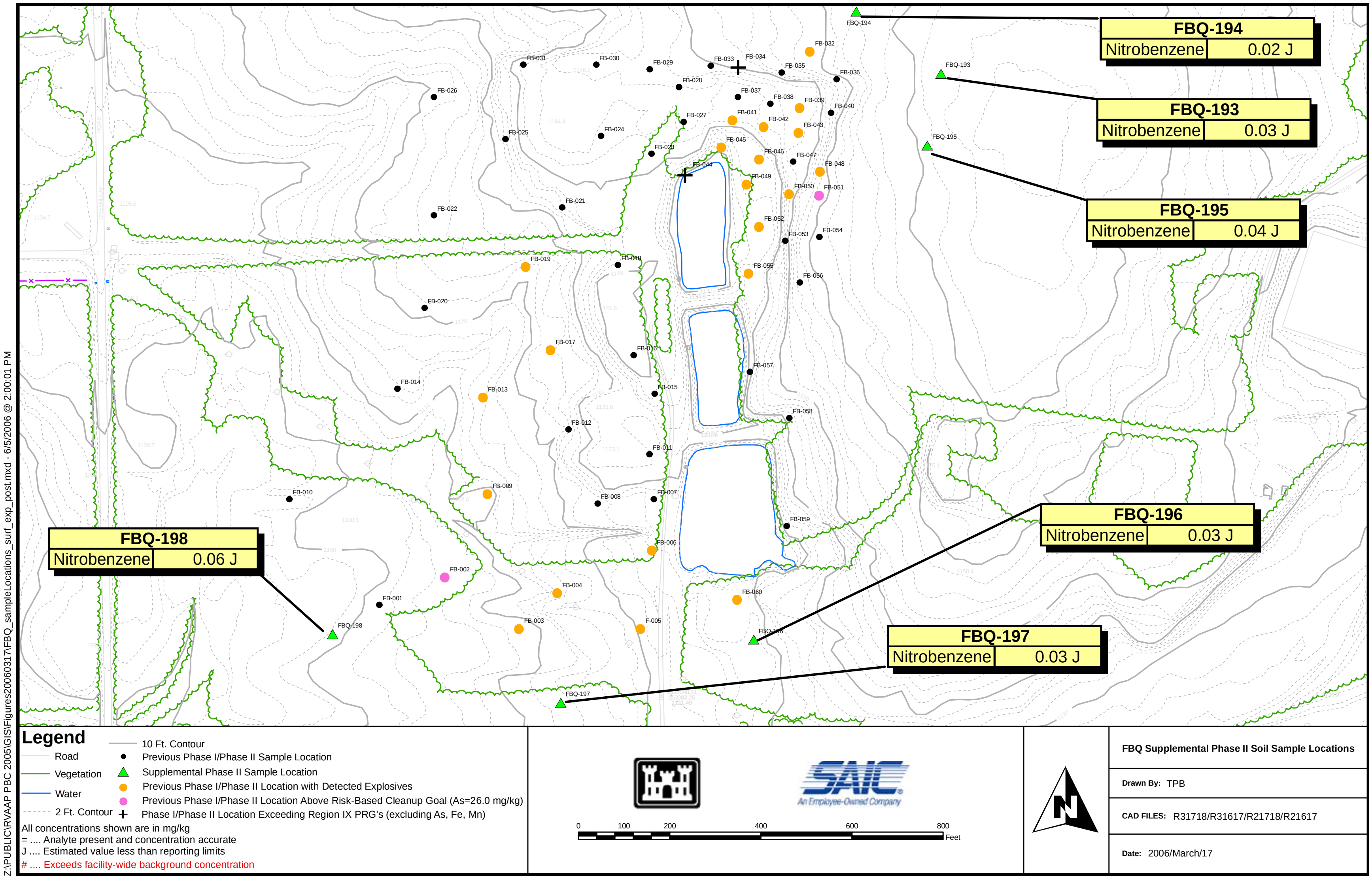

Figure 2B-2. Occurrences of Detected Explosives in Surface Soil (0-1 ft), FBQ Supplemental Phase II RI

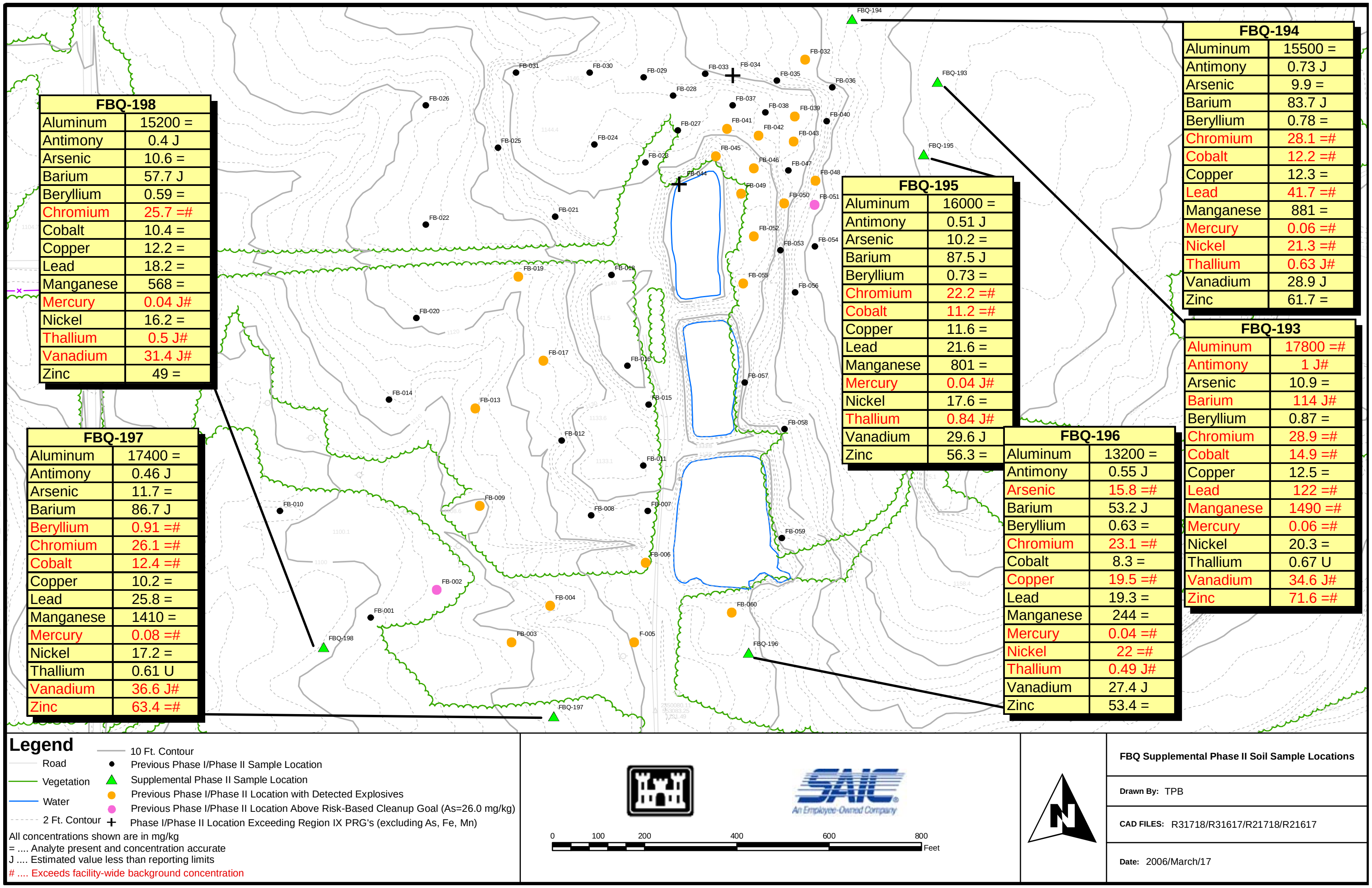

Figure 2B-3. Occurrences of Detected Inorganic SRCs in Surface Soil (0-1 ft), FBQ Supplemental Phase II RI

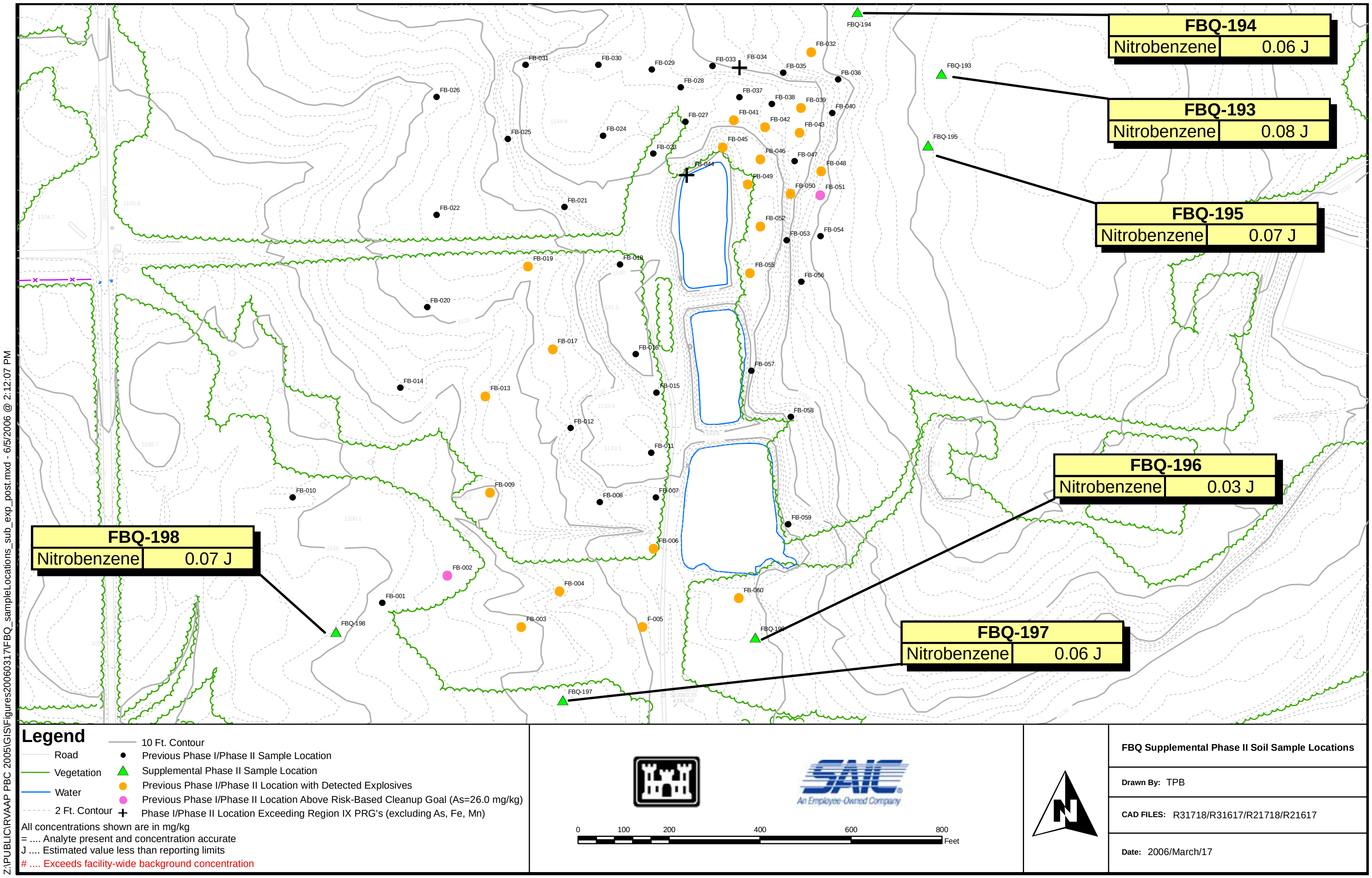

Figure 2B-4. Occurrences of Detected Explosives in Subsurface Soil (1-3 ft), FBQ Supplemental Phase II RI

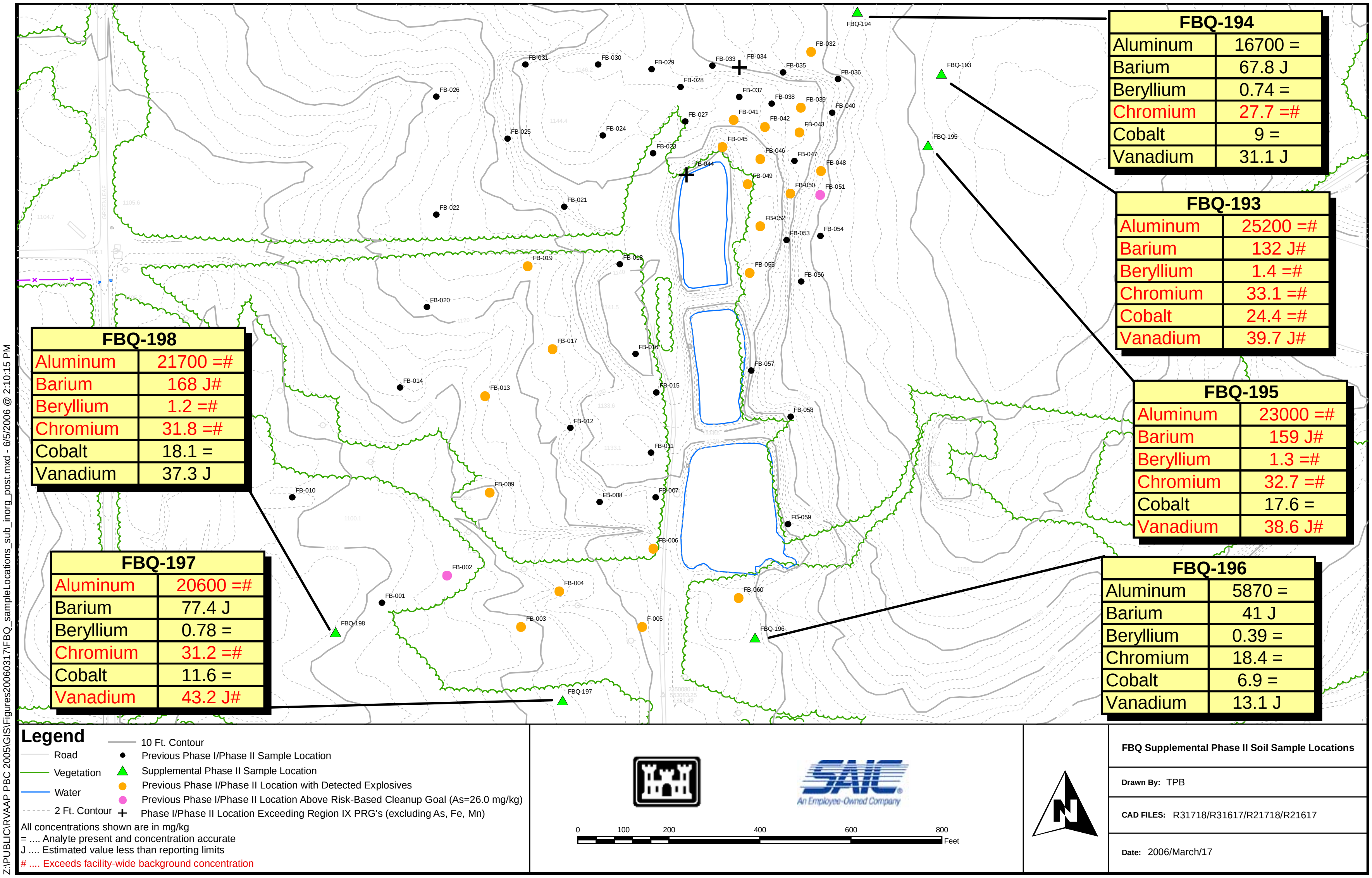

Figure 2B-5. Occurrences of Detected Inorganic SRCs in Subsurface Soil (1-3 ft), FBQ Supplemental Phase II RI

ATTACHMENT A

SOIL SAMPLING LOGS

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ATTACHMENT A
SOIL SAMPLING LOGS

DISCRETE SURFACE AND SUBSURFACE SOIL SAMPLES

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DISCRETE SURFACE AND SUBSURFACE SOIL SAMPLES

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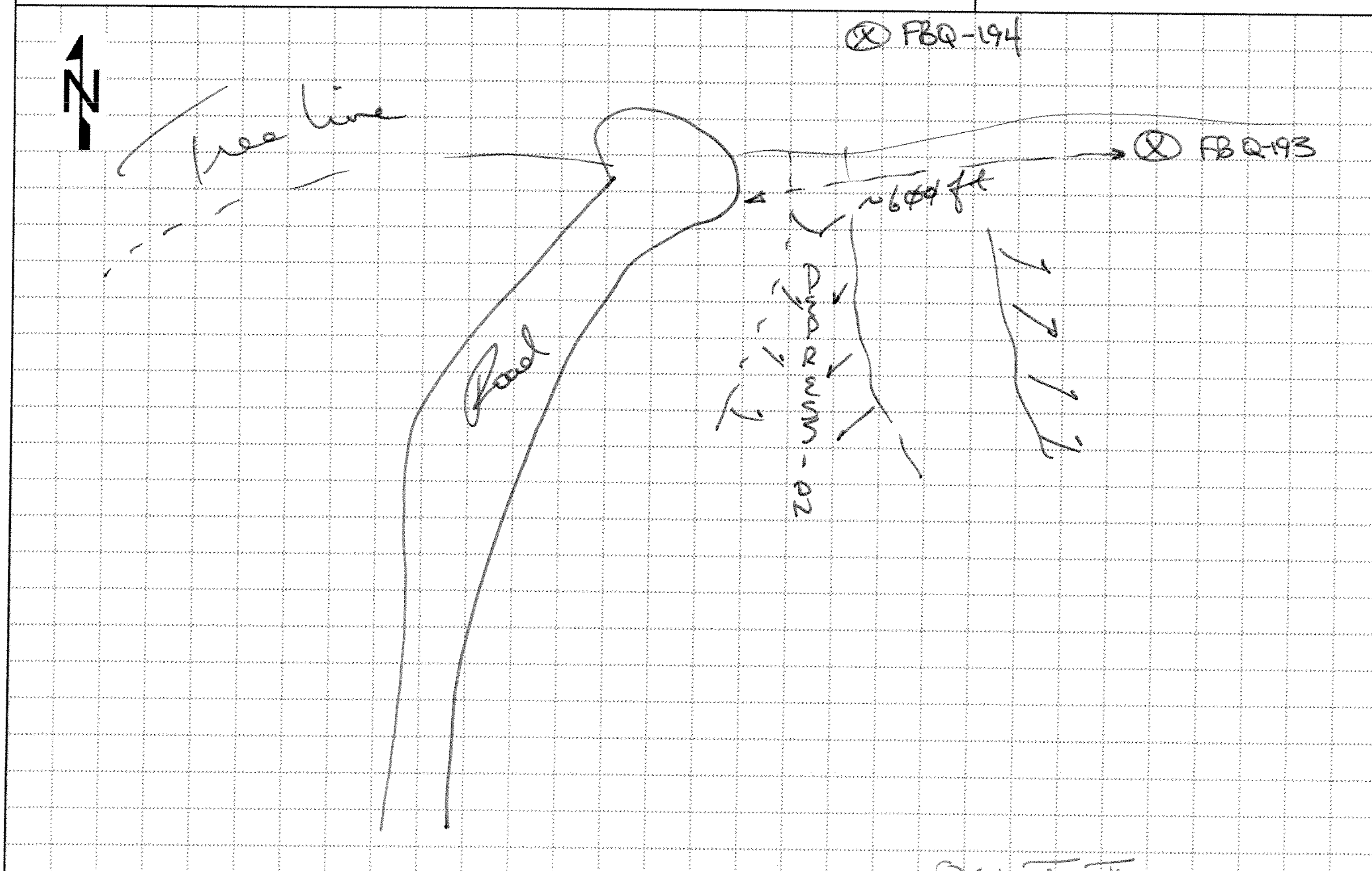
HTRW DRILLING LOG

DISTRICT: USACE - Louisville	BOREHOLE NUMBER: FBQ-193	
1. COMPANY NAME: SAIC	2. DRILL SUBCONTRACTOR: NA	SHEET 1 OF 2
3. PROJECT: Supplemental Phase II at CBP, FBQ, and ODA2	4. LOCATION: RVAAP	
5. NAME OF DRILLER: SAIC - Jed Thomas	6. MAKE/MODEL OF DRILL: na	
7. SIZES AND TYPES OF SAMPLING EQUIPMENT: SS Hand Auger (3-in) SS. Bowl & Spoon BW	8. BOREHOLE LOCATION: Fuse & Booster Quarry	
	9. SURFACE ELEVATION/DATUM: N/A	
	10. DRILL DATE/TIME STARTED: 0825 COMPLETED: 0845	
	15. DEPTH GROUNDWATER ENCOUNTERED: N/A	
12. OVERBURDEN THICKNESS: N/A	16. DEPTH TO WATER/ELAPSED TIME AFTER BOREHOLE COMPLETION: NA	
13. DEPTH DRILLED INTO BEDROCK: N/A	17. OTHER WATER LEVEL MEASUREMENTS (INLCLUDE DATE/TIME): NA	
14. TOTAL DEPTH OF BOREHOLE: 3 ft.		
18. GEOTECHNICAL SAMPLES: N/A UNDISTURBED: — DISTURBED: —	19. TOTAL NUMBER OF CORE BOXES: N/A	
20. CHEMICAL SAMPLES: METALS EXPL OTHER: —	21. TOTAL CORE RECOVERY %: N/A	
22. DISPOSITION OF BOREHOLE: DATE STARTED/INSTALLED: 11/15/05	DATE COMPLETED/ABANDONED: 11/15/05	
BACKFILL TYPE: ☐ GROUT ☒ BENTONITE ☐ TEMPORARY WELL POINT	☐ MONITORING WELL	

LOCATION SKETCH/COMMENTS **SCALE:** None



QC by: Jed Thomas

PROJECT: Supplemental Phase II at CBP, FBQ, and ODA2	INSPECTOR SIGNATURE/DATE: B. Williams 11/15/05	BOREHOLE NUMBER: FBQ-193

HTRW DRILLING LOG (continued)

DISTRICT: USACE - Louisville	BOREHOLE NUMBER: FBQ-193	
1. COMPANY NAME: SAIC	2. DRILL SUBCONTRACTOR: N/A	SHEET 2 OF 2
3. PROJECT: Supplemental Phase II at CBP, FBQ, and ODA2	4. LOCATION: RVAAP	
5. NAME OF DRILLER: SAIC - Jed Thomas	6. DIRECTION OF BOREHOLE: [X] VERTICAL [ ] INCLINED DEGREES	
7. NOTES PID MAKE/MODEL: Perkins Elmer Photovac 2020	PID SERIAL#: ED KR 303	

ELEVATION	DEPTH (0.1 Feet)	USCS	CLASSIFICATION OF MATERIALS	ANALYTICAL SAMPLE NUMBER	MONITORING (PPM)	REMARKS
	0.8 / 1	CL	2.5Y 4/2 dark grayish brown Silt with clay and fine sand; roots; damp; poorly sorted very fine to fine angular stones.	FBQss-193-0500-SO	0.0	BW 11/15/05
	1.0			1.0ft		
	2.0	CL	2.5Y 5/4 light olive brown with 10YR5/8 yellowish brown mottling (20%) fine poorly sorted angular stones - damp.			
	3.0		2.5Y 5/4 light olive brown lean BW stiff clay - damp	FBQso-193-0501-SO	0.1	
			Bottom of borehole			
	4					
	5					
	6					
	7		BW 11/15/05			
	8					
	9					
	10					

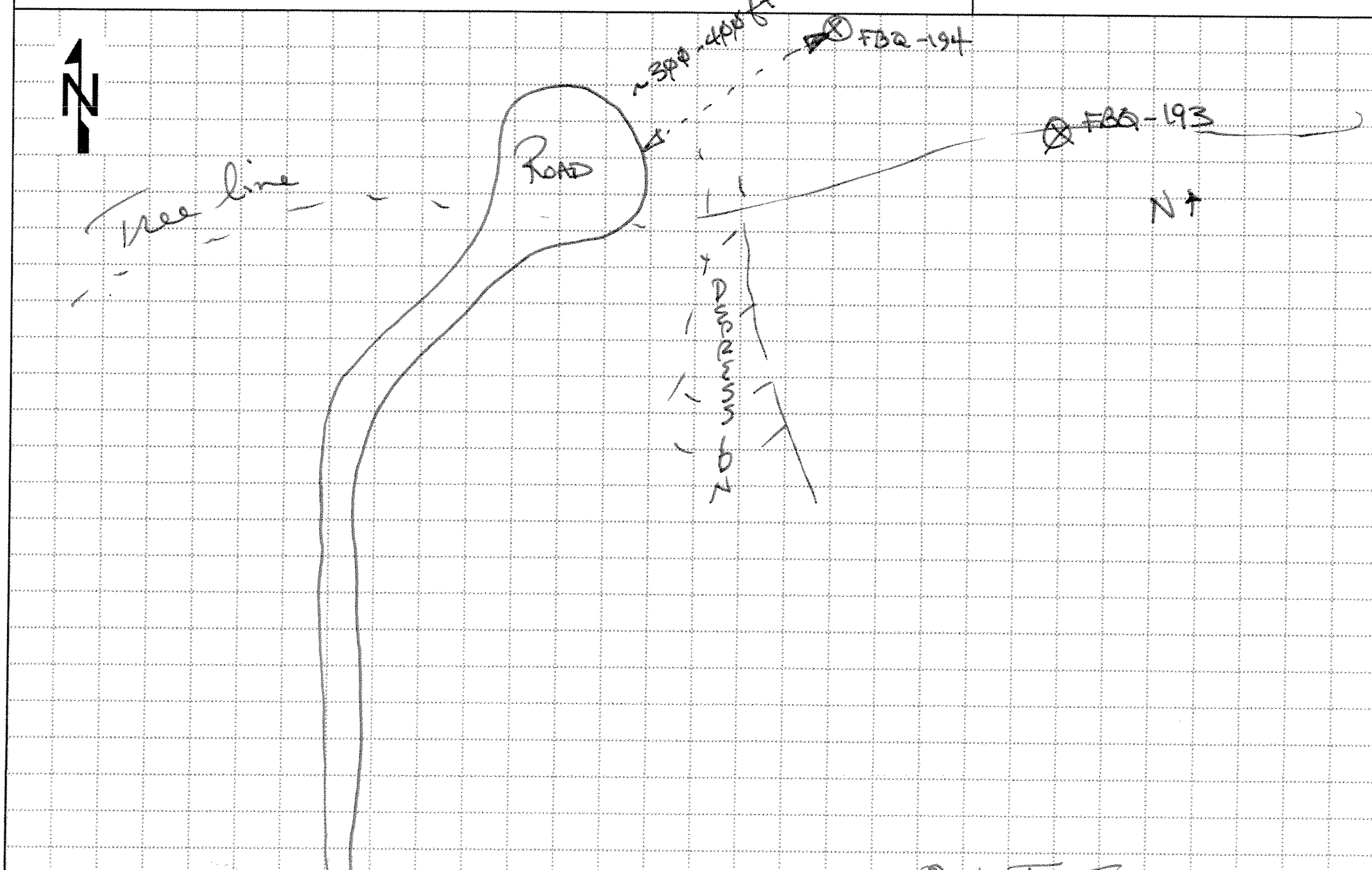
QC by Jed Thomas

PROJECT	INSPECTOR SIGNATURE/DATE	BOREHOLE NUMBER
Supplemental Phase II at CBP, FBQ, and ODA2	B Williams 11/15/05	FBQ-193

HTRW DRILLING LOG

HTRW DRILLING LOG	DISTRICT: USACE - Louisville	BOREHOLE NUMBER: FBQ-194
1. COMPANY NAME: SAIC	2. DRILL SUBCONTRACTOR: NA	SHEET 1 OF 2
3. PROJECT: Supplemental Phase II at CBP, FBQ, and ODA2	4. LOCATION: RVAAP	
5. NAME OF DRILLER: SAIC - Martha Clough	6. MAKE/MODEL OF DRILL: na	
7. SIZES AND TYPES OF SAMPLING EQUIPMENT: SS. Hand Auger (3-in) SS. Bowl and spoon BW	8. BOREHOLE LOCATION: Fuse & Booster Quarry	
	9. SURFACE ELEVATION/DATUM: N/A	
	10. DRILL DATE/TIME STARTED: 0810 COMPLETED: 0830	
	15. DEPTH GROUNDWATER ENCOUNTERED: N/A	
	16. DEPTH TO WATER/ELAPSED TIME AFTER BOREHOLE COMPLETION: NA	
12. OVERBURDEN THICKNESS: N/A		
13. DEPTH DRILLED INTO BEDROCK: N/A	17. OTHER WATER LEVEL MEASUREMENTS (INLCLUDE DATE/TIME): NA	
14. TOTAL DEPTH OF BOREHOLE: 2.3 ft.		
18. GEOTECHNICAL SAMPLES: N/A UNDISTURBED: DISTURBED:	19. TOTAL NUMBER OF CORE BOXES: N/A	
20. CHEMICAL SAMPLES: METALS EXPL OTHER:	21. TOTAL CORE RECOVERY %: N/A	
22. DISPOSITION OF BOREHOLE: DATE STARTED/INSTALLED: 11/15/05	DATE COMPLETED/ABANDONED: 11/15/05	
BACKFILL TYPE: ☐ GROUT ☒ BENTONITE ☐ TEMPORARY WELL POINT ☐ MONITORING WELL		

LOCATION SKETCH/COMMENTS | **SCALE:** None



QC by: [illegible]

PROJECT	INSPECTOR SIGNATURE/DATE	BOREHOLE NUMBER
Supplemental Phase II at CBP, FBQ, and ODA2	B. Williams 11/15/05	FBQ-194

HTRW DRILLING LOG (continued)

HTRW DRILLING LOG (continued)	DISTRICT USACE - Louisville	BOREHOLE NUMBER FBQ-194
1. COMPANY NAME SAIC	2. DRILL SUBCONTRACTOR N/A	SHEET 2 OF 2
3. PROJECT Supplemental Phase II at CBP, FBQ, and ODA2	4. LOCATION RVAAP	
5. NAME OF DRILLER SAIC - Martha Clough	6. DIRECTION OF BOREHOLE X VERTICAL ☐ INCLINED DEGREES	
7. NOTES PID MAKE/MODEL: Perkins Elmer Photovac 2020	PID SERIAL#: ED KR 383	

ELEVATION	DEPTH (0.1 Feet)	USCS	CLASSIFICATION OF MATERIALS	ANALYTICAL SAMPLE NUMBER	MONITORING (PPM)	REMARKS
	0.9 1		2.5Y 3/2 very dark grayish brown. Silt with clay and fine angular sand. Roots. Damp	FBQss-194-0502-SO	0.2	BW
	2 2.3 3	CL	2.5Y 5/3 light olive brown. Lean clay with very fine to fine ~~angular~~ [BW] sand. [BW] Damp. 2% angular to subangular poorly sorted fine to medium Stone.	1.0 FBQso-194-0503-SO	0.2	Refusal (rock at 2.3 ft). BW
	4 5 6 7 8 9 10		Bottom of borehole BW 11/15/05			

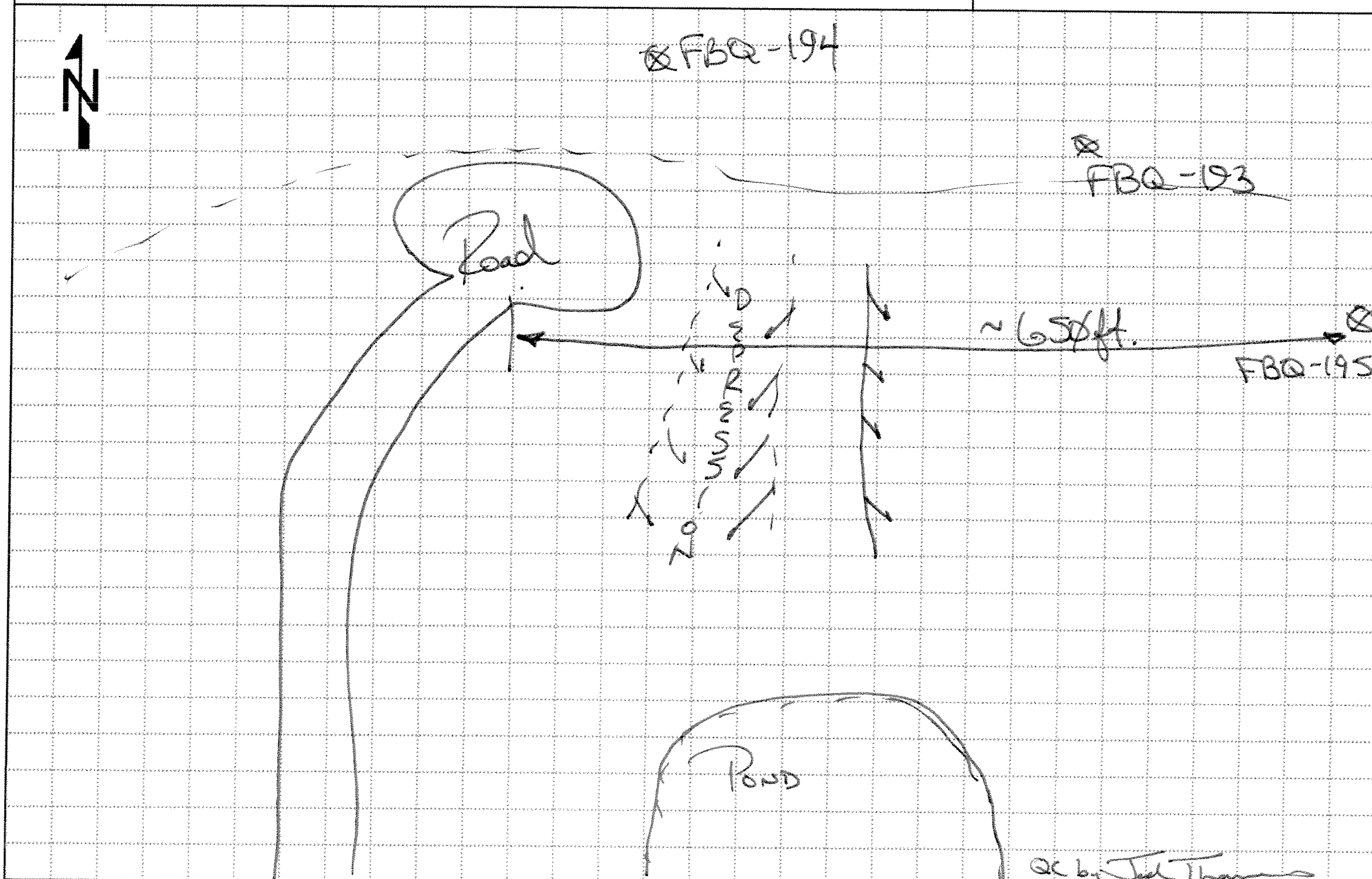
QC by Jed Thomas

PROJECT Supplemental Phase II at CBP, FBQ, and ODA2	INSPECTOR SIGNATURE/DATE B. Williams 11/15/05	BOREHOLE NUMBER FBQ-194

HTRW DRILLING LOG

HTRW DRILLING LOG	DISTRICT USACE - Louisville	BOREHOLE NUMBER FBQ-195
1. COMPANY NAME SAIC	2. DRILL SUBCONTRACTOR NA	SHEET 1 OF 2
3. PROJECT Supplemental Phase II at CBP, FBQ, and ODA2	4. LOCATION RVAAP	
5. NAME OF DRILLER SAIC - Martha Clough	6. MAKE/MODEL OF DRILL na	
7. SIZES AND TYPES OF SAMPLING EQUIPMENT S.S. Hand Auger (3-in) S.S. Bowl & Spoon BW	8. BOREHOLE LOCATION Fuse & Booster Quarry 9. SURFACE ELEVATION/DATUM N/A 10. DRILL DATE/TIME STARTED: 11/15/05 0835 COMPLETED: 11/15/05 0851 15. DEPTH GROUNDWATER ENCOUNTERED N/A 16. DEPTH TO WATER/ELAPSED TIME AFTER BOREHOLE COMPLETION NA	
12. OVERBURDEN THICKNESS N/A		
13. DEPTH DRILLED INTO BEDROCK N/A	17. OTHER WATER LEVEL MEASUREMENTS (INLCLUDE DATE/TIME)	
14. TOTAL DEPTH OF BOREHOLE 2.3 ft.	NA	
18. GEOTECHNICAL SAMPLES N/A UNDISTURBED: — DISTURBED: —	19. TOTAL NUMBER OF CORE BOXES N/A	
20. CHEMICAL SAMPLES METALS EXPL OTHER:	21. TOTAL CORE RECOVERY % N/A	
22. DISPOSITION OF BOREHOLE DATE STARTED/INSTALLED: 11/15/05	DATE COMPLETED/ABANDONED: 11/15/05	
BACKFILL TYPE: ☐ GROUT ☒ BENTONITE	☐ TEMPORARY WELL POINT ☐ MONITORING WELL	

LOCATION SKETCH/COMMENTS **SCALE:** None



QC by Jed Thomas

PROJECT	INSPECTOR SIGNATURE/DATE	BOREHOLE NUMBER
Supplemental Phase II at CBP, FBQ, and ODA2	B. Will 11/15/05	FBQ-195

HTRW DRILLING LOG (continued)

DISTRICT: USACE - Louisville		BOREHOLE NUMBER: FBQ-195
1. COMPANY NAME: SAIC	2. DRILL SUBCONTRACTOR: N/A	SHEET 2 OF 2
3. PROJECT: Supplemental Phase II at CBP, FBQ, and ODA2	4. LOCATION: RVAAP	
5. NAME OF DRILLER: SAIC - Martha Clough	6. DIRECTION OF BOREHOLE: ☒ VERTICAL ☐ INCLINED DEGREES	
7. NOTES PID MAKE/MODEL: Perkins Elmer Photovac 2020	PID SERIAL#: ED KR 303	

ELEVATION	DEPTH (0.1 Feet)	USCS	CLASSIFICATION OF MATERIALS	ANALYTICAL SAMPLE NUMBER	MONITORING (PPM)	REMARKS
	0.4 – 1.0		2.5Y 4/2 dark grayish brown Silt with fine sand. Round well sorted medium quartz stones. - damp (1%)	FBQss-195-0504-SO	0.1	BW
	1.0 – 2.3	CL	2.5Y 6/2 light brownish gray with 10YR 5/8 yellowish brown mottling (15%) Clay (lean) with fine sand; fine angular to subangular stone (3%)	1.0 ft FBQso-195-0505-SO	0.0	Refusal at 2.3 ft.
	3		Bottom of borehole			
	4					
	5					
	6		BW 11/15/05			
	7					
	8					
	9					
	10					

QC by Jed Thomas

PROJECT: Supplemental Phase II at CBP, FBQ, and ODA2	INSPECTOR SIGNATURE/DATE: B. Williams 11/15/05	BOREHOLE NUMBER: FBQ-195

HTRW DRILLING LOG

HTRW DRILLING LOG	DISTRICT USACE - Louisville	BOREHOLE NUMBER FBQ-196
1. COMPANY NAME SAIC	2. DRILL SUBCONTRACTOR NA	SHEET 1 OF 2

3. PROJECT Supplemental Phase II at CBP, FBQ, and ODA2	4. LOCATION RVAAP
5. NAME OF DRILLER SAIC - Martha Clough	6. MAKE/MODEL OF DRILL na BW
7. SIZES AND TYPES OF SAMPLING EQUIPMENT S.S. Hand Auger (3-in) S.S. Bowl & Spoon BW	8. BOREHOLE LOCATION Fuse & (Quarry) Booster 9. SURFACE ELEVATION/DATUM 10. DRILL DATE/TIME STARTED: 0930 COMPLETED: 0955 15. DEPTH GROUNDWATER ENCOUNTERED N/A 16. DEPTH TO WATER/ELAPSED TIME AFTER BOREHOLE COMPLETION NA
12. OVERBURDEN THICKNESS N/A	
13. DEPTH DRILLED INTO BEDROCK N/A	17. OTHER WATER LEVEL MEASUREMENTS (INLCLUDE DATE/TIME) NA
14. TOTAL DEPTH OF BOREHOLE 2.8 ft	

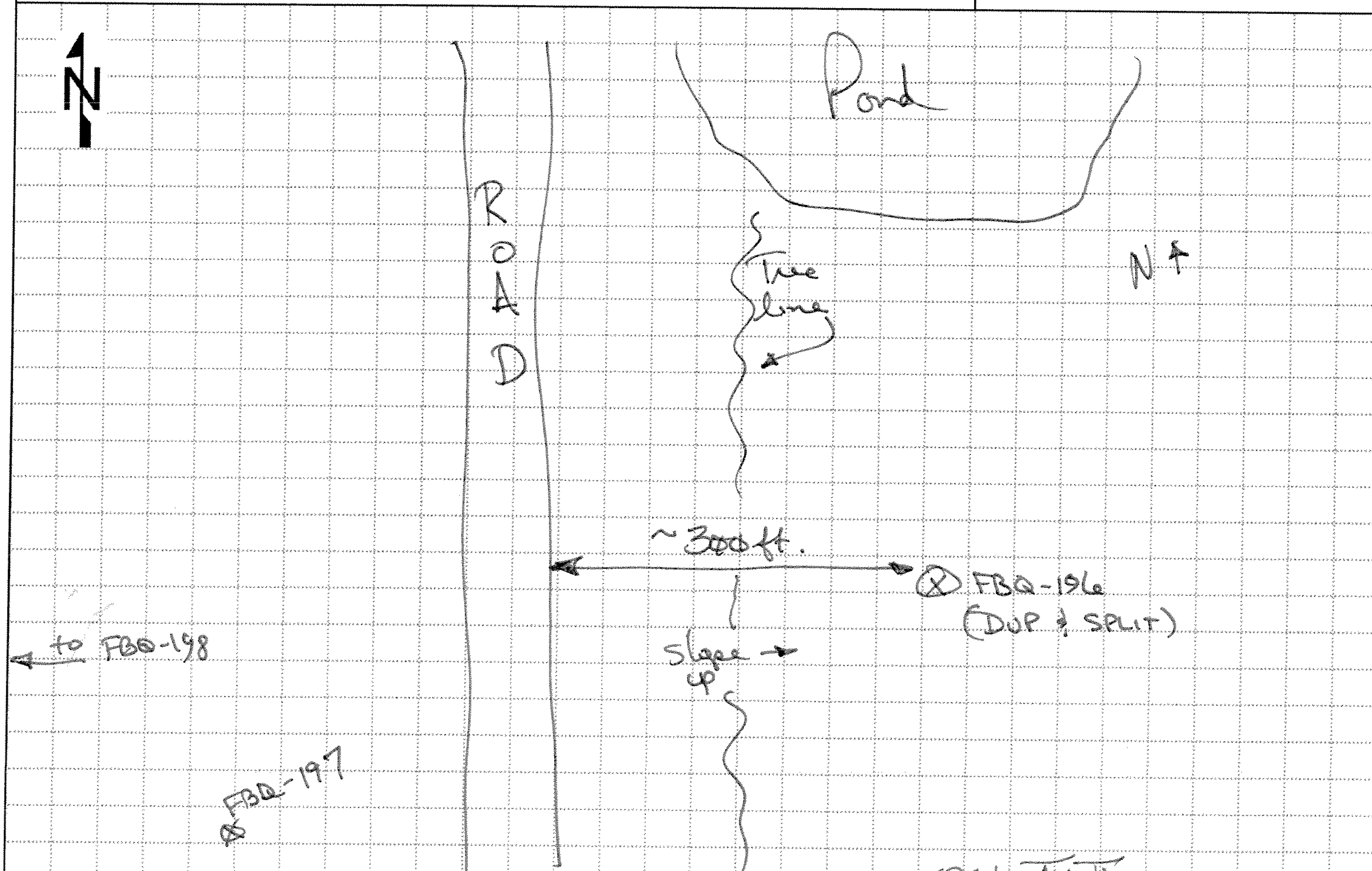
18. GEOTECHNICAL SAMPLES N/A UNDISTURBED: —— DISTURBED: —— | 19. TOTAL NUMBER OF CORE BOXES N/A

20. CHEMICAL SAMPLES METALS EXPL OTHER: —— | 21. TOTAL CORE RECOVERY % N/A

22. DISPOSITION OF BOREHOLE DATE STARTED/INSTALLED: 11/15/05 DATE COMPLETED/ABANDONED: 11/15/05

BACKFILL TYPE: ☐ GROUT ☒ BENTONITE ☐ TEMPORARY WELL POINT ☐ MONITORING WELL

LOCATION SKETCH/COMMENTS **SCALE:** None



QC by [illegible]

PROJECT Supplemental Phase II at CBP, FBQ, and ODA2	INSPECTOR SIGNATURE/DATE B. Williams 11/15/05	BOREHOLE NUMBER FBQ-196

HTRW DRILLING LOG (continued)

HTRW DRILLING LOG (continued)	DISTRICT: USACE - Louisville		BOREHOLE NUMBER: FBQ-196
1. COMPANY NAME: SAIC	2. DRILL SUBCONTRACTOR: N/A		SHEET 2 OF 2
3. PROJECT: Supplemental Phase II at CBP, FBQ, and ODA2	4. LOCATION: RVAAP		
5. NAME OF DRILLER: SAIC - Martha Clough	6. DIRECTION OF BOREHOLE: ☒ VERTICAL ☐ INCLINED		DEGREES
7. NOTES PID MAKE/MODEL: Perkins Elmer Photovac 2020	PID SERIAL#: ED KR 303		

ELEVATION	DEPTH (0.1 Feet)	USCS	CLASSIFICATION OF MATERIALS	ANALYTICAL SAMPLE NUMBER	MONITORING (PPM)	REMARKS
	0.2 – 1.0		2.5Y 2.5/1 black silt with fine to medium sand. Roots. moist. (organic layer); fine subangular stones.	FBQss-196-0506-SO; FBQss-196-0512-SO (DUP.)	0.0	Duplicate
	2.0		2.5Y 5/4 light olive brown sand with clay; fine roots; (course sand) very; medium angular, flat, & subangular stone - moist (poorly sorted - high variety)	FBQss-196-0513-SO (split) 1.0 ft; FBQso-196-0507-SO	0.0	Split; Sand stone Bedrock refusal at 2.8 ft.
	2.8 – 3, 4		2.5Y 5/6 light olive brown fine sand; very fine to fine subangular poorly sorted (variety of size & type stone			
	5		Bedrock Bottom of borehole			
	6					
	7		BW 11/15/05			
	8					
	9					
	10					

QC by Joel Thomas

PROJECT	INSPECTOR SIGNATURE/DATE	BOREHOLE NUMBER
Supplemental Phase II at CBP, FBQ, and ODA2	B. Williams 11/15/05	FBQ-196

HTRW DRILLING LOG

HTRW DRILLING LOG	DISTRICT USACE - Louisville	BOREHOLE NUMBER FBQ-197
1. COMPANY NAME SAIC	2. DRILL SUBCONTRACTOR NA	SHEET 1 OF 2

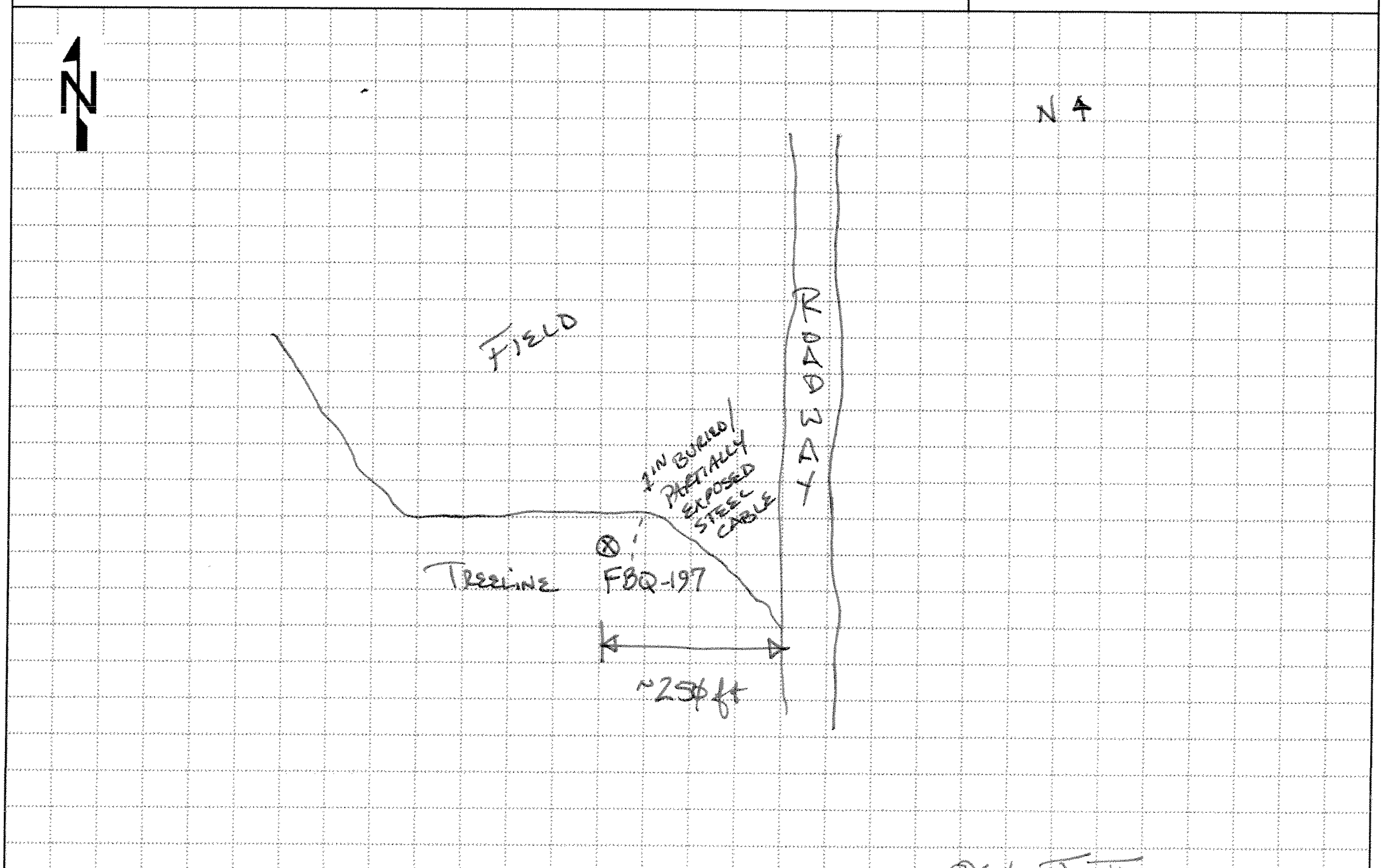
3. PROJECT Supplemental Phase II at CBP, FBQ, and ODA2	4. LOCATION RVAAP
5. NAME OF DRILLER SAIC - Martha Clough	6. MAKE/MODEL OF DRILL na
7. SIZES AND TYPES OF SAMPLING EQUIPMENT S.S. HAND AUGER (3-in) S.S. BOWL & SPOON BW	8. BOREHOLE LOCATION (FBQ-197) Fuse & Booster Quarry BW
	9. SURFACE ELEVATION/DATUM N/A
	10. DRILL DATE/TIME STARTED: 14~~00~~ COMPLETED: ~~1410~~ 1430
	15. DEPTH GROUNDWATER ENCOUNTERED N/A
	16. DEPTH TO WATER/ELAPSED TIME AFTER BOREHOLE COMPLETION NA
12. OVERBURDEN THICKNESS N/A	
13. DEPTH DRILLED INTO BEDROCK N/A	17. OTHER WATER LEVEL MEASUREMENTS (INLCLUDE DATE/TIME) NA
14. TOTAL DEPTH OF BOREHOLE ~~0-1 FT~~ BW 0-3 FT	

18. GEOTECHNICAL SAMPLES N/A UNDISTURBED: ——— DISTURBED: ———	19. TOTAL NUMBER OF CORE BOXES N/A
20. CHEMICAL SAMPLES METALS EXPL OTHER: ———	21. TOTAL CORE RECOVERY % N/A

22. DISPOSITION OF BOREHOLE DATE STARTED/INSTALLED: 11/14/05 DATE COMPLETED/ABANDONED: 11/15/05

BACKFILL TYPE: ☐ GROUT ☒ BENTONITE ☐ TEMPORARY WELL POINT ☐ MONITORING WELL

LOCATION SKETCH/COMMENTS **SCALE:** None



QC by [signature]

PROJECT Supplemental Phase II at CBP, FBQ, and ODA2	INSPECTOR SIGNATURE/DATE B. Williams 11/14/05	BOREHOLE NUMBER FBQ-197

HTRW DRILLING LOG (continued)

HTRW DRILLING LOG (continued)	DISTRICT: USACE - Louisville	BOREHOLE NUMBER: FBQ-197
1. COMPANY NAME: SAIC	2. DRILL SUBCONTRACTOR: N/A	SHEET 2 OF 2
3. PROJECT: Supplemental Phase II at CBP, FBQ, and ODA2	4. LOCATION: RVAAP	
5. NAME OF DRILLER: SAIC	6. DIRECTION OF BOREHOLE: ☒ VERTICAL ☐ INCLINED DEGREES	
7. NOTES: PID MAKE/MODEL: Perkin Elmer Photovac 2020	PID SERIAL#: ED KR 303	

ELEVATION	DEPTH (0.1 Feet)	USCS	CLASSIFICATION OF MATERIALS	ANALYTICAL SAMPLE NUMBER	MONITORING (PPM)	REMARKS
		CL	2.5Y 3/3 Lean Clay with fine sand - damp	FBQss-197-0508-SO	0.0	BW
	0.8 / 1.0	CL	5Y 5/2 with 7.5YR 6/8 mottling (10%) - Lean Clay with silt - damp. Roots. Course Round to subangular poorly sorted stones.			
	2.0					
		CL	5Y 5/2 with 7.5YR 6/8 10% Mottling - Lean Clay with silt - damp; Flat to round poorly sorted stones; mix of granite, Round quartz & flat, angular lime/sandstone.	FBQso-197-0509-SO	0.0	Refusal @ 2.9 ft.
	3.0					
	4.0					
			Bottom of borehole			
	5					
	6					
	7		BW 11/14/05			
	8					
	9					
	10				QC by Ted Thomas	

PROJECT	INSPECTOR SIGNATURE/DATE	BOREHOLE NUMBER
Supplemental Phase II at CBP, FBQ, and ODA2	B. Williams 11/14/05	FBQ-197

HTRW DRILLING LOG

HTRW DRILLING LOG	DISTRICT USACE - Louisville	BOREHOLE NUMBER FBQ-198
1. COMPANY NAME SAIC	2. DRILL SUBCONTRACTOR NA	SHEET 1 OF 2

3. PROJECT Supplemental Phase II at CBP, FBQ, and ODA2	4. LOCATION RVAAP BW
5. NAME OF DRILLER SAIC – Martha Clough	6. MAKE/MODEL OF DRILL na
7. SIZES AND TYPES OF SAMPLING EQUIPMENT SS. HAND AUGER (3-in) SS. BOWL & SPOON BW	8. BOREHOLE LOCATION (FBQ-197) Fuse & Booster Quarry
	9. SURFACE ELEVATION/DATUM N/A BW
	10. DRILL DATE/TIME STARTED: 1445 COMPLETED: ~~1515~~ 1520
	15. DEPTH GROUNDWATER ENCOUNTERED 2.9 FT BW ~~1.8~~ FT IN 1 OF EXPLOSIVES HOLE
	16. DEPTH TO WATER/ELAPSED TIME AFTER BOREHOLE COMPLETION NA
12. OVERBURDEN THICKNESS N/A	
13. DEPTH DRILLED INTO BEDROCK N/A	17. OTHER WATER LEVEL MEASUREMENTS (INLCLUDE DATE/TIME)
14. TOTAL DEPTH OF BOREHOLE 3.0 FT	NA

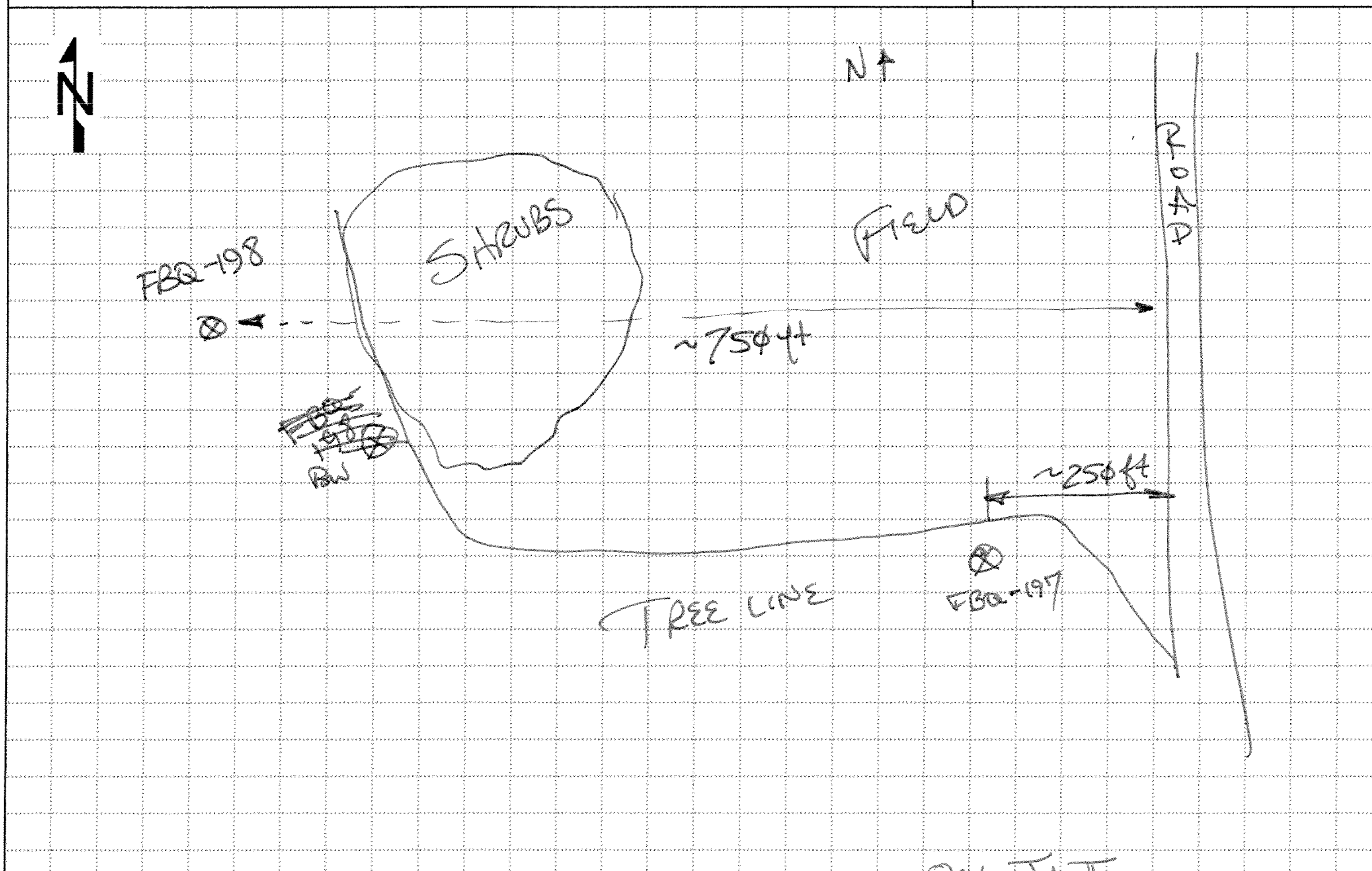
18. GEOTECHNICAL SAMPLES N/A UNDISTURBED: — DISTURBED: — | 19. TOTAL NUMBER OF CORE BOXES N/A

20. CHEMICAL SAMPLES METALS EXPL OTHER: — | 21. TOTAL CORE RECOVERY % N/A

22. DISPOSITION OF BOREHOLE DATE STARTED/INSTALLED: 11/14/05 DATE COMPLETED/ABANDONED: 11/15/05

BACKFILL TYPE: ☐ GROUT ☒ BENTONITE ☐ TEMPORARY WELL POINT ☐ MONITORING WELL

LOCATION SKETCH/COMMENTS **SCALE:** None



QC by

PROJECT Supplemental Phase II at CBP, FBQ, and ODA2	INSPECTOR SIGNATURE/DATE 11/14/05	BOREHOLE NUMBER FBQ-198

HTRW DRILLING LOG (continued)	DISTRICT: USACE - Louisville	BOREHOLE NUMBER: ~~FBH~~ FBQ-198 BW
1. COMPANY NAME: SAIC	2. DRILL SUBCONTRACTOR:	SHEET 2 OF 2
3. PROJECT: Supplemental Phase II at CBP, FBQ, and ODA2	4. LOCATION: RVAAP	
5. NAME OF DRILLER: SAIC - Martha Clough	6. DIRECTION OF BOREHOLE: [X] VERTICAL [ ] INCLINED DEGREES	
7. NOTES: PID MAKE/MODEL: Perkin Elmer - Photovac 2020 BW	PID SERIAL#: ED KR 303	

ELEVATION	DEPTH (0.1 Feet)	USCS	CLASSIFICATION OF MATERIALS	ANALYTICAL SAMPLE NUMBER	MONITORING (PPM)	REMARKS
	0.25	CL	2.5Y 3/3 Dark Olive Brown Lean Clay with fine sand - damp.	FBQss-198-0514-SO	0.0	BW
	1.0	CL	5Y 5/2 olive gray with 7.5 YR 6/8 reddish yellow mottling (10%) Lean clay with course sand, poorly sorted (high variety) very fine angular to round stone, roots	~~FBQso-198-0511-SO~~ BW	0.0	One of the three explosives holes filled with 1-1.5 inches of water. Sketch: NP 
	2	CL				
	3		5Y 5/2 olive gray with 7.5YR 6/8 reddish yellow mottling (10%) - lean clay with course sand	FBQso-198-0511-SO	0.0	BW
	4		2.5Y 6/1 gray with 2.5YR 4/4 olive brown mottling (50%). Lean clay with fine sand, poorly sorted very fine angular stones.	BW	0.0	
	5					
	6		Bottom of borehole			
	7		BW			
	8					
	9					
	10					

QC by [illegible]

PROJECT	INSPECTOR SIGNATURE/DATE	BOREHOLE NUMBER
Supplemental Phase II at CBP, FBQ, and ODA2	B. Wil[illegible] 11/14/05	FBQ-198

ATTACHMENT B

IDW LETTER REPORT

An Employee-Owned Company

Science Applications International Corporation

December 21, 2005

Mr. Paul Zorko
U.S. Army Corps of Engineers, Louisville District
ATTN: CELRL-ED-E
600 Martin Luther King, Jr. Place
P.O. Box 59
Louisville, KY 40202-0059

SUBJECT: **Contract No. GS-10F-0076J Delivery Order W912QR-05-F-0033, Performance-Based Contract for Six Environmental Areas of Concern at Ravenna Army Ammunition Plant (RVAAP), Ravenna, Ohio**

RE: **DRAFT Investigation Derived Waste (IDW) Characterization and Disposal Report for Soil Cuttings and Decontamination Fluids**

Dear Mr. Zorko:

Investigation activities conducted during November 2005 for the Supplemental Phase II Remedial Investigation (RI) at RVAAP-04 Open Demolition Area #2 (ODA2); RVAAP-16 Fuze and Booster Quarry Landfill/Ponds (FBQ); and RVAAP-49 Central Burn Pits (CBP) at RVAAP resulted in the generation of IDW consisting of soil and decontamination fluids. The purpose of this letter report is to summarize characterization and classification information to assist in determining the proper disposition of IDW consisting of soil cuttings (contained in 2 open-topped 55 gallon drums) and decon fluids from small tool decontamination (contained in 1 close-topped 55 gallon drum).

This letter report includes a summary of IDW generated, its origin (Table 1), as well as classification and recommendations for disposal of the IDW (Table 2). This letter report follows guidance established by the Facility-Wide Sampling and Analysis Plan (SAP) (USACE 2001), the SAP Addendum No. 1 for the Supplemental Phase II RI of ODA2, FBQ, and CBP (November 2005), and Ohio EPA (November 1997) regarding IDW disposition at RVAAP.

Table 1. Summary of Supplemental Phase II RI IDW

CONTAINER NUMBER	CONTAINER TYPE AND SIZE	CONTENTS	GENERATION DATES	SAMPLE ID
DECON-01	55- Gallon Closed Top Drum	Deon Fluids From Small Tool Decon	11/15/2005-11/21/2005	CBP0133
SOIL-01	55-Gallon Open Top Drum	Soil Cuttings	11/15/2005-11/18/2005	CBP0134
SOIL-02	55-Gallon Open Top Drum	Soil Cuttings	11/21/2005	

IDW – WATER:

Per Section 7 of the Facility-Wide SAP, non-indigenous IDW is characterized for disposal on the basis of composite samples collected from waste stream storage containers. A composite waste sample was collected and submitted for laboratory analysis to characterize the waste stream for disposal. One liquid composite sample was collected, CBP0133 (composite of decontamination fluids). Upon receipt of analytical results from the laboratory, the analytical results were reviewed to determine if the waste is potentially hazardous. This review consisted of a comparison of the analytical results against toxicity characteristic leaching procedure (TCLP) criteria presented in Table 7-1, Maximum Concentration of Contaminants for the Toxicity Characteristic (40 CFR 261.24) presented in the Facility-Wide SAP (USACE 2001).

Attachment 1 presents the analytical laboratory data for TCLP analysis for IDW water (CBP0133) generated during the November 2005 sampling event. All analytical results were below quantitation limits (BQL). The waste is considered non-hazardous, contaminated wastewater.

IDW – SOILS:

Per Section 7 of the Facility-Wide SAP, indigenous IDW contained in 55-gallon open-topped drums are characterized for disposal on the basis of composite samples collected and submitted for laboratory analysis of full TCLP. One composite sample was collected from the two 55-gallon drums of soil cuttings generated during this reporting period. Upon receipt of analytical results from the laboratory, the analytical results were reviewed to determine if any potentially hazardous waste exist. This review consisted of a comparison of the analytical results against the TCLP criteria presented in Table 7-1, Maximum Concentration of Contaminants for the Toxicity Characteristic (40 CFR 261.24) presented in the Facility-Wide SAP (USACE 2001).

Attachment 1 presents the analytical laboratory data for TCLP analysis for IDW soil cuttings (CBP0134) generated during the November 2005 sampling event. All analytical results were below quantitation limits (BQL). The waste is considered non-hazardous, contaminated solid waste.

Table 2 presents the disposal option identified as a result of these data. Disposal at a permitted solid waste or water treatment facility is recommended for all IDW wastes generated during the November 2005 sampling activities.

Table 2. Summary of Final Waste Classification and Recommended Disposal Options

NON-HAZARDOUS, CONTAMINATED WASTE			
Container Number	**Medium**	**Waste Criterion**	**Disposal Recommendation**
DECON-01	Water	Inorganics, organics	Permitted Wastewater Treatment Facility or Permitted Solid Waste Facility
SOIL-01	Soils	Inorganics, organics	Permitted Wastewater Treatment Facility or Permitted Solid Waste Facility
SOIL-02	Soils	Inorganics, organics	Permitted Wastewater Treatment Facility or Permitted Solid Waste Facility

Please note the IDW addressed in this letter report has been characterized under provisions of the Facility-Wide SAP and SAP Addendum No. 1 using TCLP analyses and process knowledge. Unless RVAAP has additional information that would result in the IDW meeting, or containing materials that meet, the definition of a listed hazardous waste as defined in 40 CFR Part 261 Subpart D, it is recommended that the IDW, as presently characterized, be disposed as summarized in Table 2.

Since RVAAP, under RCRA, is the generator of this material, SAIC requests concurrence or direction on the waste classification prior to disposal to ensure materials are properly disposed. Following your direction and immediate approval, we will proceed with appropriate waste disposal.

If you have any questions, or require additional information, please do not hesitate to contact me at (330) 405-5804.

Sincerely,

SCIENCE APPLICATIONS INTERNATIONAL CORPORATION

Martha Clough
Project IDW Coordinator

cc: Glen Beckham, USACE
Todd Fisher, Ohio EPA DERR
JoAnn Watson, USAEC
Irv Venger, RVAAP
Kevin Jago, SAIC
SAIC Project Files
SAIC CRF

Attachment 1
Analytical IDW Data

Analysis Type	Chemical	Units	Reporting Limit (mg/L)	TCLP Criteria (mg/L)	Results	
					CBP0134 (Soils)	CBP0133 (Water)
Semi-Volatile Organics	1,4-Dichlorobenzene	µg/L	0.05	7.50	BQL	BQL
Semi-Volatile Organics	2,4,5-Trichlorophenol	µg/L	0.05	400.00	BQL	BQL
Semi-Volatile Organics	2,4,6-Trichlorophenol	µg/L	0.05	2.00	BQL	BQL
Semi-Volatile Organics	2,4-Dinitrotoluene	µg/L	0.05	0.13	BQL	BQL
Semi-Volatile Organics	2-methylphenol	µg/L	0.05		BQL	BQL
Semi-Volatile Organics	3 & 4-Methylphenol	µg/L	0.05		BQL	BQL
Semi-Volatile Organics	Hexachlorobenzene	µg/L	0.05	0.13	BQL	BQL
Semi-Volatile Organics	Hexachlorobutadiene	µg/L	0.05	0.50	BQL	BQL
Semi-Volatile Organics	Hexachloroethane	µg/L	0.05	3.00	BQL	BQL
Semi-Volatile Organics	Nitrobenzene	µg/L	0.05	2.00	BQL	BQL
Semi-Volatile Organics	Pentachlorophenol	µg/L	0.1	100.00	BQL	BQL
Semi-Volatile Organics	Pyidine	µg/L	0.05	5.00	BQL	BQL
TCLP Metals	Arsenic	µg/L	0.2	5.00	BQL	BQL
TCLP Metals	Barium	µg/L	1	100.00	BQL	BQL
TCLP Metals	Cadmium	µg/L	0.06	1.00	BQL	BQL
TCLP Metals	Chromium	µg/L	0.05	5.00	BQL	BQL
TCLP Metals	Lead	µg/L	0.1	5.00	BQL	BQL
TCLP Metals	Mercury	µg/L	0.002	0.20	BQL	BQL
TCLP Metals	Selenium	µg/L	0.2	1.00	BQL	BQL
TCLP Metals	Silver	µg/L	0.05	5.00	BQL	BQL
TCLP Herbicides	2,4,5-TP (Silvex)	µg/L	0.005	1.00	BQL	BQL
TCLP Herbicides	2,4-D	µg/L	0.005	10.00	BQL	BQL
TCLP Pesticides and/or PCBs	Chlordane	µg/L	0.005	0.03	BQL	BQL
TCLP Pesticides and/or PCBs	Endrin	µg/L	0.00025	0.02	BQL	BQL
TCLP Pesticides and/or PCBs	Gamma-BHC (Lindane)	µg/L	0.00025	0.40	BQL	BQL
TCLP Pesticides and/or PCBs	Heptachlor	µg/L	0.00025	0.01	BQL	BQL
TCLP Pesticides and/or PCBs	Heptachlor Epoxide	µg/L	0.00025	0.01	BQL	BQL
TCLP Pesticides and/or PCBs	Methoxychlor	µg/L	0.00025	10.00	BQL	BQL
TCLP Pesticides and/or PCBs	Toxaphene	µg/L	0.005	0.50	BQL	BQL
Semi-Volatile Organics	1,1-Dichloroethene	µg/L	0.1		BQL	BQL
Semi-Volatile Organics	1,2-Dichloroethane	µg/L	0.1	0.50	BQL	BQL
Semi-Volatile Organics	1,4-Dichlorobenzene	µg/L	0.1	7.50	BQL	BQL
Semi-Volatile Organics	2-Butanone	µg/L	0.1		BQL	BQL
Semi-Volatile Organics	Benzene	µg/L	0.1	0.50	BQL	BQL
Semi-Volatile Organics	Carbon Tetrachloride	µg/L	0.1	0.50	BQL	BQL
Semi-Volatile Organics	Chlorobenzene	µg/L	0.1	100.00	BQL	BQL
Semi-Volatile Organics	Chloroform	µg/L	0.1	6.00	BQL	BQL
Semi-Volatile Organics	Tetrachloroethylene	µg/L	0.1	0.70	BQL	BQL
Semi-Volatile Organics	Trichloroethene	µg/L	0.1	0.50	BQL	BQL
Semi-Volatile Organics	Vinyl Chloride	µg/L	0.1	0.20	BQL	BQL

BQL - below quantitation limits

TCLP - toxicity characteristic leaching procedure

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ONYX

ENVIRONMENTAL SERVICES

Please type or print in block letters. (Form designed for use on elite (12-pitch) typewriter.)

NH040

NON-HAZARDOUS WASTE MANIFEST

1. Generator's US EPA ID No. OH5210020736 Manifest Document No. 601
2. Page 1 of 1

A. Non-hazardous Manifest Document Number Z 178520

3. Generator's Name and Mailing Address
RAVENNA ARMY AMMO PLANT
8451 SATE RT 5
RAVENNA, OH 44266

4. Generator's Phone (330) 405-5804

B. State Generator's ID SAME

5. Transporter 1 Company Name HAZMAT ENVIRONMENTAL GROUP INC
6. US EPA ID Number NYD980769947

C. State Trans. ID 1241 B7NY
D. Transporter's Phone (716) 827-7200

7. Transporter 2 Company Name
8. US EPA ID Number

E. State Trans. ID
F. Transporter's Phone ( )

9. Designated Facility Name and Site Address
ONYX ENVIRONMENTAL SVCS,L.L.C.
4301 INFIRMARY ROAD
WEST CARROLLTON, OH 45449

10. US EPA ID Number OHD093945293

G. State Facility's ID
H. Facility's Phone (937) 859-6101

11. US DOT Description (Including Proper Shipping Name, Hazard Class, and ID Number) HM		12. Containers No.	Type	13. Total Quantity	14. Unit Wt/Vol	I. Waste No.
a.	NON RCRA AND DOT NON REGULATED LIQUID, NONE, NONE	004	DM	01600	P	NONE
b.	NON RCRA AND DOT NON REGULATED SOLID, NONE, NONE	002	DM	00800	P	NONE
c.						
d.						

J. Additional Descriptions for Materials Listed Above
a. L/- 236022//NON HAZ WATER
b. S/- 236023//NON HAZ SOIL
c.
d.

K. Handling Codes for Wastes Listed Above
a.
b.
c.
d.

15. Special Handling Instructions and Additional Information
PACKING SLIPS ATTACHED FOR CLARIFICATION - EMERGENCY NUMBER-INFOTRAC: 1-800-535-5053

16. **GENERATOR'S CERTIFICATION:** I hereby declare that the contents of this consignment are fully and accurately described above by the proper shipping name, and are classified, packaged, marked and labelled/placarded, and are in all respects in proper condition for transport according to applicable international and national governmental regulations.

I hereby certify that the above-named material is not hazardous waste as defined by 40 CFR Part 261 or any applicable state law.

Printed/Typed Name: Irv Venger
Signature: Irv Venger
Month Day Year: 02 23 06

17. Transporter 1 Acknowledgement of Receipt of Materials
Printed/Typed Name: Darrell Ferguson
Signature: Darrell Ferguson
Month Day Year: 02 23 06

18. Transporter 2 Acknowledgement of Receipt of Materials
Printed/Typed Name
Signature
Month Day Year

19. Discrepancy Indication Space

20. Facility Owner or Operator: Certification of receipt of non-hazardous materials covered by this manifest except as noted in Item 19.
Printed/Typed Name
Signature
Month Day Year

1-GENERATOR COPY

SIGNATURE AND INFORMATION *MUST* BE LEGIBLE ON ALL COPIES

ATTACHMENT C

PROJECT QUALITY ASSURANCE SUMMARY

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TABLE OF CONTENTS

ACRONYMS

CQC	contractor quality control
FBQ	Fuze and Booster Quarry Landfill/Ponds
FCO	field change order
GPL	GPL Laboratories, Inc.
M&TE	materials and testing equipment
NCR	Nonconformance Report
QA	quality assurance
QC	quality control
RI	remedial investigation
RVAAP	Ravenna Army Ammunition Plant
SAIC	Science Applications International Corporation
SAP	sampling and analysis plan
SOW	Statement of Work
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency

C.0 PROJECT QUALITY CONTROL SUMMARY REPORT

This attachment presents the actions and methodologies undertaken to meet the quality assurance/quality control (QA/QC) goals for the Supplemental Phase II remedial investigation (RI) at Fuze and Booster Quarry Ponds/Landfills (FBQ) at the Ravenna Army Ammunition Plant (RVAAP). These goals were established in the *Facility-wide Sampling and Analysis Plan (SAP) for the Ravenna Army Ammunition Plant* (USACE 2001) and the *Sampling and Analysis Plan Addendum No. 1 for the Supplemental Phase II Remedial Investigation* (USACE 2005). The field investigation was conducted under one mobilization; this attachment addresses QA/QC goals for the entire project. These goals were implemented through project-specific procedures and requirements, the Science Applications International Corporation (SAIC) QA Program, and the United States Army Corps of Engineers (USACE), Louisville District QA requirements. A large portion of project QA was focused on field and analytical laboratory activities and project administration.

C.1 FIELD QUALITY ASSURANCE

C.1.1 Readiness Review

Field QA was initiated for the Supplemental Phase II RI in the readiness review held at the SAIC Twinsburg, Ohio office on November 10, 2005. The purpose of the readiness review was to ensure that

- project documents and procedures were approved, controlled, and properly distributed;
- assigned personnel were trained or a schedule was established to conduct training;
- mobilization and site logistics were established;
- laboratories were ready to accept samples;
- subcontractors were ready to begin work; and
- QA systems were implemented.

All elements of the readiness review were completed prior to initiating field activities and were approved by the SAIC QA/QC Officer. Readiness review and project kickoff checklists provide documentation of this QA element and are maintained in the project file.

C.1.2 Procedures

Standard operating methods for field activities performed during the Supplemental Phase II RI are incorporated into the governing documents for the project. The facility-wide sampling and analysis plan (SAP) (USACE 2001) describes the overall approach and methodologies to be used for projects at RVAAP, and the *Supplemental Phase II RI SAP Addendum* (USACE 2005) details project-specific requirements for field implementation. These documents were reviewed by USACE, Louisville District and by the Ohio Environmental Protection Agency prior to implementation. Clarifications and/or planned deviations from these methods were documented as field change orders (FCOs), and variances were documented as Nonconformance Reports (NCRs). Copies of the FCOs issued during the Phase I RI are attached to this attachment.

C.1.3 Training

Field team personnel were trained in all procedures applicable to their assigned tasks. Training was accomplished through a combination of classroom lectures, reading assignments, and on-the-job training.

Surveillance performed by the project SAIC contractor quality control (CQC) representative provided assessments of worker proficiency and training effectiveness.

Copies of training records and surveillance reports were maintained in the project file. Copies of training records required for Occupational Safety and Health Administration and United States Department of Transportation compliance also were maintained in the field.

C.1.4 Equipment Calibration

Various types of measuring and testing equipment (M&TE) were used during the field investigation. All M&TE was categorized, assigned unique identifiers, and listed in an inventory in the M&TE logbook. Last and next calibration recall dates were also recorded. As appropriate, instruments were calibrated daily according to the manufacturer's instructions. Only equipment and standards having verifiable traceability to nationally recognized standards were used for calibration. Daily calibration activities and results were recorded in the M&TE logbook, as well as source information for all calibration standards and reagents.

C.1.5 Quality Control Samples

Field QC samples collected included equipment rinsate blanks, source water, and field duplicates. Field QA splits were collected as specified in the *Supplemental Phase II RI SAP Addendum* (USACE 2005) pertaining to CQC. Implementation of the CQC program in the field was done by the SAIC CQC representative. Attachment D presents an evaluation of data quality and analytical performance with respect to field QC results. Field QC data and analyses of QC samples are presented in Attachment E.

C.1.6 Field Records

Field data, observations, activities, and information were recorded on standardized field sheets and in bound field logbooks. The use of standardized field sheets ensured that all necessary data were entered consistently. Logbook entries were checked for accuracy and completeness by independent reviewers. Other field records, which were collected and likewise maintained, included equipment/material certifications, boring logs, and air-bill forms.

C.2 ANALYTICAL LABORATORY QUALITY ASSURANCE

SAIC subcontracted GPL Laboratories, Inc. (GPL) to perform chemical analysis of samples collected during the Supplemental Phase II RI. The selected laboratory is certified by the USACE, Missouri River Division, Mandatory Center of Expertise in Omaha, Nebraska. In addition, this laboratory was technically audited by SAIC prior to contract award. QA split samples were collected and submitted to an independent USACE QA laboratory, Severn Trent Laboratories, Inc., located in North Canton, Ohio.

C.2.1 Readiness Review

Laboratory QA/QC activities were initiated during the readiness review. The readiness review ensured that (1) governing documents and approved analytical methods were controlled and properly distributed, (2) the laboratory was scheduled and ready to conduct the analysis, (3) logistical coordination was established between the laboratory and the field team, and (4) laboratory QA programs were consistent and compatible with the project requirements.

C.2.2 Procedures

Prior to initiation of analytical support for the Supplemental Phase II RI, GPL and SAIC reviewed and negotiated a contract based on a comprehensive laboratory Statement of Work (SOW). The laboratory SOW detailed project-specific requirements, including the parameters to be measured, analytical methods, adherence to United States Environmental Protection Agency (USEPA) SW-846 protocols, project quantitation goals (sensitivity), and data deliverables requirements. All laboratory comments and questions were resolved before analytical work proceeded.

C.2.3 Laboratory Quality Control

To document laboratory data quality and to measure the quality of the analytical process, laboratory QC samples and data verification/validation were employed. The results of laboratory QC are discussed in the project QC Summary Report (Attachment D). Analytical results of laboratory QC samples are included in the project file and form the basis of the data verification and evaluation process (Section C.2.5).

C.2.4 Laboratory Documentation

GPL maintains comprehensive information regarding the entire analytical process. The laboratory delivered summary data packages and electronic deliverables consistent with those identified in the USEPA SW-846 protocol to SAIC for validation and verification. Laboratory QC sample analyses were cross-referenced to the appropriate environmental field sample analyses in the laboratory deliverables.

C.2.5 Data Verification/Validation

Analytical data generated during this project were subjected to a rigorous process of data verification by SAIC. For verification of data, criteria were established against which the analytical results were compared and from which a judgment was rendered regarding the acceptability and qualification of the data (Attachment D). Upon receipt of data packages from each laboratory, the information was subjected to a systematic examination following standardized checklists and procedures to ensure content, presentation, administrative validity, and technical validity. Routine data changes were documented through data change forms. Data deficiencies or formal laboratory-related nonconformances were documented through an NCR process, as required.

C.3 QUALITY ASSURANCE DOCUMENTATION

Primary methods for documenting QA during the Supplemental Phase II RI include the completion of FCOs requiring USACE concurrence and NCRs generated in accordance with SAIC QA procedures. Copies of FCOs completed during the investigation are included in this attachment. Copies of NCRs are on record in the SAIC RVAAP project file.

C.3.1 Field Change Control

The FCOs were completed during the RI to request and document the rationale and approval for any departures from protocols specified in the approved Facility-Wide SAP and the Supplemental Phase II RI SAP Addendum. Field changes provide clarification to the scope or refinement in the procedural approach to a specific field activity. All FCOs were reviewed and approved by designated technical representatives of USACE, Louisville District prior to implementation. None of the FCOs resulted in an adverse impact to project quality, schedule, or scope. Copies of the approved FCOs are included in this attachment. The following FCO was implemented during the Supplemental Phase I RI activities:

- FCO No. RVAAPPBC-001 documented the correction of sample ID numbers.

C.3.2 Nonconformance Reports

To identify and correct conditions adverse to quality, as described in the field and laboratory QA plans, NCRs and associated corrective action reports were completed, as necessary. No NCRs were identified throughout the duration of the project.

C.4 REFERENCES

USACE 2001. *Facility-wide Sampling and Analysis Plan (SAP) for the Ravenna Army Ammunition Plant, Ravenna, Ohio,* DACA62-00-D-0001, DO CY 02, March 2001.

USACE 2005. *Sampling and Analysis Plan Addendum No. 1 for Supplemental Phase II Remedial Investigation of ODA2, FBQ, and CBP*. November 2005.

FIELD CHANGE ORDERS

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Field Change Request (FCR)

FCR NO. RVAAPPBC-001 DATE INITIATED 12/22/2005

PROJECT Supplemental Phase II RI at ODA2, FBQ, and CBP

CONTRACT NO. GS-10F-0076J Delivery Order No. W912QR-05-F-00

REQUESTOR IDENTIFICATION

NAME Martha Clough ORGANIZATION SAIC, Division 1700 PHONE (330)405-5804

TITLE Field Manager SIGNATURE ______

BASELINE IDENTIFICATION

BASELINE(S) AFFECTED ☐ Cost ☐ Scope ☐ Milestone ☒ Method of Accomplishment

AFFECTED DOCUMENT (TITLE, NUMBER AND SECTION)
Final Sampling and Analysis Plan Addendum No.1, Supplemental Phase II RIs, Table 5-1
DESCRIPTION OF CHANGE: Station and Sample IDs presented in Table 5-1, Baseline Sample Identification for the Supplemental Phase II RI for FBQ were changed prior to implementing field activities based on review of the database. The Sample IDs FBQ-180 through FBQ-185 were changed to FBQ-193 through FBQ-198.

JUSTIFICATION: Facility-Wide SAP for RVAAP requires sequential sample IDs for an AOC. Sample IDs FBQ-180 through FBQ-185 were used previously.

IMPACT OF NOT IMPLEMENTING REQUEST: Repeat use of FBQ Sample IDs

PARTICIPANTS AFFECTED BY IMPLEMENTING REQUEST: Field Samplers, Database Administrator

COST ESTIMATE ($) 0 ESTIMATOR SIGNATURE NA

PHONE __ DATE __

PREVIOUS FCR AFFECTED ☐ YES ☒ NO; IF YES, FCR NO. __

SAIC PROJECT MANAGER: ______ ______

W. Kevin Jago

DATE: 12/22/05

CLIENT PROJECT MANAGER: ______ ______

DATE:

SAIC H&S MANGER SIGNATURE (IF APPLICABLE): NA ______
DATE: NA

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ATTACHMENT D

DATA QUALITY CONTROL SUMMARY REPORT

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TABLE OF CONTENTS

LIST OF TABLES

ACRONYMS

ADR	Automated Data Review
AOC	area of concern
CBP	Central Burn Pits
DQA	data quality assessment
DQCR	Data Quality Control Report
DQO	data quality objective
FBQ	Fuze and Booster Quarry Landfill/Ponds
GPL	GPL Laboratories, Inc.
LCS	laboratory control sample
MDL	method detection level
MPR	monthly progress report
MS	matrix spike
MSD	matrix spike duplicate
PCB	polychlorinated biphenyl
QA	quality assurance
QAPP	quality assurance project plan
QC	quality control
RI	remedial investigation
RPD	relative percent difference
RVAAP	Ravenna Army Ammunition Plant
SAIC	Science Applications International Corporation
SAP	sampling and analysis plan
SVOC	semivolatile organic compound
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
VOC	volatile organic compound

D1.0 PURPOSE OF THIS REPORT

Environmental data must always be interpreted relative to its known limitations and its intended use. As can be expected in environmental media of this type, there are areas and data points where the user needs to be cautioned relative to the quality of the project information presented. The data verification process and this data quality assessment (DQA) are intended to provide current and future data users assistance throughout the interpretation of these data.

The purpose of this DQA report is (1) to describe the quality control (QC) procedures followed to ensure data generated by Science Applications International Corporation (SAIC) during these investigations at the Ravenna Army Ammunition Plant (RVAAP) would meet project requirements; (2) to describe the quality of the data collected; and (3) to describe problems encountered during the course of the study and their solutions. A separate Chemical Quality Assessment Report will be completed by the United States Army Corp of Engineers (USACE) quality assurance (QA) representative and will cover data generated from QA split samples remanded to their custody.

This report provides an assessment of the analytical information gathered during the course of the RVAAP Supplemental Phase II Remedial Investigation (RI) for the Fuze and Booster Quarry Landfill/Ponds (FBQ), area performed during November 2005. It documents that the quality of the data employed for the RI report and evaluation met their objectives. Evaluation of field and laboratory QC measures will constitute the majority of this assessment; however, references will also be directed toward those QA procedures that establish data credibility. The primary intent of this assessment is to illustrate that data generated for these studies can withstand scientific scrutiny, are appropriate for their intended purpose, are technically defensible, and are of known and acceptable sensitivity, precision, and accuracy.

Multiple activities were performed to achieve the desired data quality for this project. As discussed in the report, decisions were made during the initial scoping of the RI to define the quality and quantity of data required. Data quality objectives (DQOs) were established to guide the implementation of the field sampling and laboratory analysis (refer to the *RVAAP Sampling and Analysis Plan [SAP] Addendum* November 2005 [USACE 2005]). A QA program was established to standardize procedures and to document activities (refer to the RVAAP Facility-wide Quality Assurance Project Plan [QAPP] March 2001). This program provided a means to detect and correct any deficiencies in the process. Upon receipt by the project team, data were subjected to verification and validation review to identify and qualify problems related to the analysis. These review steps contributed to this final DQA where data used in the investigation are identified as having met the criteria and are being employed appropriately.

D2.0 QUALITY ASSURANCE PROGRAM

A Facility-Wide QAPP and a Supplemental Phase II RI QAPP Addendum were developed to guide the investigation. These plans are found in Part II of the Facility-wide SAP for RVAAP (USACE 2001) and the Supplemental Phase II RI SAP Addendum No. 1 (USACE 2005). The purpose of these documents was to enumerate the quantity and type of samples to be taken to inspect the area of concern (AOC), and to define the quantity and type of QA/QC samples to be used to evaluate the quality of the data obtained.

The QAPP established requirements for both field and laboratory QC procedures. In general, field QC duplicates and QA split samples were required for each environmental sample matrix collected in the area being investigated; volatile organic compound (VOC) trip blanks were to accompany each cooler containing water samples for VOC determinations; and analytical laboratory QC duplicates, matrix spikes (MSs), laboratory control samples (LCSs), and method blanks were required for every 20 samples or less of each matrix and analyte.

A primary goal of the RVAAP QA Program was to ensure that the quality of results for all environmental measurements were appropriate for their intended use. To this end, the QAPP and standardized field procedures were compiled to guide the investigation. Through the process of readiness review, training, equipment calibration, QC implementation, and detailed documentation, the project has successfully accomplished the goals set for the QA Program. Surveillances were conducted to determine the adequacy of field performance as evaluated against the QA plan and procedures.

D2.1 MONTHLY PROGRESS REPORTS

Monthly Progress Reports (MPRs) were completed by the SAIC Project Manager for the duration of the project. The MPRs contained the following information: work completed, problems encountered, corrective actions/solutions, summary of findings, and upcoming work. These reports were issued to the USACE, Louisville District Project Manager. Access to these reports can be obtained through the USACE, Louisville District Project Manager.

D2.2 DAILY QUALITY CONTROL REPORTS

The Field Team Leader produced all Daily Quality Control Reports (DQCRs). These include information such as, but not limited to, sub-tier contractors on-site, equipment on-site, work performed summaries, QC activities, Health and Safety activities, problems encountered, and corrective actions. The DQCRs were submitted to the USACE, Louisville District Project Manager and may be obtained through his office.

D2.3 LABORATORY "DEFINITIVE" LEVEL DATA REPORTING

The QAPP for this project identified requirements for laboratory data reporting and identified GPL Laboratory, Inc. (GPL), Gaithersburg, Maryland as the laboratory for the project. During the execution of the project, the GPL facility performed all of the analyses. United States Environmental Protection Agency (USEPA) "definitive" data have been reported, including the following basic information:

a. laboratory case narratives

b. sample results (soils/sediments reported per dry weight)

c. laboratory method blank results

d. LCS results

e. laboratory sample MS recoveries

f. laboratory duplicate results

g. surrogate recoveries (VOCs, semivolatile organic compounds [SVOCs], pesticides, polychlorinated biphenyls [PCBs], and explosives)

h. sample extraction dates

i. sample analysis dates.

This information from the laboratory, along with field information, provides the basis for subsequent data evaluation relative to sensitivity, precision, accuracy, representativeness, and completeness. These have been presented in Chapter 4.0.

D3.0 DATA VERIFICATION

The objective when evaluating the project data quality is to determine its usability. The evaluation is based on the interpretation of laboratory QC measures, field QC measures, and the project DQOs. This project implemented the Automated Data Review (ADR) electronic review process in combination with technical oversight to facilitate laboratory data review. ADR output was reviewed by the project-designated verification staff and the project laboratory coordinator. The ADR product is retained in the project database and available within that structure.

D3.1 FIELD DATA VERIFICATION

DQCRs were completed by the Field Team Leader. The DQCRs and other field-generated documents such as sampling logs, boring logs, daily health and safety summaries, daily safety inspections, equipment calibration and maintenance logs, and sample management logs were peer reviewed on-site. These logs and all associated field information have been delivered to the USACE, Louisville District Project Manager and can be obtained through his office.

D3.2 LABORATORY DATA VERIFICATION

Analytical data generated for this project have been subjected to a process of data verification and review. The following describes this systematic process and the evaluation activities performed. Several criteria have been established against which the data were compared and from which a judgment was rendered regarding the acceptance and qualification of the data. These and project specific QC criteria are programmed into the database and evaluated using the ADR programming. Because it is beyond the scope of this report to cite those criteria, the reader is directed to the following documents for specific detail:

- SAIC Technical Support Contractor QA Technical Procedure (TP-DM-300-7) Data Verification and Validation;
- USEPA – National Functional Guidelines for Inorganic Data Review, USEPA 540/R-94/013, February 1994;
- USEPA – National Functional Guidelines for Organic Data Review, USEPA-540/R-99/008, October 1999; and
- Supplemental Phase II RI at RVAAP, SAP Addendum, USACE, November 2005.

Upon receipt of field and analytical data, verification staff performed a systematic examination of the reports, utilizing the ADR process to ensure the content, presentation, and administrative validity of the data. Discrepancies identified during this process were recorded and documented utilizing the dataset. As part of data verification, standardized laboratory electronic data deliverables were subjected to review. This technical evaluation ensured that all contract-specified requirements had been met, and that electronic information conformed to reported hardcopy data. QA Program Nonconformance Report and Corrective Action systems were implemented as required.

During the verification phase of the review and evaluation process, data were subjected to a systematic technical review by examining all field and analytical QC results and laboratory documentation, following USEPA functional guidelines, the ADR process, and SAIC internal procedures for laboratory data review. These data review guidelines define the technical review criteria, methods for evaluation of the criteria, and actions to be taken resulting from the review of these criteria. The primary objective of this phase was to assess and summarize the quality and reliability of the data for the intended use and to document factors that may affect the usability of the data. This process did not include in-depth review of raw data instrument out-put or recalculation of results from the primary instrument out-put. This data verification, validation, and analytical review process included, but was not necessarily limited to, the following parameters:

- data completeness;
- analytical holding times and sample preservation;
- calibration (initial and continuing);
- method blanks;
- sample results verification;
- surrogate recovery;
- LCS analysis;
- internal standard performance;
- MS recovery;
- duplicate analysis comparison;
- reported detection limits;
- compound, element, and isotope quantification;
- reported detection levels; and
- secondary dilutions.

As an end result of this phase of the review, the data were qualified based on the technical assessment of the verification/validation criteria. Qualifiers were applied to each field and analytical result to indicate the usability of the data for its intended purpose.

D3.3 DEFINITION OF DATA QUALIFIERS (FLAGS)

During the data verification process, all laboratory data were assigned appropriate data qualification flags and reason codes. Qualification flags are defined as follows:

“U” Indicates the analyte was analyzed for, but not detected above, the level of the associated value.

“J” Indicates the analyte was positively identified; however, the associated numerical value is an approximate concentration of the analyte in the sample.

“UJ” Indicates the analyte was analyzed for, but not detected above, the associated value; however, the reported value is an estimate and demonstrates a decreased knowledge of its accuracy or precision.

“R” Indicates the analyte value reported is unusable. The integrity of the analyte’s identification, accuracy, precision, or sensitivity has raised significant questions as to the reality of the information presented.

“=” Indicates the analyte has been validated, the analyte has been positively identified, and the associated concentration value is accurate.

D3.4 DATA ACCEPTABILITY

Thirteen environmental soil and field QC samples were collected with approximately 480 discrete analyses (i.e., analytes) being obtained, reviewed, and integrated into the assessment (these totals do not include field measurements and field descriptions). The project produced acceptable results for 100% of the sample analyses performed and successfully collected investigation samples under the direction of the SAP and the USACE, Louisville District.

Table D-1 presents a summary of the collected investigation samples. It tallies the successful collection of all targeted field QC and QA split samples, while Table D-2 identifies a cross reference for duplicate and QA split sample pair numbers. Table D-3 provides a summary of rejected analyses grouped by media and analyte category. The majority of estimated values were based on values observed between the laboratory method detection levels (MDLs) and the project reporting levels. Values determined in this region have an inherently higher variability and need to be considered estimated at best.

Table D-1. Fuze and Booster Quarry Investigation Summary

Area	Media	Environmental Samples	Field Duplicates	Trip Blanks	Equipment Rinsate Blanks	Site Source Water Blanks	USACE Split Samples
FBQ	Soils	12	1	-	*	*	1

USACE = United States Army Corps of Engineers.
* = Associated Equipment Rinsate and Source Water analyzed in conjunction with Central Burn Pit samples.

Table D-2. Primary, Duplicate, and Split Sample Correlation Table
Fuze and Booster Quarry Investigation

Media	Station #	Sample #	Duplicate #	Laboratory SDG #	Split #
Soil	FBQ-196	FBQSS-196-0506-SO	FBQSS-196-0512-SO	511091	FBQSS-196-0513-SO

SDG = Sample delivery group.

Table D-3. Fuze and Booster Quarry Investigation
Summary of Rejected Analytes (Laboratory)
(grouped by medium and analysis group)

Media	Analysis Group	Rejected/	Total	Percent Rejected
Soil (surface and subsurface	Metals Explosives	0/ 0/	299 182	0.0 0.0
Project Total		0/	481	0.0

For this RVAAP study, one field duplicate was analyzed for soil media. Equipment rinsate, site potable water source and deionized water source samples were collected in conjunction with the concurrent sampling program at the Central Burn Pits (CBP).

D4.0 DATA QUALITY EVALUATION

D4.1 METALS, SOILS

Analytical holding times were met for all samples. Initial calibration and continuing calibration criteria were achieved for all elements analyzed. Method blank levels or continuing calibration blank levels did not result in any qualification of data. Antimony concentrations were consistently qualified as estimated “J or UJ” due to low MS results; however, none of the values were rejected. Barium, magnesium, potassium and vanadium were qualified as estimated “J or UJ” due to MS recoveries being above criteria. Other metals exhibited acceptable recoveries and were not qualified. LCS determinations were considered acceptable throughout the data set. Reporting levels are considered to be acceptable relative to the QAPP goals. Laboratory duplicate comparisons were acceptable. Although some analyses were qualified as estimated, the deviations observed should not have a primary influence on the results and the values are considered technically sound and defensible. None of the metal soil results were rejected. Complete data summary tables, with associated qualifiers, are provided in Chapter 4.0 of the main text of the report, and can be found in the RVAAP Environmental Information Management System.

D4.2 EXPLOSIVE ANALYSES, SOILS

Analytical holding times were met for all samples. Initial calibration criteria and continuing calibration criteria were met for all compounds. None of the method blanks exhibited any explosive compound concentrations. Surrogate compound recoveries were acceptable for all analyses, with the exception of slightly elevated recoveries for sample FBQSS-196-0507-SO. Impact compound results were qualified as estimated “J”. LCS and MS/matrix spike duplicate (MSD) recoveries were within criteria. Although some analyses were qualified as estimated, the deviations observed should not have a primary influence on the results and the values are considered technically sound and defensible. Complete data summary tables, with associated qualifiers, are provided in Chapter 4.0 of the main text of the report, and can be found in the RVAAP Environmental Information Management System.

D4.3 PRECISION

A field duplicate sample was collected to ascertain the contribution to variability (i.e., precision) due to the combination of environmental media, sampling consistency, and analytical precision. The field duplicate sample was collected from the same spatial and temporal conditions as the primary environmental sample. The sample was collected from the same sampling device, after homogenization.

Field duplicate comparison information in Table D-4 presents the absolute difference or relative percent difference (RPD) for field duplicate measurements, by analyte. RPD was calculated only when both samples were > 5 times the reporting level. When one or both sample values were between the reporting level and 5 times the reporting level, the absolute difference was evaluated. If both samples were not detected for a given analyte, precision was considered acceptable. To review information, this DQA has implemented general criteria for comparison of absolute difference measurements and RPDs. RPD criteria were set at 50 and absolute difference criteria were set at 3 times the reporting level. All field duplicate comparisons are considered good, with the highest difference being for arsenic in the soil duplicate at 19 RPD.

D4.4 SENSITIVITY

Determination of minimum detectable values allows the investigation to assess the relative confidence that can be placed in a value relative to the magnitude or level of analyte concentration observed. The closer a measured value comes to the minimum detectable concentration, the less confidence and more variation the measurement will have. Project sensitivity goals were expressed as quantitation level goals in the QAPP. These levels were achieved or exceeded throughout the analytical process. Actual laboratory MDLs achieved during this investigation achieved project quantitation level goals. Individual analyte reporting levels varied due to matrix differences and contaminant analyte concentrations. Reporting levels were elevated in soils due to inherent moisture content variability and results being reported in the standard dry weight format. Reporting level variations have been considered during data interpretation and statistical applications.

Method blank determinations were performed with each analytical sample batch for each analyte under investigation. These blanks were evaluated during data review to determine their potential impact on individual data points, if any. Review action levels are set at 5 times the reporting level for all analytes, except those designated as common laboratory contaminants (methylene chloride, acetone, toluene, 2-butanone, and phthalate compounds) with action levels set at 10 times reporting levels. During data review, reported sample concentrations are assessed against method blank action levels and the following qualifications are made when reportable quantities of analyte were observed in the associated method blank.

- When the analyte sample concentration is above 5 or 10 times the action level, the data are not qualified and it is considered a positive value.

- When the analyte sample concentration is determined below 5 or 10 times the action level but above the reporting level, the data are considered impacted by the method blank and the value reported is qualified as a non-detect at the analyte value reported. These data are then qualified as “U”.

Table D-4. Field Duplicate Comparison, Fuze and Booster Quarry Investigation

Analysis	FBQSS-196-0506-SO/ FBQSS-196-0512-SO Soil RPD
Aluminum	1
Antimony	*
Arsenic	19
Barium	1
Beryllium	3
Cadmium	*
Calcium	1
Chromium	6
Cobalt	5
Copper	0
Iron	3
Lead	3
Magnesium	1
Manganese	14
Mercury	*
Nickel	1
Potassium	2
Selenium	*
Silver	*
Sodium	*
Thallium	*
Vanadium	2

Analysis	FBQSS-196-0506-SO/ FBQSS-196-0512-SO Soil RPD
Zinc	1
All compounds	*

* = At least one value is < 5 times the reporting level, and duplicate comparison is within 3 times the reporting level.
RPD = Relative percent difference.
RVAAP = Ravenna Army Ammunition Plant.
UNAC = At least one value is < 5 times the reporting level, and duplicate comparison is NOT within 3 times the reporting level.

- When the analyte sample concentration is determined below 5 or 10 times the action level and below the reporting level, the data are considered impacted by the method blank and the value reported is qualified as a non-detect at the reporting level. These data are then qualified as "U".

Evaluation of overall project sensitivity can be gained through review of field blank information. These actual sample analyses may provide a comprehensive look at the combined sampling and analysis sensitivity attained by the project. Field QC blanks obtained during sampling activities at RVAAP included samples of VOC trip blank waters and site water sources.

Equipment rinsate sample (CBP-QC-130-QC) did not exhibit any concentrations of explosive compounds. Minor levels of chromium, copper, iron, lead, magnesium, manganese, nickel, potassium, and sodium were observed. All rinsates were associated with soil sampling equipment cleaning operations and none of the contaminant levels impacted the sample values being reported.

Field source water blank CBP-QC-132-QC (deionized water source) exhibited a few analyte levels similar to those observed in the equipment blanks. Source water blank CBP-QC-131-QC (potable water source) contained normal levels of barium, calcium, copper, iron, lead, magnesium, manganese, potassium, sodium, and zinc for this type of water source. Neither of these sources contained any explosive compound levels. There is no indication that the source waters impacted associated sample levels.

D4.5 REPRESENTATIVENESS AND COMPARABILITY

Representativeness expresses the degree to which data accurately reflect the analyte or parameter of interest for the environmental site and is the qualitative term most concerned with the proper design of the sampling program. Factors that affect the representativeness of analytical data include proper preservation, holding times, use of standard sampling and analytical methods, and determination of matrix or analyte interferences. Samples were delivered to the laboratory by overnight express courier, were received in good condition, and at appropriate temperature. All analyses were performed within the recommended analytical holding times. Sample preservation, analytical methodologies, and soil sampling methodologies were documented to be adequate and consistently applied.

Comparability, like representativeness, is a qualitative term relative to an individual project data set. These RVAAP AOC investigations employed appropriate sampling methodologies, site surveillance, 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 data sets. Through the proper implementation and documentation of these standard practices, the project has established the confidence that the data will be comparable to other project and programmatic information. Table D-5 presents the standardized parameter groups, analytical methods, sample containers, preservation techniques, and associated holding times.

D4.6 COMPLETENESS

Usable data are defined as those data that pass individual scrutiny during the verification and validation process and are accepted for unrestricted application to the human health risk assessment evaluation or equivalent type applications. It has been determined that estimated data are acceptable for RVAAP project objectives.

Objectives for FBQ data have been achieved. The project produced usable results for 100% of the sample analyses performed and successfully collected all the samples planned.

D5.0 DATA QUALITY ASSESSMENT SUMMARY

The overall quality of RVAAP FBQ information meets or exceeds the established project objectives. Through proper implementation of the project data verification and assessment process, project information has been determined to be acceptable for use.

Data, as presented, have been qualified as usable or estimated "J or UJ". Data that have been estimated provide indications of either accuracy, precision, or sensitivity being less than desired but adequate for interpretation. Qualifiers have been applied to data when necessary.

Data produced for this project demonstrate that they can withstand scientific scrutiny, are appropriate for its intended purpose, are technically defensible, and are of known and acceptable sensitivity, precision, and accuracy. Data integrity has been documented through proper implementation of QA and QC measures. The environmental information presented has an established confidence that allows utilization for the project objectives and provides data for future needs.

Table D-5. Container Requirements for Soil and Sediment Samples at RVAAP, Ravenna, Ohio

Analyte Group	Container	Minimum Sample Size	Preservative	Holding Time
Explosive Compounds 8330	One 4-oz glass jar with Teflon®-lined cap	60 g	Cool, 4°C	14 day (extraction) 40 day (analysis)
Metals 6010B and 7471	One 4-oz glass jar with Teflon®-lined cap	50 g	Cool, 4°C	180 day; Hg @ 28 day

D6.0 REFERENCES

USACE 2001. *Facility-wide Sampling and Analysis Plan (SAP) for the Ravenna Army Ammunition Plant, Ravenna, Ohio*, DACA62-00-D-0001, DO CY 02, March 2001.

USACE 2005. *Sampling and Analysis Plan Addendum No. 1 for Supplemental Phase II Remedial Investigation of ODA2, FBQ, and CBP*. November 2005.

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ATTACHMENT E

LABORATORY ANALYTICAL RESULTS AND COCs

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ATTACHMENT E
LABORATORY ANALYTICAL RESULTS

DISCRETE SURFACE AND SUBSURFACE SOIL SAMPLES

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Table E-1. Discrete Surface Soil Samples - Inorganics

Station			**DA2-125**	**DA2-126**	**DA2-127**	**DA2-128**
Sample ID			**DA2SS-125-0900-SO**	**DA2SS-126-0902-SO**	**DA2SS-127-0904-SO**	**DA2SS-128-0906-SO**
Customer ID			**DA2SS-125-0900-SO**	**DA2SS-126-0902-SO**	**DA2SS-127-0904-SO**	**DA2SS-128-0906-SO**
Date			**11/15/2005**	**11/15/2005**	**11/15/2005**	**11/15/2005**
Depth (ft)			**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**
Field Type			**Spatial Composite**	**Spatial Composite**	**Spatial Composite**	**Spatial Composite**
Analyte (mg/kg)	**Units**	**Facility-wide Background**				
Inorganics						
Aluminum	MG/KG	17700	14600 /=	12700 /=	9400 /=	18400 /=#
Antimony	MG/KG	0.96	0.37 UN/UJ	0.27 UN/UJ	0.33 JN/J	0.52 JN/J
Arsenic	MG/KG	15.4	8.5 N/J	8.7 /=	11.4 /=	19.4 N/J#
Barium	MG/KG	88.4	61.3 N/J	80.8 N/J	92.1 N/J#	132 N/J#
Beryllium	MG/KG	0.88	0.58 /=	0.69 /=	0.53 /=	1 /=#
Cadmium	MG/KG		0.05 J/J#	0.02 U/U	0.33 /=#	0.73 /=#
Calcium	MG/KG	15800	266 /=	637 /=	2160 /=	946 /=
Chromium	MG/KG	17.4	21.9 /=#	16.6 /=	14.5 /=	23.9 /=#
Cobalt	MG/KG	10.4	10.4 /=	12.1 /=#	9 /=	18.3 /=#
Copper	MG/KG	17.7	13.5 /=	22.1 N/J#	31.2 N/J#	25.3 /=#
Iron	MG/KG	23100	19400 /=	20600 /=	18600 /=	29200 /=#
Lead	MG/KG	26.1	15.6 /=	15.7 /=	24.5 /=	32.3 /=#
Magnesium	MG/KG	3030	2240 N/J	2150 N/J	1950 N/J	2610 N/J
Manganese	MG/KG	1450	702 /=	971 D/=	760 /=	2890 D/=#
Mercury	MG/KG	0.036	0.04 /=#	0.04 /=#	0.07 /=#	0.08 /=#
Nickel	MG/KG	21.1	15.2 /=	14.1 /=	14.8 /=	22.9 /=#
Potassium	MG/KG	927	1020 N/J#	865 N/J	704 N/J	1650 N/J#
Selenium	MG/KG	1.4	0.35 J/J	0.41 U/U	0.53 J/J	0.94 J/J
Silver	MG/KG		0.04 U/U	0.04 U/U	0.04 U/U	0.04 U/U
Sodium	MG/KG	123	70 J/J	79.1 J/UJ	80.2 /U	78.1 J/J
Thallium	MG/KG		0.36 J/J#	0.98 UD/U	0.48 U/U	0.49 U/U
Vanadium	MG/KG	31.1	23.7 N/J	24.3 N/=	17.7 N/=	40.1 N/J#
Zinc	MG/KG	61.8	61.3 /=	63.9 /=#	87.9 /=#	101 /=#

Table E-1. Discrete Surface Soil Samples – Inorganics (continued)

Station			DA2-129	DA2-129	DA2-130
Sample ID			DA2SS-129-0908-SO	DA2SS-129-0912-SO	DA2SS-130-0910-SO
Customer ID			DA2SS-129-0908-SO	DA2SS-129-0912-SO	DA2SS-130-0910-SO
Date			11/15/2005	11/15/2005	11/15/2005
Depth (ft)			0.0 - 1.0	0.0 - 1.0	0.0 - 1.0
Field Type			Spatial Composite	Field Duplicate	Spatial Composite
Analyte (mg/kg)	Units	Facility-wide Background			
Inorganics					
Aluminum	MG/KG	17700	8100 /=	8030 /=	10800 /=
Antimony	MG/KG	0.96	0.44 JN/J	0.25 JN/J	0.71 JN/J
Arsenic	MG/KG	15.4	16.1 /=#	10.6 /=	8.2 N/J
Barium	MG/KG	88.4	51.7 N/J	51.4 N/J	46.1 N/J
Beryllium	MG/KG	0.88	0.44 /=	0.45 /=	0.42 /=
Cadmium	MG/KG		0.91 /=#	1 /=#	0.18 /=#
Calcium	MG/KG	15800	1150 /=	1150 /=	340 /=
Chromium	MG/KG	17.4	14 /=	14.4 /=	28.7 /=#
Cobalt	MG/KG	10.4	9.7 /=	9.7 /=	8 /=
Copper	MG/KG	17.7	175 N/J#	175 N/J#	23.2 /=#
Iron	MG/KG	23100	20700 /=	19600 /=	14700 /=
Lead	MG/KG	26.1	32.3 /=#	31 /=#	36.8 /=#
Magnesium	MG/KG	3030	1930 N/J	1920 N/J	1620 N/J
Manganese	MG/KG	1450	454 /=	454 /=	311 /=
Mercury	MG/KG	0.036	2.4 D/=#	2.3 D/=#	0.07 /=#
Nickel	MG/KG	21.1	16.8 /=	16.8 /=	19.5 /=
Potassium	MG/KG	927	836 N/J	826 N/J	796 N/J
Selenium	MG/KG	1.4	0.39 U/U	0.36 U/U	0.63 J/J
Silver	MG/KG		0.04 U/U	0.04 U/U	0.05 U/U
Sodium	MG/KG	123	73.4 J/UJ	65.9 J/UJ	76.7 J/J

Station			DA2-129	DA2-129	DA2-130
Sample ID			**DA2SS-129-0908-SO**	**DA2SS-129-0912-SO**	**DA2SS-130-0910-SO**
Customer ID			**DA2SS-129-0908-SO**	**DA2SS-129-0912-SO**	**DA2SS-130-0910-SO**
Date			**11/15/2005**	**11/15/2005**	**11/15/2005**
Depth (ft)			**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**
Field Type			**Spatial Composite**	**Field Duplicate**	**Spatial Composite**
Analyte (mg/kg)	**Units**	**Facility-wide Background**			
Thallium	MG/KG		0.47 U/U	0.44 U/U	0.31 U/U
Vanadium	MG/KG	31.1	15.6 N/=	15.4 N/=	19.5 N/J
Zinc	MG/KG	61.8	199 /=#	203 /=#	72.6 /=#

Note: Data Qualifiers are presented as Laboratory qualifiers/Validation qualifiers
- value above facility wide background
J - estimated value less than reporting limits.
N - Matrix spike recovery outside control limits
E - Result estimated because of the presence of interference.
B - for organics-compound was detected in the blank as well as the sample
= - analyte present and concentration accurate.
U - Not detected
* - Duplicate analysis outside control limits.
P - greater than 25% difference between two GC columns
NA – not analyzed
B - for inorganics-result was less than the contract required detection limit but greater than the instrument detection limit.
Facility wide background was determined for the Winklepeck Burning Ground Phase II Remedial Investigation (USACE 2001c)

Table E-2. Discrete Surface Soil Samples - Explosives

Station		**DA2-125**	**DA2-126**	**DA2-127**	**DA2-128**
Sample ID		**DA2SS-125-0900-SO**	**DA2SS-126-0902-SO**	**DA2SS-127-0904-SO**	**DA2SS-128-0906-SO**
Customer ID		**DA2SS-125-0900-SO**	**DA2SS-126-0902-SO**	**DA2SS-127-0904-SO**	**DA2SS-128-0906-SO**
Date		**11/15/2005**	**11/15/2005**	**11/15/2005**	**11/15/2005**
Depth (ft)		**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**
Field Type		**Spatial Composite**	**Spatial Composite**	**Spatial Composite**	**Spatial Composite**
Analyte (mg/kg)	**Units**				
Explosives					
1,3,5-Trinitrobenzene	MG/KG	0.1 U/U	0.1 U/U	0.1 U/U	0.1 U/U
1,3-Dinitrobenzene	MG/KG	0.1 U/U	0.1 U/U	0.1 U/U	0.1 U/U
2,4,6-Trinitrotoluene	MG/KG	0.1 U/U	0.1 U/U	0.1 U/U	0.1 U/U
2,4-Dinitrotoluene	MG/KG	0.1 U/U	0.1 U/U	0.1 U/U	0.1 U/U
2,6-Dinitrotoluene	MG/KG	0.1 U/U	0.1 U/U	0.1 U/U	0.1 U/U
2-Amino-4,6-Dinitrotoluene	MG/KG	0.1 U/U	0.1 U/U	0.1 U/U	0.1 U/U
2-Nitrotoluene	MG/KG	0.2 U/U	0.2 U/U	0.2 U/U	0.2 U/U
3-Nitrotoluene	MG/KG	0.2 U/U	0.2 U/U	0.2 U/U	0.2 U/U
4-Amino-2,6-Dinitrotoluene	MG/KG	0.1 U/U	0.1 U/U	0.1 U/U	0.1 U/U
4-Nitrotoluene	MG/KG	0.2 U/U	0.2 U/U	0.2 U/U	0.2 U/U
HMX	MG/KG	0.2 U/U	0.2 U/U	0.2 U/U	0.2 U/U
Nitrobenzene	MG/KG	0.1 JB/UJ	0.03 J/J	0.02 J/J	0.1 JB/UJ
RDX	MG/KG	0.2 U/U	0.2 U/U	0.2 U/U	0.2 U/U
Tetryl	MG/KG	0.2 U/U	0.2 U/U	0.01 J/J	0.2 U/U

Table E-2. Discrete Surface Soil Samples – Explosives (continued)

Station		**DA2-129**	**DA2-129**	**DA2-130**
Sample ID		**DA2SS-129-0908-SO**	**DA2SS-129-0912-SO**	**DA2SS-130-0910-SO**
Customer ID		**DA2SS-129-0908-SO**	**DA2SS-129-0912-SO**	**DA2SS-130-0910-SO**
Date		**11/15/2005**	**11/15/2005**	**11/15/2005**
Depth (ft)		**0.0 - 1.0**	**0.0 - 1.0**	**0.0 - 1.0**
Field Type		**Spatial Composite**	**Field Duplicate**	**Spatial Composite**
Analyte (mg/kg)	**Units**			
Explosives				
1,3,5-Trinitrobenzene	MG/KG	0.1 U/U	0.1 U/U	0.1 U/U
1,3-Dinitrobenzene	MG/KG	0.1 U/U	0.1 U/U	0.1 U/U
2,4,6-Trinitrotoluene	MG/KG	0.1 U/U	0.1 U/U	0.1 U/U
2,4-Dinitrotoluene	MG/KG	0.1 U/U	0.1 U/U	0.1 U/U
2,6-Dinitrotoluene	MG/KG	0.1 U/U	0.1 U/U	0.1 U/U
2-Amino-4,6-Dinitrotoluene	MG/KG	0.04 J/J	0.05 J/J	0.1 U/U
2-Nitrotoluene	MG/KG	0.2 U/U	0.2 U/U	0.2 U/U
3-Nitrotoluene	MG/KG	0.2 U/U	0.2 U/U	0.2 U/U
4-Amino-2,6-Dinitrotoluene	MG/KG	0.03 J/J	0.06 J/J	0.1 U/U
4-Nitrotoluene	MG/KG	0.2 U/U	0.2 U/U	0.2 U/U
HMX	MG/KG	0.2 U/U	0.2 U/U	0.2 U/U
Nitrobenzene	MG/KG	0.02 J/J	0.1 U/U	0.1 U/U
RDX	MG/KG	0.2 U/U	0.2 U/U	0.2 U/U
Tetryl	MG/KG	0.23 /J	0.15 J/J	0.2 U/U

Note: Data Qualifiers are presented as Laboratory qualifiers/Validation qualifiers
- value above facility wide background
J - estimated value less than reporting limits.
N - Matrix spike recovery outside control limits
E - Result estimated because of the presence of interference.
B - for organics-compound was detected in the blank as well as the sample
= - analyte present and concentration accurate.
U - Not detected
* - Duplicate analysis outside control limits.
P - greater than 25% difference between two GC columns
NA – not analyzed
B - for inorganics-result was less than the contract required detection limit but greater than the instrument detection limit.
Facility wide background was determined for the Winklepeck Burning Ground Phase II Remedial Investigation (USACE 2001c)

Table E-3. Discrete Subsurface Soil Samples - Inorganics

Station			**DA2-125**	**DA2-126**	**DA2-127**	**DA2-128**
Sample ID			**DA2SO-125-0901-SO**	**DA2SO-126-0903-SO**	**DA2SO-127-0905-SO**	**DA2SO-128-0907-SO**
Customer ID			**DA2SO-125-0901-SO**	**DA2SO-126-0903-SO**	**DA2SO-127-0905-SO**	**DA2SO-128-0907-SO**
Date			**11/15/2005**	**11/15/2005**	**11/15/2005**	**11/15/2005**
Depth (ft)			**1.0 - 3.0**	**1.0 - 3.0**	**1.0 - 3.0**	**1.0 - 3.0**
Field Type			**Spatial Composite**	**Spatial Composite**	**Spatial Composite**	**Spatial Composite**
Analyte (mg/kg)	**Units**	**Facility-wide Background**				
Inorganics						
Aluminum	MG/KG	19500	20500 /=#	11700 /=	9570 /=	20000 /=#
Antimony	MG/KG	0.96	0.36 JN/J	0.32 JN/J	0.34 UN/UJ	0.51 JN/J
Arsenic	MG/KG	19.8	15.1 N/J	13.5 /=	11 N/J	20.4 N/J#
Barium	MG/KG	124	102 N/J	83.7 N/J	37.5 N/J	102 N/J
Beryllium	MG/KG	0.88	1.2 /=#	0.68 /=	0.38 /=	0.93 /=#
Cadmium	MG/KG		0.02 U/U	0.07 J/J#	0.01 U/U	0.01 U/U
Calcium	MG/KG	35500	1260 /=	3690 /=	455 /=	1010 /=
Chromium	MG/KG	27.2	29.1 /=#	19.3 /=	13.5 /=	27.8 /=#
Cobalt	MG/KG	23.2	16.9 /=	16.6 /=	7.6 /=	18.1 /=
Copper	MG/KG	32.3	24.9 /=	31.4 N/J	9.5 /=	21.6 /=
Iron	MG/KG	35200	34000 /=	23800 /=	17500 /=	36000 /=#
Lead	MG/KG	19.1	15 /=	28.4 /=#	10.5 /=	18.9 /=
Magnesium	MG/KG	8790	4930 N/J	2970 N/J	1690 N/J	3870 N/J
Manganese	MG/KG	3030	376 /=	535 /=	373 /=	587 /=
Mercury	MG/KG	0.044	0.02 J/J	0.06 /=#	0.03 J/J	0.02 J/J
Nickel	MG/KG	60.7	37 /=	22 /=	12.2 /=	27.6 /=
Potassium	MG/KG	3350	2830 N/J	1060 N/J	959 N/J	2360 N/J
Selenium	MG/KG	1.5	0.59 J/J	0.4 U/U	0.39 J/J	0.87 /=
Silver	MG/KG		0.04 U/U	0.04 U/U	0.04 U/U	0.04 U/U
Sodium	MG/KG	145	101 J/J	80.4 /U	71.2 J/J	80.9 J/J
Thallium	MG/KG	0.91	0.76 J/J	0.48 U/U	0.27 U/U	1 J/J#
Vanadium	MG/KG	37.6	32.1 N/J	21.1 N/=	18.9 N/J	36.4 N/J
Zinc	MG/KG	93.3	78.1 /=	75.8 /=	40.3 /=	69.8 /=

Table E-3. Discrete Subsurface Soil Samples – Inorganics (continued)

Station			**DA2-129**	**DA2-129**	**DA2-130**
Sample ID			**DA2SO-129-0909-SO**	**DA2SO-129-0914-SO**	**DA2SO-130-0911-SO**
Customer ID			**DA2SO-129-0909-SO**	**DA2SO-129-0914-SO**	**DA2SO-130-0911-SO**
Date			**11/15/2005**	**11/15/2005**	**11/15/2005**
Depth (ft)			**1.0 - 3.0**	**1.0 - 3.0**	**1.0 - 1.9**
Field Type			**Spatial Composite**	**Field Duplicate**	**Spatial Composite**
Analyte (mg/kg)	**Units**	**Facility-wide Background**			
Inorganics					
Aluminum	MG/KG	19500	16500 /=	17000 /=	12700 /=
Antimony	MG/KG	0.96	0.55 JN/J	0.42 JN/J	0.37 JN/J
Arsenic	MG/KG	19.8	16.6 N/J	16.1 N/J	11.8 N/J
Barium	MG/KG	124	48.6 N/J	49.7 N/J	37.6 N/J
Beryllium	MG/KG	0.88	0.64 /=	0.65 /=	0.45 /=
Cadmium	MG/KG		0.06 /=#	0.06 /=#	0.05 /=#
Calcium	MG/KG	35500	343 /=	363 /=	205 /=
Chromium	MG/KG	27.2	25 /=	24.2 /=	18.9 /=
Cobalt	MG/KG	23.2	8.6 /=	8.7 /=	7.9 /=
Copper	MG/KG	32.3	24.5 /=	25.8 /=	16.6 /=
Iron	MG/KG	35200	27700 /=	29100 /=	21300 /=
Lead	MG/KG	19.1	14 /=	14.2 /=	12.4 /=
Magnesium	MG/KG	8790	3170 N/J	3320 N/J	2380 N/J
Manganese	MG/KG	3030	222 /=	219 /=	250 /=
Mercury	MG/KG	0.044	0.13 /=#	0.13 /=#	0.04 /=
Nickel	MG/KG	60.7	21.9 /=	21.9 /=	17 /=
Potassium	MG/KG	3350	1790 N/J	1790 N/J	1130 N/J
Selenium	MG/KG	1.5	0.48 J/J	0.58 J/J	0.55 J/J
Silver	MG/KG		0.04 U/U	0.04 U/U	0.04 U/U
Sodium	MG/KG	145	74.5 J/J	79.8 J/J	64.2 J/J

Station			DA2-129	DA2-129	DA2-130
Sample ID			DA2SO-129-0909-SO	DA2SO-129-0914-SO	DA2SO-130-0911-SO
Customer ID			DA2SO-129-0909-SO	DA2SO-129-0914-SO	DA2SO-130-0911-SO
Date			11/15/2005	11/15/2005	11/15/2005
Depth (ft)			1.0 - 3.0	1.0 - 3.0	1.0 - 1.9
Field Type			Spatial Composite	Field Duplicate	Spatial Composite
Analyte (mg/kg)	Units	Facility-wide Background			
Thallium	MG/KG	0.91	0.49 J/J	0.48 J/J	0.47 J/J
Vanadium	MG/KG	37.6	27.5 N/J	28 N/J	23.5 N/J
Zinc	MG/KG	93.3	82.7 /=	84.7 /=	53.8 /=

Note: Data Qualifiers are presented as Laboratory qualifiers/Validation qualifiers
- value above facility wide background
= - analyte present and concentration accurate.
J - estimated value less than reporting limits.
U - Not detected
N - Matrix spike recovery outside control limits
* - Duplicate analysis outside control limits.
E - Result estimated because of the presence of interference.
P - greater than 25% difference between two GC columns
B - for organics-compound was detected in the blank as well as the sample
NA – not analyzed
B - for inorganics-result was less than the contract required detection limit but greater than the instrument detection limit.
Facility wide background was determined for the Winklepeck Burning Ground Phase II Remedial Investigation (USACE 2001c)

Table E-4. Discrete Subsurface Soil Samples - Explosives

Station		**DA2-125**	**DA2-126**	**DA2-127**	**DA2-128**
Sample ID		**DA2SO-125-0901-SO**	**DA2SO-126-0903-SO**	**DA2SO-127-0905-SO**	**DA2SO-128-0907-SO**
Customer ID		**DA2SO-125-0901-SO**	**DA2SO-126-0903-SO**	**DA2SO-127-0905-SO**	**DA2SO-128-0907-SO**
Date		**11/15/2005**	**11/15/2005**	**11/15/2005**	**11/15/2005**
Depth (ft)		**1.0 - 3.0**	**1.0 - 3.0**	**1.0 - 3.0**	**1.0 - 3.0**
Field Type		**Spatial Composite**	**Spatial Composite**	**Spatial Composite**	**Spatial Composite**
Analyte (mg/kg)	**Units**				
Explosives					
1,3,5-Trinitrobenzene	MG/KG	0.1 U/U	0.1 U/U	0.1 U/U	0.1 U/U
1,3-Dinitrobenzene	MG/KG	0.1 U/U	0.1 U/U	0.1 U/U	0.1 U/U
2,4,6-Trinitrotoluene	MG/KG	0.1 U/U	0.1 U/U	0.1 U/U	0.1 U/U
2,4-Dinitrotoluene	MG/KG	0.1 U/U	0.1 U/U	0.1 U/U	0.1 U/U
2,6-Dinitrotoluene	MG/KG	0.1 U/U	0.1 U/U	0.1 U/U	0.1 U/U
2-Amino-4,6-Dinitrotoluene	MG/KG	0.1 U/U	0.1 U/U	0.1 U/U	0.1 U/U
2-Nitrotoluene	MG/KG	0.2 U/U	0.2 U/U	0.2 U/U	0.2 U/U
3-Nitrotoluene	MG/KG	0.2 U/U	0.2 U/U	0.2 U/U	0.2 U/U
4-Amino-2,6-Dinitrotoluene	MG/KG	0.1 U/U	0.1 U/U	0.1 U/U	0.1 U/U
4-Nitrotoluene	MG/KG	0.2 U/U	0.2 U/U	0.2 U/U	0.2 U/U
HMX	MG/KG	0.2 U/U	0.2 U/U	0.2 U/U	0.2 U/U
Nitrobenzene	MG/KG	0.1 B/UJ	0.03 J/J	0.1 JB/UJ	0.1 B/UJ
RDX	MG/KG	0.2 U/U	0.2 U/U	0.2 U/U	0.2 U/U
Tetryl	MG/KG	0.2 U/U	0.2 U/U	0.2 U/U	0.2 U/U

Table E-4. Discrete Subsurface Soil Samples – Explosives (continued)

Station		DA2-129	DA2-129	DA2-130
Sample ID		DA2SO-129-0909-SO	DA2SO-129-0914-SO	DA2SO-130-0911-SO
Customer ID		DA2SO-129-0909-SO	DA2SO-129-0914-SO	DA2SO-130-0911-SO
Date		11/15/2005	11/15/2005	11/15/2005
Depth (ft)		1.0 - 3.0	1.0 - 3.0	1.0 - 1.9
Field Type		Spatial Composite	Field Duplicate	Spatial Composite
Analyte (mg/kg)	Units			
Explosives				
1,3,5-Trinitrobenzene	MG/KG	0.1 U/U	0.1 U/U	0.1 U/U
1,3-Dinitrobenzene	MG/KG	0.1 U/U	0.1 U/U	0.1 U/U
2,4,6-Trinitrotoluene	MG/KG	0.1 U/U	0.1 U/U	0.1 U/U
2,4-Dinitrotoluene	MG/KG	0.1 U/U	0.1 U/U	0.1 U/U
2,6-Dinitrotoluene	MG/KG	0.1 U/U	0.1 U/U	0.1 U/U
2-Amino-4,6-Dinitrotoluene	MG/KG	0.1 U/U	0.1 U/U	0.1 U/U
2-Nitrotoluene	MG/KG	0.2 U/U	0.2 U/U	0.2 U/U
3-Nitrotoluene	MG/KG	0.2 U/U	0.2 U/U	0.2 U/U
4-Amino-2,6-Dinitrotoluene	MG/KG	0.1 U/U	0.1 U/U	0.1 U/U
4-Nitrotoluene	MG/KG	0.2 U/U	0.2 U/U	0.2 U/U
HMX	MG/KG	0.2 U/U	0.2 U/U	0.2 U/U
Nitrobenzene	MG/KG	0.1 JB/UJ	0.1 JB/UJ	0.1 JB/UJ
RDX	MG/KG	0.2 U/U	0.2 U/U	0.2 U/U
Tetryl	MG/KG	0.03 J/J	0.16 J/J	0.2 U/U

Note: Data Qualifiers are presented as Laboratory qualifiers/Validation qualifiers
- value above facility wide background
J - estimated value less than reporting limits.
N - Matrix spike recovery outside control limits
E - Result estimated because of the presence of interference.
B - for organics-compound was detected in the blank as well as the sample
= - analyte present and concentration accurate.
U - Not detected
* - Duplicate analysis outside control limits.
P - greater than 25% difference between two GC columns
NA – not analyzed
B - for inorganics-result was less than the contract required detection limit but greater than the instrument detection limit.
Facility wide background was determined for the Winklepeck Burning Ground Phase II Remedial Investigation (USACE 2001c)

Chain of Custody Record

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Page 1 of 2

COC No.: RVAAP-GPL-001
Date: 11/16/2005

Name: Science Applications International Corporation
Address: 151 Layfayette Drive Oak Ridge, TN 37831
Phone Number: (865) 481-4600
Project Manager: Kevin Jago
Project Name: RVAAP Six High Priority AOCs
Job/P.O. #: 01 1700 04 3265 505

Sampler (Signature) Martha Clough (Printed Name) Martha Clough

Laboratory Name: GPL Laboratories, LLLP
Address: 7210A Corporate CT
Frederick, MD 21703
Phone: 301.694.5310
Contact: Virginia Zusman

Requested Parameters

Station	Sample ID	Depth	Date	Time	Matrix	S Explosives (A)	S Metals, TAL (A)	S Chromium +6 (A)	S TCLP- VOC, SVOC, PEST, HERB, MET (A)	S Chromium +6 and Total Chromium	W Explosives (A)	W Metals (C)	W Chromium +6 (A)	No. of Containers	OBSERVATIONS, COMMENTS SPECIAL INSTRUCTIONS
FBQ-193	FBQSS-193-500-SO	0-1	11/15/2005	0825	SO	1	1							2	
FBQ-193	FBQSO-193-0501-SO	1-3	11/15/2005	0835	SO	1	1							2	
FBQ-194	FBQSS-194-0502-SO	0-1	11/15/2005	0810	SO	1	1							2	
FBQ-194	FBQSO-194-0503-SO	1-2.3	11/15/2005	0820	SO	1	1							2	
FBQ-195	FBQSS-195-0504-SO	0-1	11/15/2005	0835	SO	1	1							2	
FBQ-195	FBQSO-195-0505-SO	1-2.3	11/15/2005	0850	SO	1	1							2	
FBQ-196	FBQSS-196-0506-SO	0-1	11/15/2005	0930	SO	1	1							2	
FBQ-196	FBQSS-196-0507-SO	1-2.8	11/15/2005	0945	SO	1	1							2	
FBQ-196	FBQSS-196-0512-SO	0-1	11/15/2005	0930	SO	1	1							2	
FBQ-197	FBQSS-197-0508-SO	0-1	11/14/2005	1400	SO	1	1							2	
FBQ-197	FBQSO-197-0509-SO	1-2.9	11/14/2005	1415	SO	1	1							2	
FBQ-198	FBQSS-198-0510-SO	0-1	11/14/2005	1445	SO	1	1							2	
FBQ-198	FBQSO-198-0511-SO	1-3	11/14/2005	1505	SO	1	1							2	

Subtotal Number of Containers: 26

Relinquished by	Date	Received by	Date
Signature: Martha Clough	11/16/05	Signature: Chino	9/17/05
Printed Name: Martha Clough	Time: 1700	Printed Name: Chino	Time: 9:30
Company:		Company: GPL	
Relinquished by	Date	Received by	Date
Signature:		Signature:	
Printed Name:	Time:	Printed Name:	Time:
Company:		Company:	

Notes:
A. Cool 4°C
B. HCl to pH<2, Cool 4°C
C. HNO_3 to pH<2, Cool 4°C
D. H_2SO_4 to pH<2, Cool 4°C
E. NaOH + Zn, Cool 4°C
F. $Na_2S_2O_3$ + Cool 4°C

COOLER IDs: GPL-01 AND GPL-02

S=soils
W=water

511091

Shipment Method:
FEDEX

Airbill No.:
853098769614
853098769603

Field Contact: Martha Clough
330-405-5804 (work)
216-287-0450 (cell)

Science Applications International Corporation

Chain of Custody Record

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COC No.: RVAAP-GPL-001
Page 2 of 2
Date: 11/16/2005

Name: Science Applications International Corporation
Address: 151 Layfayette Drive Oak Ridge, TN 37831
Phone Number: (865) 481-4600
Project Manager: Kevin Jago
Project Name: RVAAP Six High Priority AOCs
Job/P.O. #: 01 1700 04 3265 505

Sampler (Signature) Martha Clough (Printed Name) Martha Clough

Laboratory Name: GPL Laboratories, LLLP
Address: 7210A Corporate CT
Frederick, MD 21703
Phone: 301.694.5310
Contact: Virginia Zusman

Requested Parameters

Station	Sample ID	Depth	Date	Time	Matrix	S Explosives (A)	S Metals, TAL (A)	S Chromium +6 (A)	S TCLP- VOC, SVOC, PEST, HERB, MET (A)	S Chromium +6 and Total Chromium	W Explosives (A)	W Metals (C)	W Chromium +6 (A)	No. of Containers	OBSERVATIONS, COMMENTS SPECIAL INSTRUCTIONS
DA2-125	DA2SS-125-0900-SO	0-1	11/15/2005	1315	SO	1	1							2	
DA2-125	DA2SO-125-0901-SO	1-3	11/15/2005	1330	SO	1	1							2	
DA2-127	DA2SO-127-0905-SO	1-3	11/15/2005	1425	SO	1	1							2	
DA2-128	DA2SS-128-0906-SO	0-1	11/15/2005	1440	SO	1	1							2	
DA2-128	DA2SO-128-0907-SO	1-3	11/15/2005	1455	SO	1	1							2	
DA2-129	DA2SO-129-0909-SO	1-3	11/15/2005	1215	SO	1	1							2	
DA2-129	DA2SO-129-0914-SO	1-3	11/15/2005	1215	SO	1	1							2	
DA2-130	DA2SS-130-0910-SO	0-1	11/15/2005	1230	SO	1	1							2	
DA2-130	DA2SO-130-0911-SO	0-1.9	11/15/2005	1250	SO	1	1							2	
CBP-035	CBPSS-035-0100-SO	0-1	11/14/2005	1410	SO	1	1							2	
CBP-035	CBPSO-035-0101-SO	1-3	11/14/2005	1425	SO	1	1							2	
CBP-QC	CBP-QC-0131-QC	na	11/16/2005	1530	WA						2	1	1	4	
CBP-QC	CBP-QC-0132-QC	NA	11/16/2005	1550	WA						2	1	1	4	

Subtotal Number of Containers: 30

Relinquished by	Date	Received by	Date
Signature: Martha Clough	11/16/05	Signature: [illegible]	11/17/05
Printed Name: Martha Clough	Time: 1700	Printed Name: Chino	Time: 9:30
Company: SAIC		Company: GPL	

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

Notes: TOTAL NUMBER OF CONTAINERS 56
A. Cool 4°C
B. HCl to pH<2, Cool 4°C
C. HNO3 to pH<2, Cool 4°C
D. H2SO4 to pH<2, Cool 4°C
E. NaOH + Zn, Cool 4°C
F. $Na_2S_2O_3$ + Cool 4°C

COOLER IDs: GPL-01 AND GPL-02

S=soils
W=water

511093

Shipment Method: FEDEX

Airbill No.:
853098769614
853098769603

Field Contact: Martha Clough
330-405-5804 (work)
216-287-0450 (cell)

Science Applications International Corporation

Chain of Custody Record

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COC No.: RVAAP-GPL-002
Date: 11/17/2005

Name: Science Applications International Corporation
Address: 151 Layfayette Drive Oak Ridge, TN 37831
Phone Number: (865) 481-4600
Project Manager: Kevin Jago
Project Name: RVAAP Six High Priority AOCs
Job/P.O. #: 01 1700 04 3265 505

Sampler (Signature) Martha Clough (Printed Name) Martha Clough

Laboratory Name: GPL Laboratories, LLLP
Address: 7210A Corporate CT
Frederick, MD 21703
Phone: 301.694.5310
Contact: Virginia Zusman

Station	Sample ID	Depth	Date	Time	Matrix	S Explosives (A)	S Metals, TAL (A)	S Chromium +6 (A)	S TCLP- VOC, SVOC, PEST, HERB, MET (A)	S Chromium +6 and Total Chromium	S Metals, TAL and Chromium +6	W Explosives (A)	W Metals (C)	W Chromium +6 (A)	No. of Containers	OBSERVATIONS, COMMENTS SPECIAL INSTRUCTIONS
DA2-126	DA2SS-126-0902-SO	0-1	11/15/2005	1515	SO	1	1								2	14-21 day Turn Around Time Requested
DA2-126	DA2SO-126-0903-SO	1-3	11/15/2005	1525	SO	1	1								2	14-21 day Turn Around Time Requested
DA2-127	DA2SS-127-0904-SO	0-1	11/15/2005	1405	SO	1	1								2	14-21 day Turn Around Time Requested
DA2-129	DA2SS-129-0908-SO	0-1	11/15/2005	1155	SO	1	1								2	14-21 day Turn Around Time Requested
DA2-129	DASS-129-0912-SO	0-1	11/15/2005	1155	SO	1	1								2	14-21 day Turn Around Time Requested
CBP-037	CBPSO-037-0105-SO	1-3	11/16/2005	1015	SO	1	1								2	14-21 day Turn Around Time Requested
CBP-037	CBPSS-037-0104-SO	0-1	11/16/2005	1005	SO	1	1								2	14-21 day Turn Around Time Requested
CBP-037	CBPSS-037-0125-SO	0-1	11/16/2005	1005	SO	1	1								2	14-21 day Turn Around Time Requested
CBP-038	CBPSS-038-0106-SO	0-1	11/16/2005	1030	SO	1	1								2	14-21 day Turn Around Time Requested
CBP-038	CBPSO-038-0107-SO	1-3	11/16/2005	1040	SO	1	1								2	14-21 day Turn Around Time Requested
CBP-052	CBPSS-052-0122-SO	0-1	11/16/2005	0920	SO					1					1	14-21 day Turn Around Time Requested
CBP-052	CBPSS-052-0129-SO	0-1	11/16/2005	0920	SO					1					1	14-21 day Turn Around Time Requested
CBP-044	CBPSS-044-0114M-SO	0-5	11/16/2005	1430	SO	1			1		1				3	7-14 day Turn Around Time Requested

Subtotal Number of Containers: 25

Relinquished by: Martha Clough (Signature) | Date: 11/17/05 | Time: 1700
Printed Name: Martha Clough
Company: SAIC

Received by: (Signature) | Date: 11/18/05 | Time: 9:20
Printed Name: Chiao
Company: GPL

Relinquished by: Signature / Printed Name / Company | Date | Time

Received by: Signature / Printed Name / Company | Date | Time

Notes:
A. Cool 4°C
B. HCl to pH<2, Cool 4°C
C. HNO3 to pH<2, Cool 4°C
D. H2SO4 to pH<2, Cool 4°C
E. NaOH + Zn, Cool 4°C
F. $Na_2S_2O_3$ + Cool 4°C

COOLER IDs: GPL-03

S=soils
W=water

511101

Shipment Method: FEDEX

Airbill No.: 853098769669

Field Contact: Martha Clough
330-405-5804 (work)
216-287-0450 (cell)

Science Applications International Corporation

Chain of Custody Record

SAIC Science Applications International Corporation
..n Employee Owned Company

Page 2 of 2

COC No.: RVAAP-GPL-002
Date: 11/17/2005

Name: Science Applications International Corporation
Address: 151 Layfayette Drive Oak Ridge, TN 37831
Phone Number: (865) 481-4600
Project Manager: Kevin Jago
Project Name: RVAAP Six High Priority AOCs
Job/P.O. #: 01 1700 04 3265 505

Sampler (Signature) Martha Clough (Printed Name) Martha Clough

Laboratory Name: GPL Laboratories, LLLP
Address: 7210A Corporate CT
Frederick, MD 21703
Phone: 301.694.5310
Contact: Virginia Zusman

Requested Parameters

Station	Sample ID	Depth	Date	Time	Matrix	S Explosives (A)	S Metals, TAL (A)	S Chromium +6 (A)	S TCLP- VOC, SVOC, PEST, HERB, MET (A)	S Chromium +6 and Total Chromium	S Metals, TAL and Chromium +6	W Explosives (A)	W Metals (C)	W Chromium +6 (A)	No. of Containers	OBSERVATIONS, COMMENTS SPECIAL INSTRUCTIONS
CBP-QC	CBP-QC-0130-QC	NA	11/17/2005	1615	WA							2	1	1	4	
CBP-053	CBPSS-053-0123-SO	0-1	11/16/2005	0915	SO					1					1	14-21 day Turn Around Time Requested
CBP-036	CBPSS-036-0102-SO	0-1	11/16/2005	0825	SO	1	1								2	14-21 day Turn Around Time Requested
CBP-036	CBPSO-036-0103-SO	1-3	11/16/2005	0845	SO	1	1								2	14-21 day Turn Around Time Requested
CBP-039	CBPSS-039-0108-SO	0-1	11/16/2005	1105	SO	1	1								2	14-21 day Turn Around Time Requested
CBP-039	CBPS0-039-0109-SO	1-3	11/16/2005	1115	SO	1	1								2	14-21 day Turn Around Time Requested

Subtotal Number of Containers: 13

Relinquished by	Date	Received by	Date
Signature: Martha Clough	11/17/05	Signature: Chino	11/18/05
Printed Name: Martha Clough	Time: 1700	Printed Name: Chino	Time: 9:20
Company: SAIC		Company: GPL	

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

Notes: TOTAL NUMBER OF CONTAINERS 38
A. Cool 4°C C. HNO3 to pH<2, Cool 4°C
B. HCl to pH<2, Cool 4°C D. H2SO4 to pH<2, Cool 4°C
E. NaOH + Zn, Cool 4°C F. $Na_2S_2O_3$ + Cool 4°C

COOLER IDs: GPL-03

S=soils
W=water

511101

Shipment Method: FEDEX

Airbill No.: 853098769669

Field Contact: Martha Clough
330-405-5804 (work)
216-287-0450 (cell)

Science Applications International Corporation

Chain of Custody Record

Science Applications International Corporation
An Employee Owned Company

COC No.: RVAAP-GPL-003
Page 1 of 1
Date: 11/18/2005

Name: Science Applications International Corporation
Address: 151 Layfayette Drive Oak Ridge, TN 37831
Phone Number: (865) 481-4600
Project Manager: Kevin Jago
Project Name: RVAAP Six High Priority AOCs
Job/P.O. #: 01 1700 04 3265 505

Sampler (Signature) Martha Clough (Printed Name) Martha Clough

Laboratory Name: GPL Laboratories, LLLP
Address: 7210A Corporate CT
Frederick, MD 21703
Phone: 301.694.5310
Contact: Virginia Zusman

Requested Parameters

Station	Sample ID	Depth	Date	Time	Matrix	S Explosives (A)	S Metals, TAL (A)	S Chromium +6 (A)	S TCLP- VOC, SVOC, PEST, HERB, MET (A)	S Chromium +6 and Total Chromium	S Metals, TAL and Chromium +6	W Explosives (A)	W Metals (C)	W Chromium +6 (A)	No. of Containers	OBSERVATIONS, COMMENTS SPECIAL INSTRUCTIONS
CBP-040	CBPSS-040-0110M-SO	0-3	11/17/2005	0800	SO	1			1		1				3	7-14 day Turn Around Time Requested
CBP-041	CBPSS-041-0111M-SO	0-7	11/17/2005	0945	SO	1			1		1				3	7-14 day Turn Around Time Requested
CBP-041	CBPSS-041-0127M-SO	0-7	11/17/2005	0945	SO	1					1				2	7-14 day Turn Around Time Requested
CBP-042	CBPSS-042-0112M-SO	0-10	11/17/2005	1020	SO	1			1		1				3	7-14 day Turn Around Time Requested
CBP-042	CBPSS-042-0136M-SO	0-10	11/17/2005	1020	SO	1					1				2	7-14 day Turn Around Time Requested
CBP-043	CBPSS-043-0113M-SO	0-5	11/17/2005	1225	SO	1			1		1				3	7-14 day Turn Around Time Requested
CBP-045	CBPSS-045-0115M-SO	0-8	11/17/2005	1350	SO	1			1		1				3	7-14 day Turn Around Time Requested
CBP-046	CBPSS-046-0116M-SO	0-3	11/17/2005	1245	SO	1			1		1				3	7-14 day Turn Around Time Requested
CBP-048	CBPSS-048-0118M-SO	0-3	11/17/2005	1530	SO	1			1		1				3	7-14 day Turn Around Time Requested

Subtotal Number of Containers: 25

Relinquished by	Date	Received by	Date
Signature: Martha Clough	11/18/2005	Signature: Isaac	11/19/05
Printed Name: Martha Clough	Time: 1700	Printed Name: Isaac Chung	Time: 10:15
Company: SAIC		Company: GPL	

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

Notes: TOTAL NUMBER OF CONTAINERS 25
A. Cool 4°C C. HNO3 to pH<2, Cool 4°C
B. HCl to pH<2, Cool 4°C D. H2SO4 to pH<2, Cool 4°C
E. NaOH + Zn, Cool 4°C F. $Na_2S_2O_3$ + Cool 4°C

COOLER IDs: GPL-04

S=soils
W=water

511115

Shipment Method:
FEDEX

Airbill No.:
853098769636

Field Contact: Martha Clough
330-405-5804 (work)
216-287-0450 (cell)

Science Applications International Corporation

Chain of Custody Record

SAIC Science Applications International Corporation
An Employee Owned Company

COC No.: RVAAP-GPL-004
Page 1 of 1
Date: 11/21/2005

Name: Science Applications International Corporation
Address: 151 Layfayette Drive Oak Ridge, TN 37831
Phone Number: (865) 481-4600
Project Manager: Kevin Jago
Project Name: RVAAP Six High Priority AOCs
Job/P.O. #: 01 1700 04 3265 505
Sampler (Signature) [signature] (Printed Name) Martha Clough

Laboratory Name: GPL Laboratories, LLLP
Address: 7210A Corporate CT, Frederick, MD 21703
Phone: 301.694.5310
Contact: Virginia Zusman

Requested Parameters

Station	Sample ID	Depth	Date	Time	Matrix	S Explosives (1A)	S Metals, TAL and Chromium +6 (A)	S Total Chromium and Chromium +6 (A)	S TCLP - VOC, SVOC, PEST, HERB, MET (A)	W VOC - TCLP (4A)	W SVOCs - TCLP (5A)	W Metals - TCLP (6A)	W Pesticides - TCLP	W Herbicides - TCLP	No. of Containers	Observations, Comments, Special Instructions
CBP-054	CBPSS-054-0124-SO	0-1	11/17/2005	0950	SO			1							1	14-21 DAY TURN AROUND
CBP-049	CBPSS-049-0119M-SO	0-5	11/18/2005	0800	SO	1	1		1						3	7-14 DAY TURN AROUND
CBP-047	CBPSS-047-0117M-SO	0-8	11/18/2005	0945	SO	1	1		1						3	7-14 DAY TURN AROUND
CBP-050	CBPSS-050-0120M-SO	0-6	11/18/2005	0810	SO	1	1		1						3	7-14 DAY TURN AROUND
CBP-051	CBPSS-051-0121M-SO	0-6	11/18/2005	0805	SO	1	1		1						3	7-14 DAY TURN AROUND
CBP-IDW	CBP-IDW-0134-SO	NA	11/21/2005	1130	SO				1						1	
CBP-IDW	CBP-IDW-0133-DW	NA	11/21/2005	1230	WA					2	2	1	2	2	9	

Subtotal Number of Containers: 23

Relinquished by	Date	Received by	Date
Signature: [signature]	11/21/05	Signature: Chino	11/22/05
Printed Name: Martha Clough	Time: 1600	Printed Name: [signature]	Time: 9:45
Company: SAIC		Company: GPL	

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

Notes:
A. Cool 4°C
B. HCl to pH<2, Cool 4°C
C. HNO3 to pH<2, Cool 4°C
D. H2SO4 to pH<2, Cool 4°C
E. NaOH + Zn, Cool 4°C
F. $Na_2S_2O_3$ + Cool 4°C

S=soils
W=water

511120

Shipment Method: FEDEX
Airbill No.: 7924 4374 0739
Field Contact: Martha Clough
330-405-5804 (work)
216-287-0450 (cell)

Science Applications International Corporation

ATTACHMENT F

TOPOGRAPHIC SURVEY DATA

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Sample ID	Easting	Northing	Elevation
FBQ-193	2350691.741	554449.086	1174.27
FBQ-194	2350506.794	554584.976	1179.227
FBQ-195	2350662.088	554291.795	1169.706
FBQ-196	2350281.923	553209.866	1118.925
FBQ-197	2349859.282	553071.773	1105.886
FBQ-198	2349360.373	553221.706	1098.237
- coordinate system is Ohio State Plan 1983 Ohio North 3401 NAD 1983 Feet			

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ATTACHMENT G

MUNITIONS AND EXPLOSIVES OF CONCERN AVOIDANCE SURVEY REPORT

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4 January 2006

Science Applications International Corporation
Attn: Martha L. Clough
8866 Commons Blvd., Suite 201
Twinsburg, OH 44087

RE: After Action Report (AAR) for the MEC Avoidance Support at the Ravenna Army Ammunition Plant (RVAAP), Ravenna, Ohio.

Dear Martha Clough,

USA Environmental, Inc. (USAE) completed the Munitions and Explosives of Concern (MEC) Avoidance Support at the Ravenna Army Ammunition Plant located in Ravenna, Ohio, from 13-19 November 2005. All operations were completed safely, on time, within budgeted funding, and in accordance with the project technical scope of work.

Throughout the project operations, USAE encountered two munitions debris, which were identified as possible fragments from a 3.5-Inch Rocket. Other than the two munitions debris found, USAE did not encounter any unexploded ordnance (UXO)/MEC items at any of the RVAAP areas of concern (AOCs): the Open Demolition Area 2 (RVAAP-04), the Fuze and Booster Quarry Landfill/Ponds (RVAAP-16), and the Central Burn Pits (RVAAP-49).

Upon receipt of the approval of the work plan and a notice to proceed from Science Applications International Corporation (SAIC), USAE mobilized one UXO qualified personnel, Mr. Dale Miller, and the project support equipment to the RVAAP project site. Mr. Miller has completed the U.S. Naval Explosive Ordnance Disposal training, which details procedures for evaluation and disposal of MEC. Prior to beginning work on site, Mr. Miller also completed a health and safety training program, which complies with Occupational Safety and Health Administration (OSHA) Regulations 29 CFR 1910.120e(9). All USAE employees who work on hazardous sites receive training, which includes an equivalent of 40 hours of training off-site and actual field experience under the direct supervision of a trained, experienced Supervisor. Management and Supervisors receive an additional 8 hours of training on program supervision. Each employee receives 8 hours of OSHA refresher training annually.

Mr. Miller arrived on site at Building 1036 at 0830 on 14 November 2005. Mr. Miller coordinated with Ms. Martha Clough (SAIC Site Manager) for site safety and pre-operation orientation. Upon completion of the orientation and prior to beginning the field operations, Mr. Miller performed a tailgate safety briefing for all field personnel. Mr. Miller commenced the marking sample location operations at areas RVAAP 16 and RVAAP-04. During MEC avoidance support of areas RVAAP-16 and RVAAP-04, Mr. Miller did not encounter any MEC/UXO related items.

On 15 November 2005, prior to beginning the field operations, Mr. Miller provided the daily and tailgate safety briefings and then commenced the soil sample collection operations at the RVAAP-16 and RVAAP-04. During the surface sweep of area RVAAP-16, Mr. Miller did not encounter any MEC/UXO related items. However, during the surface sweep of area RVAAP-04, Mr. Miller encountered two pieces of munitions debris located at sample location #130. Mr. Miller identified these items as potential fragments from a 3.5-Inch Rocket. The two munitions debris encountered were reported to SAIC and avoided. Mr. Miller successfully completed the soil sample collection of both areas at RVAAP-16 and RVAAP-04 with no incidents or accidents.

On 16 November 2005, prior to beginning the field operations, Mr. Miller provided the daily and tailgate safety briefings and then commenced the soil sample collection operations at the Central Burn Pits (RVAAP-49). The soil sample collection activities of this sample area continued for the remaining duration of the project. During the surface sweep of area RVAAP-49, Mr. Miller did not encounter any MEC/UXO related items. Mr. Miller successfully completed the soil sample collection of area RVAAP-49 on 18 November 2005 and demobilized on 19 November 2005.

USAE completed all field operations at the RVAAP in accordance with the approved Work Plan and contract requirements. All site operations were completed safely, efficiently, and in accordance with the Technical Scope of Work.

Sincerely,

Manok N. Synakorn
Project Manager

Encl: Attachment 1, Daily Site Summaries and Daily Safety Briefings

Attachment 1

Daily Site Summaries and Daily Safety Briefings.

USA Environmental, Inc.

Tailgate Safety Briefing

Date: 11 / 18 / 05 **Location:** Ravenna AAP

Time: 7:50 AM PM **Team #:** ______

1. Reason for Briefing:

✓	Daily Safety Briefing		New Site Procedure
	Initial Safety Briefing		New Site Information
	New Task Briefing		Review of Site Information
	Periodic Safety Meeting		Other: (Specify)

2. Personnel Attending:

Name	Signature	Position
Martha Clough	Martha Clough	FM / SSHO
Brian Williams	Brian Williams	Tech.
Jed Thomas	Jed Thomas	Tech

Briefing Given By:

Name	Signature	Position
Dale E. Miller	Dale E. Miller	T-3

3. Topics: (Check All That Apply)

	Site Safety Personnel		Decontamination Procedures
	Site/Work Area Description	✓	Emergency Response/Equipment
✓	Physical Hazards		On-Site Injuries/Illnesses
	Chemical/Biological Hazards		Reporting Procedures
✓	Heat/Cold Stress		Directions to Medical Facility
	Work/Support Zones		Drug and Alcohol Policies
✓	PPE		Medical Monitoring
✓	Safe Work Practices	✓	Evacuation/Egress Procedures
	Air Monitoring		Communications
	Task Training		Confined Spaces
✓	MEC Precautions		Other:

4. Remarks:

USA Environmental, Inc.

Tailgate Safety Briefing

Date: 11 / 17 / 05 Location: Ravenna AAP

Time: 7:55 AM PM Team #: ______

1. Reason for Briefing:

✓	Daily Safety Briefing		New Site Procedure
	Initial Safety Briefing		New Site Information
	New Task Briefing		Review of Site Information
	Periodic Safety Meeting		Other: (Specify)

2. Personnel Attending:

Name	Signature	Position
Martha Clough	Martha Clough	FM/SSHO
Brian Williams	B. Williams	Tech
Jed Thomas	Jed Thomas	Tech

Briefing Given By:

Name	Signature	Position
Dale E. Miller	Dale E. Miller	T-3

3. Topics: (Check All That Apply)

	Site Safety Personnel		Decontamination Procedures
	Site/Work Area Description	✓	Emergency Response/Equipment
✓	Physical Hazards		On-Site Injuries/Illnesses
	Chemical/Biological Hazards		Reporting Procedures
✓	Heat/Cold Stress		Directions to Medical Facility
	Work/Support Zones		Drug and Alcohol Policies
✓	PPE		Medical Monitoring
✓	Safe Work Practices	✓	Evacuation/Egress Procedures
	Air Monitoring		Communications
	Task Training		Confined Spaces
✓	MEC Precautions		Other:

4. Remarks:

USA Environmental, Inc.

Tailgate Safety Briefing

Date: 11 / 16 / 05 **Location:** Ravenna AAP

Time: 7:10 AM PM **Team #:** ______

1. Reason for Briefing:			
✓	Daily Safety Briefing		New Site Procedure
	Initial Safety Briefing		New Site Information
	New Task Briefing		Review of Site Information
	Periodic Safety Meeting		Other: (Specify)

2. Personnel Attending:

Name	Signature	Position
Martha Clough	Martha Clough	FM SHSO
Jed Thomas	Jed Thomas	Field Crew
Beau Williams	Beau Williams	Field Crew

Briefing Given By:

Name	Signature	Position
Dale E. Miller	Dale E. Miller	T-3

3. Topics: (Check All That Apply)			
	Site Safety Personnel		Decontamination Procedures
	Site/Work Area Description	✓	Emergency Response/Equipment
✓	Physical Hazards		On-Site Injuries/Illnesses
	Chemical/Biological Hazards		Reporting Procedures
✓	Heat/Cold Stress		Directions to Medical Facility
	Work/Support Zones		Drug and Alcohol Policies
✓	PPE		Medical Monitoring
✓	Safe Work Practices	✓	Evacuation/Egress Procedures
	Air Monitoring		Communications
	Task Training		Confined Spaces
✓	MEC Precautions		Other:

4. Remarks:

USA Environmental, Inc.

Tailgate Safety Briefing

Date: 11 / 15 / 05 **Location:** Ravenna AAP

Time: 7:20 AM PM **Team #:** ______

1. Reason for Briefing:			
✓	Daily Safety Briefing		New Site Procedure
	Initial Safety Briefing		New Site Information
	New Task Briefing		Review of Site Information
	Periodic Safety Meeting		Other: (Specify)

2. Personnel Attending:

Name	Signature	Position
Martha Clough	Martha Clough	FM SHSO
Jed Thomas	Jed Thomas	Field Crew
Beau Williams	Beau Williams	Field Crew

Briefing Given By:

Name	Signature	Position
Dale E. Miller	Dale E. Miller	T-3

3. Topics: (Check All That Apply)			
	Site Safety Personnel		Decontamination Procedures
	Site/Work Area Description	✓	Emergency Response/Equipment
✓	Physical Hazards		On-Site Injuries/Illnesses
	Chemical/Biological Hazards		Reporting Procedures
✓	Heat/Cold Stress		Directions to Medical Facility
	Work/Support Zones		Drug and Alcohol Policies
✓	PPE		Medical Monitoring
✓	Safe Work Practices	✓	Evacuation/Egress Procedures
	Air Monitoring		Communications
	Task Training		Confined Spaces
✓	MEC Precautions		Other:

4. Remarks:

USA Environmental, Inc.

Tailgate Safety Briefing

Date: 11 / 14 / 05 **Location:** Ravenna AAP

Time: 9:15 AM PM **Team #:**

1. Reason for Briefing:

✓	Daily Safety Briefing		New Site Procedure
	Initial Safety Briefing		New Site Information
	New Task Briefing		Review of Site Information
	Periodic Safety Meeting		Other: (Specify)

2. Personnel Attending:

Name	Signature	Position
Martha Clough	Martha Clough	FM, SHSO
Jed Thomas	Jed Thomas	Field Crew
Beau Williams	Beau Williams	Field Crew

Briefing Given By:

Name	Signature	Position
Dale E. Miller	Dale E. Miller	T-3

3. Topics: (Check All That Apply)

	Site Safety Personnel		Decontamination Procedures
	Site/Work Area Description	✓	Emergency Response/Equipment
✓	Physical Hazards		On-Site Injuries/Illnesses
	Chemical/Biological Hazards		Reporting Procedures
✓	Heat/Cold Stress		Directions to Medical Facility
	Work/Support Zones		Drug and Alcohol Policies
✓	PPE		Medical Monitoring
✓	Safe Work Practices	✓	Evacuation/Egress Procedures
	Air Monitoring		Communications
	Task Training		Confined Spaces
✓	MEC Precautions		Other:

4. Remarks:

DAILY OPERATIONS SUMMARY

DATE: 11/13/05 thru 11/19/05

PAGE 1 OF 5 PAGES

SITE / LOCATION: Ravenna Army Ammunition Plant

1. WORK SUMMARY

a. Work Accomplished:

	Number Completed	Total Remaining
(1) Survey		
(2) Preparation		
(3) Mag & Flag		
(4) Geophysical		
(5) Intrusive		
(6) Quality Control		
(7) Quality Assurance		

b. Discrepancies: ______

c. Inspection Results:

	Pass	Fail
(1) Quality Control		
(2) Quality Assurance		
(3) Safety		

2. INSTRUCTIONS RECEIVED FROM CUSTOMER REPRESENTATIVE:

Escort SAIC personnel while collecting soil samples to ensure ordnance avoidance in all phases of the project.

Daily Operations Summary Con't.

3. UXO SUMMARY

a. UXO Located: None

Type:	Quantity:	Live/Prac.:	Remarks:

Daily Operations Summary Con't.

b. Demolition Supplies Expended: None

Type:	Quantity:	Remarks:

c. Scrap Generation / Deposition: None

Type:	Quantity:	Weight:	Remarks:

Daily Operations Summary Con't.

4. Utilization

a. Daily Man-hours:

Labor Category:	Task #:	M/H Used this ~~Today:~~ Week!	M/H Remaining:	% M/H Remaining:	Remarks:
Project Manager					
SUXO					
UXO Tech. III		44			
UXO Tech. II					
UXO Tech. I					
Laborer					
UXOSO					
UXOQCS					
Admin Personnel					
Visitor					
Sub-Contractor Personnel (List by Category)					

Daily Operations Summary Con't.

PAGE 5 of 5 PAGES

b. Daily Equipment:

Description:	Task:	Hours Used:	Hours Remaining:	% Hours Remaining:	Remarks:
Schonstedt		44			
Geophysical					
Truck (Heavy)					
Truck (Light)		44			
Radio, Base					
Radio, Handheld					
Backhoe					
Front-end Loader					
Rental Car					
GPS					
Weedeater					
Chainsaw					
Chipper					

5. Operational Remarks:

6. Signature / Date:

Dale E. Miller
SUXO / Project Manager

Date: 11 / 19 / 05

11/13/05

1

Dale E. Miller, Tech III mobilized from Aberdeen, OH to Ravenna Army Ammunition Plant.

1935 Arrived at Hampton Inn, Brimfield, OH

Received 4 packages shipped from USA Environmental.

1 Schoenstadt
1 MK 26 Forrester
1 First Aid Kit
1 Water Jug (5 gal)
2 Radios with chargers
1 Hard Hat
4 pr Safety glasses
2 pr Gloves
1 Safety Vest
1 roll engineers tape
1 roll package tape
10 pr ear plugs
1 pkg 9V batteries

Dale E. Miller
11/13/05

11/14/05

0830 Arrived at Ravenna Army Ammunition Plant and met SAIC personnel. Martha Clough, site manager, Jed Thomas and Beau Williams.

0900 Morning safety briefing by Martha Clough.

0920 Departed Bldg 1036 for the field.

0935 Tailgate safety brief.

0945 Commenced marking sample sites in Fuse, Booster Quarry area.

1115 Completed marking sample sites in FBQ area. Moved to Open Demolition Area 2.

1200 Lunch break.

1245 Lunch break over, back to ODA2.

1405 Completed marking sample sites in ODA2. Moving back to FBQ area to begin taking soil samples.

1645 Completed taking samples from two sample sites. Returning to bldg 1036.

1700 Secured for the day. No MEC or residue encountered today.

Dale E. Muller

11/14/05

11/15/05

0700 Morning safety brief.
0720 Tailgate safety brief.
0725 Departed Bldg 1036 to collect soil samples.
0755 Arrived at the FBQ area to collect samples.
1115 Finished collection of samples in the FBQ area. Will break for lunch.
1145 Lunch break complete. Moving to the Open Detonation Area #2 to collect soil samples.
1320 Encountered two pieces of frag from 3.5" rockets at sample site #130. Items moved to facilitate sampling work. No explosive residue associated with these two items.
1615 Finished collection of samples from ODA2, returning to Bldg 1036.
1657 Secured for the day. No MEC items encountered today.

Dale E. Miller
11/15/05

11/16/05

0700 Morning Safety Brief

0710 Tail gate safety brief.

0715 Departed Bldg 1036 to collect soil samples from the central burn pits area.

0740 Arrived at the central burn pits area, started collecting samples.

1210 Returned to Bldg 1036 to turn in collected samples.

1215 Taking lunch break

1245 Lunch break over. Returning to central burn pits area to continue collecting samples.

1625 Returned to Bldg 1036 with soil samples.
No MEC or related residue encountered today.

1640 Secured for the day.

Dale E. Miller
11/16/05

11/17/05

0703 Morning safety brief.

0745 Departed Bldg 1036 to collect soil samples from the central burn area.

0755 Tailgate safety brief.

0800 Started collection of soil samples.

1145 Lunch break.

1220 Lunch break over, returned to collecting soil samples.

1650 Returned to Bldg 1036 with collected samples.

1705 Secured for the day.

Dale E. Miller
11/17/05

11/18/05

0600 Gave MK 26 to desk clerk at Motel, Hampton Inn, who stated that he would call Fed Ex for pick up. MK 26 is being shipped to James Hannan in Abingdon, MD.

0700 Morning safety brief.

0735 Departed Bldg 1036 to resume collecting soil samples from the central barn area.

0750 Tailgate safety brief!

0800 Resumed collecting soil samples.

1115 Completed collection of all soil samples, returning to Bldg 1036.

1145 Completed packaging of all USHE equipment for shipment back to Tampa, FL.

1200 Departed Ravenna AAP to drop equipment for shipping.

1230 Equipment dropped for shipping.

1400 Completed paper work for project. On site work complete.

1600 Call Manok Synakorn to report that all documentation will be sent to him via Fedex on Monday.

Dale E. Miller
11/18/05

11/19/05 7

0515 Demolized from Brainfield, Ohio to ~~At~~ Aberdeen, OH.
1230 Washed truck after project use.
1300 Arrived at home of record.

Dale E. Miller
11/19/05

Appendix 3A
Fate and Transport of COCs in Soil

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3A.0 CONTAMINANT FATE AND TRANSPORT

3A.1 INTRODUCTION

An assessment of impacted soils at FBQ was conducted to evaluate their potential to impact groundwater both at the AOC (residential land use exposure scenario) and at an exposure point downgradient of the AOC (National Guard Trainee land use exposure scenario) to ensure residual concentrations in soils are protective of groundwater under both potential land use exposure scenarios. The process for identifying these soil constituents with potential to impact groundwater is explained and executed in Section 3A.2. Section 3A.3 presents the conclusion of the evaluation: a list of AOC-specific constituents producing unacceptable impact to groundwater beneath the source (affecting unrestricted land usage) or at a receptor downgradient of the source (affecting restricted land usage).

3A.2 EVALUATION

This section describes the steps implemented to identify constituents in soils impacting groundwater:

- Section 3A.2.1 lists constituents identified in the RI Report as potentially impacting groundwater.

- Section 3A.2.2 evaluates these constituents across multiple media to further refine the list of potential constituents.

- Section 3A.2.3 presents refinements to the modeling performed in the RI Report, if appropriate.

3A.2.1 RI Evaluation Process

Constituents are identified in Chapter 5 (Contaminant Fate and Transport) of the RI Report that potentially impact groundwater at FBQ. The RI Report identified potential impacts beneath the source and at receptor locations downgradient of the source.

The RI Report identified constituents with potential or observed impacts beneath a source area as CMCOPCs. Potential impacts beneath the source were determined from model predictions of observed soil sample results where the predicted concentration at the water table beneath the source exceeded the MCL or residential USEPA Region 9 preliminary remediation goal (PRG). Constituents also are identified as CMCOPCs if they were detected in AOC groundwater and exceeded the MCL or residential PRG.

The RI Report identified constituents with potential groundwater impacts at receptor locations downgradient of the source area as CMCOCs. Potential impacts to receptors downgradient of the AOC source were determined in the RI Report based on modeling of contaminant migration (i.e., CMCOPC migration) within the groundwater aquifer. All CMCOPCs were evaluated for impacts at downgradient receptors.

3A.2.2 AOC-Specific Evaluation

The constituents identified in Table 3A-1 are evaluated across multiple media. The evaluation examines the constituent distribution in soil or water compared to background concentrations. It also examines the nature of modeling completed during the RI. The criteria below were evaluated to determine the potential for impacts to groundwater from impacted soils at each of the AOCs.

Background: If model input source concentrations are less than either surface or subsurface background, predicted results are compared to observed groundwater data to assess the generally conservative nature of the modeling. As part of this evaluation, the soils data are reviewed for patterns of detections (both vertically and laterally) and nearby surface water and groundwater results are also reviewed to ensure consistency between predicted and observed results when source concentrations from the RI were at or below background:

- For CMCOPCs where all observed sample results are less than background (either surface or subsurface soils), the constituent is removed from further consideration of future groundwater impacts.

- For CMCOPCs where the source concentration (i.e., concentration input to modeling) is less than background levels (either surface or subsurface soils), the constituent is removed from further consideration of future groundwater impacts.

- For CMCOPCs where one or more samples or the source concentration exceeds background levels, RI data are further reviewed for pattern of detection (e.g., do elevated surface and subsurface soil results occur at the same location; is there a pattern of detections indicative of a contaminant plume; are the elevated detections located in separate areas with no recognizable pattern).

Predicted Time of Maximum Impact: If the predicted time of maximum impact in RI is short (e.g., less than 10 years) and activities ceased at the AOC long before that period of time, the predicted maximum impact has likely occurred in the past. In these cases, observed groundwater data are reviewed, and if maximum observed groundwater data are less than the constituent-specific MCL or RBC, the constituent is removed from further consideration of future groundwater impacts. If predicted maximum impact is less than the constituent-specific MCL or RBC, the constituent is removed from further consideration of future groundwater impacts.

Detected in Groundwater: If a constituent is detected in groundwater, but not detected in soils, the constituent is removed from further consideration of future groundwater impacts. If a constituent is detected in groundwater and is detected in soils at or below background levels, the constituent also is removed from further consideration of future groundwater impacts.

3A.2.2.1 Fuze and Booster Quarry Landfill/Ponds

Based on the results of the Phase I/Phase II RI for FBQ, six constituents are evaluated for potential impacts in groundwater beneath the source and all except for selenium are evaluated for potential impacts to groundwater at downgradient receptors (Table 3A-1). Upon further analysis, none of these constituents were predicted or identified to impact groundwater at the AOC or downgradient of the AOC as summarized below.

Table 3A-1. Potential Groundwater Impacts Identified in Phase I/Phase II RI Report for FBQ

Potential Groundwater Impact Beneath the Source[a]	Potential Groundwater Impact Downgradient of the Source[b]
Fuze and Booster Quarry Landfill/Ponds	
Chromium (total)	Chromium (total)
Manganese	Manganese
Selenium	
2,4,6-Trinitrotoluene	2,4,6-Trinitrotoluene
RDX	RDX
TCE	TCE

[a]Potential groundwater impact beneath the source is determined from either SESOIL+AT123D modeling in the Remedial Investigation (RI) of the concentration at the water table in the RI or observed MCL/PRG exceedance of groundwater samples identified in the RI.
[b]Potential groundwater impact downgradient of the source is determined from AT123D modeling of the contaminant plume migrating to receptors.
MCL = Maximum contaminant level.
PRG = United States Environmental Protection Agency Region 9 preliminary remedial goal.
TCE = Trichloroethene.
SESOIL = Seasonal Soil Compartment Model.
AT123D = Analytical Transient 1-,2-,3- Dimensional.
RDX = Hexahydro-1,3,5-trinitro-1,3,5-triazine.

- Chromium (total) is removed from further consideration of future groundwater impacts at FBQ because the source concentration is less than subsurface soil background, there is no pattern of detections indicative of migration, and observed groundwater and surface water results are below the MCL. The source concentration (25.9 mg/L - less than subsurface background) results in predicted groundwater impact beneath the AOC roughly 76 times greater than observed concentrations in groundwater due to the conservative nature of the modeling. If background concentrations in soils produced predicted groundwater concentrations, then actual observed concentrations in groundwater should be similar to predicted modeling results.

- Manganese is removed from further consideration of future groundwater impacts at FBQ because there only 2 of 97 exceedances of background; and the soil EPC is less than subsurface soil background; and observed groundwater results are at or below background.

- 2,4,6-TNT is removed from further consideration of future groundwater impacts at FBQ, because detections were limited to surface soils (0-1 ft BGS) and modeling indicates no leaching to groundwater.

- RDX was identified as CMCOPC from SESOIL source load modeling in RI with maximum impact predicted in 7 years. Given AOC history, the maximum impact likely occurred in the past. RDX is removed from further consideration of future groundwater impacts at FBQ because there is only a single detection in soils, the predicted time of maximum impact to groundwater is 7 years (so maximum impact has likely passed), and RDX has not been detected in surface water or groundwater samples at FBQ.

- TCE was detected in 3 of 13 soil samples [2 of 8 in surface soil (0-1 ft BGS) and 1 of 5 in subsurface soil (1-3 ft BGS)] with all 3 detections J-qualified and not located in area of observed groundwater impacts. Based on observed soil and groundwater sample results, TCE removed from further consideration of future groundwater impacts.

3A.2.3 Refined AOC-Specific Modeling Results

Based on analyses of the conservative fate and transport assessment performed in support of the RI for FBQ, no COCs were identified for further analysis using the SESOIL/AT123D models previously developed with refined input parameters.

3A.3 CONCLUSIONS

Impacted soils at FBQ are not predicted to impact underlying groundwater beneath the AOC. Therefore, soil remediation for protection of groundwater is not required and the AOC may be released for unrestricted land use with respect to future groundwater impacts from impacted soils.

Appendix 3B
Volume Estimates

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3B.0 VOLUME ESTIMATES

3B.1 INTRODUCTION

This appendix presents the methodology, data, and information used to estimate the volume of impacted soils and/or dry sediments at FBQ for preliminary cleanup goals based on both residential and restricted (National Guard Trainee) land use exposure scenarios. The volume of impacted soils and dry sediments is driven by the COCs and preliminary cleanup goals identified in Chapter 3 of this FS.

3B.2 ENVIRONMENTAL DATA

Chapter 3 of this FS Report details the impacted media and the associated COCs and preliminary cleanup goals identified for FBQ. Table 3B-1 summarizes the COCs and preliminary cleanup goals modeled to generate estimated volumes of impacted soils and/or dry sediments at FBQ where COCs in these media were identified to be evaluated further in the FS.

The predominant source of data for developing the volume estimates at FBQ was the RI Report. Analytical data from these investigations defined the nature and extent of contamination at FBQ and were used to determine extents for specific COCs.

Table 3B-1. Modeled COCs and Preliminary Cleanup Goals

Media	Constituent of Concern	EPC (mg/kg)	Preliminary Cleanup Goals (mg/kg)
FBQ ~ National Guard Trainee Land Use			
Sediment	Manganese (Ditch)	4,100	1,950
Fuze and Booster Quarry Landfill/Ponds ~ Resident Subsistence Farmer Land Use			
Sediment	Manganese (Ditch)	4,100	2,900

(s) = shallow surface soil EPC (0-1 ft BGS) (sub) = subsurface soil EPC (1-3 ft BGS)
BGS = Below ground surface.
EPC = Exposure point concentration.
FBQ = Fuze and Booster Quarry Landfill/Ponds.

3B.3 MODELING

Environmental data (i.e., analytical data) were used to develop 3D models of the COCs in soils and/or dry sediments using EarthVision™ Version 7.99. The 3D modeling process can be viewed as expanding traditional two-dimensional contouring programs into three dimensions. The environmental data at FBQ were collected at various locations and depths. Concentrations are contoured at user-specified levels in 3D space. Volumes of soils and dry sediments above preliminary cleanup goals are subsequently calculated from the model.

Conceptual AOC knowledge is incorporated into the model to permit a more accurate representation of contaminant extent and volume estimates. Pertinent AOC features such as topography, water table elevations, top of bedrock elevations, etc., have been incorporated into the model to establish the upper and lower extents and to determine the volume of impacted soils and dry sediments. The locations of ditches and ponds are accounted for within the model.

There are a number of assumptions inherent in the development of the impacted soil and dry sediment volume estimates of COCs at FBQ:

- Environmental data accurately represent the nature and extent of the COCs in soils and sediments at the AOC (i.e., significant contamination was detected during RI sampling activities).

- AOC knowledge (reported or observed) pertaining to the extent of the ditches, ponds, etc. permits an accurate representation of these features in the 3D models.

- The impact of constructability is equal to 25% of the calculated in situ volume.

- The increase in volume (swell factor) is equal to 20% of the calculated constructability volume. One in situ or in place cubic yard is therefore equal to 1.2 yd^3 after excavation or ex situ.

3B.3.1.1 Historical Information and Knowledge

Historical information summarized in the RI Report provided additional information regarding potential contaminant distribution which was not captured in analytical data sources.

3B.3.1.2 Over-Excavation and Constructability

Excavation will be performed in a conservative manner to ensure preliminary cleanup goals are achieved. Additional excavated volume to assure safe slopes on side walls and to address machinery limitations (i.e., constructability) is estimated, as well as the effects of over-excavation and constructability. Experience in excavation has shown that this conservatism results in an over-excavation and constructability of roughly 25% of the estimated in situ volume.

3B.3.1.3 Ex Situ Volume

The volumes presented to this point constitute “in place” or in situ volumes. The act of excavation results in an expansion of the excavated material. This expanded volume is then transported and disposed. The volume expansion, or “swell”, experienced by soil/sediment when it is excavated averages approximately 20% resulting in the overall estimated ex situ volume.

3B.4 ESTIMATED VOLUMES OF IMPACTED SOILS/DRY SEDIMENTS

The estimated soil/dry sediment volumes developed for FBQ, as described in Section 3B.3, are summarized below and in Table 3B-2.

3B.4.1 Fuze and Booster Quarry Landfill/Ponds ~ National Guard Trainee Land Use

For the restricted land use scenario at FBQ, manganese exceeded the preliminary cleanup goal in sediment (1,950 mg/kg) at the following locations:

- FBQsd-141; and
- FBQsd-142.

Figure 3B-1 depicts the modeled extent for restricted land use resulting in an estimated 68 cubic yards (in situ) of impacted sediment.

3B.4.2 Fuze and Booster Quarry Ponds/Landfill ~ Resident Subsistence Farmer Land Use

For the residential land use scenario, manganese exceeded the preliminary cleanup goal in sediment at one location (FBQsd-141). The preliminary cleanup goal for manganese in sediment is higher (2,900 mg/kg) in the residential land use scenario than in the restricted land use scenario. Figure 3B-2 depicts the modeled extent for unrestricted land use resulting in an estimated 37 yd^3 (in situ) of impacted sediment.

Table 3B-2. Estimated Volumes of Impacted Soils/Sediments

AOC /Scenario	Surface Area	In situ		In situ with Constructability[a]		Ex situ[a,b]	
	(ft^2)	Volume (ft^3)	Volume (yd^3)	Volume (ft^3)	Volume (yd^3)	Volume (ft^3)	Volume (yd^3)
FBQ National Guard Trainee Land Use – Sediment*	1,380	1,840	68	2,300	85	2,760	102
FBQ Resident Subsistence Farmer Land Use – Sediment*	750	1,000	37	1,250	46	1,500	56

*volumes are calculated based on sediment samples collected at 0.5 ft in depth and removal depths of 1.0 ft.
[a] Includes 25% constructability factor.
[b] Includes 20% swell factor.
AOC = Area of concern.
FBQ = Fuze and Booster Quarry Landfill/Ponds.

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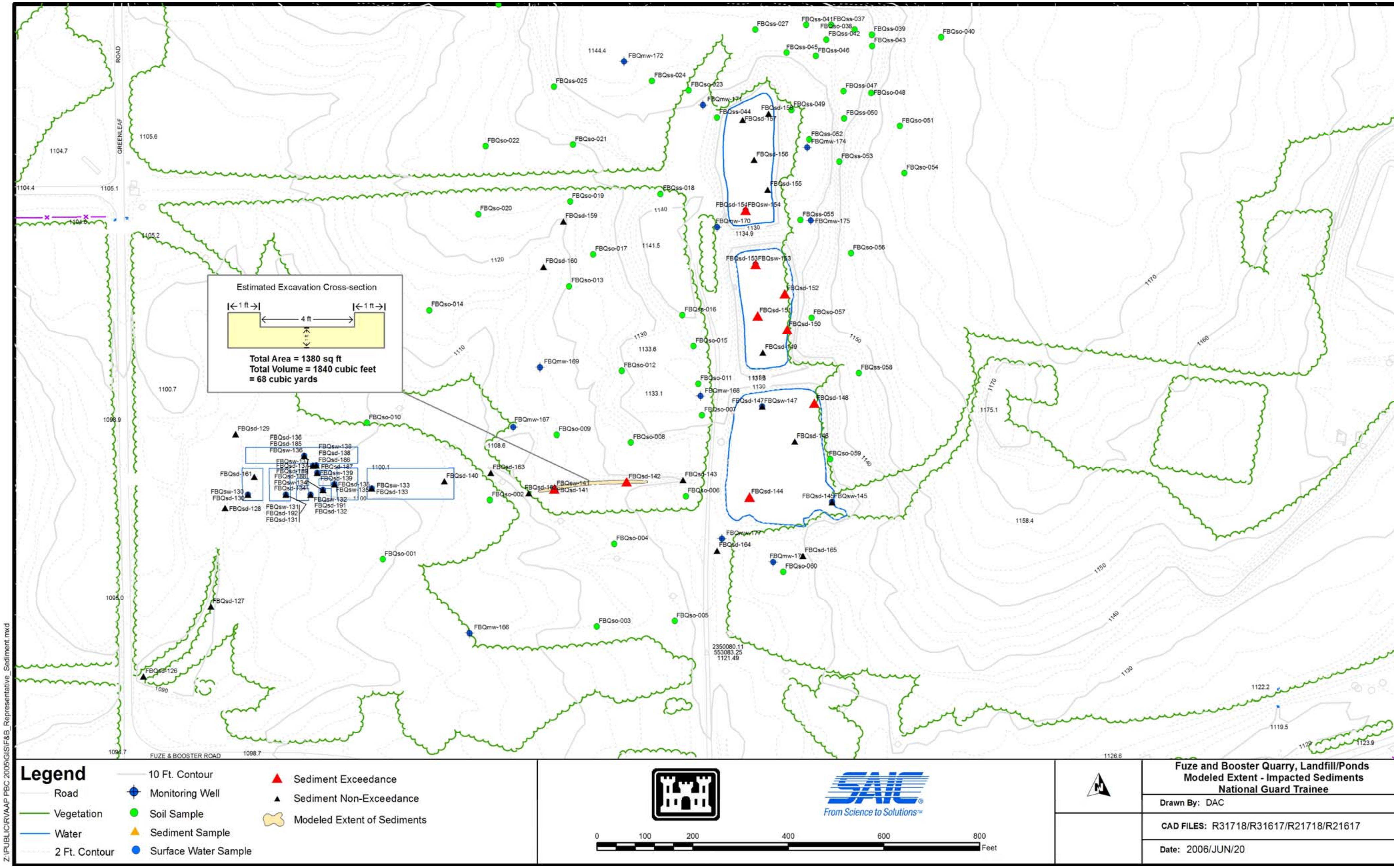

Figure 3B-1. Modeled Extent at Fuze and Booster Quarry Landfill/Ponds – National Guard Trainee Land Use

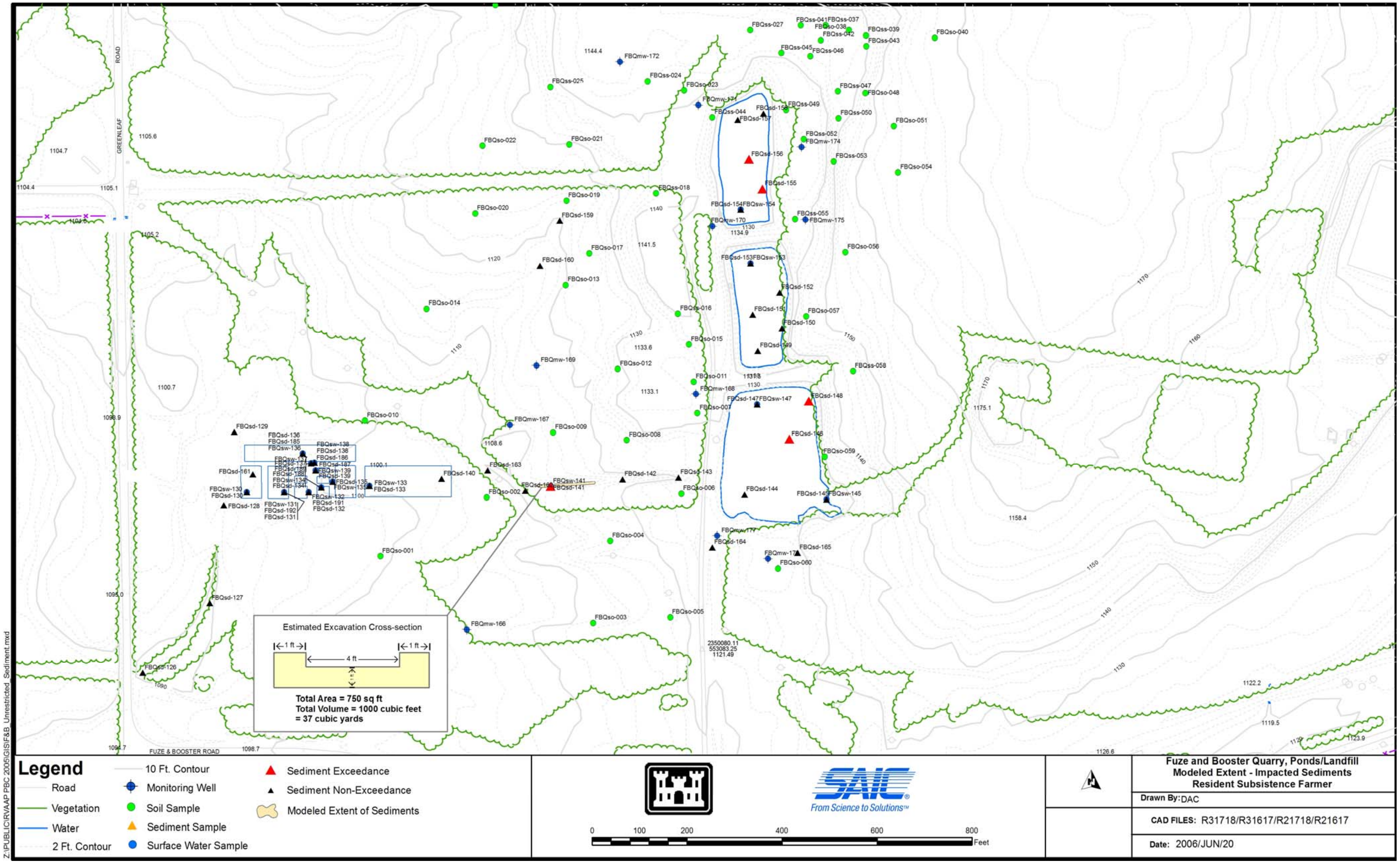

Figure 3B-2. Modeled Extent at Fuze and Booster Quarry Landfill/Ponds – Resident Subsistence Farmer Land Use

Appendix 5
Initial Screening of Technologies ~ Aqueous Media

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5.0 TECHNOLOGY SCREENING AND PROCESS OPTIONS ~ AQUEOUS MEDIA

This appendix describes the identification and screening of technology types and process options for COCs in impacted aqueous media at FBQ (as summarized in Section 3.6). The purpose of the identification and screening is to determine suitable technologies and process options that can be assembled into remedial alternatives capable of mitigating the existing contamination. The *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA* (USEPA 1988) established a structured process for this purpose. A series of steps is used to reduce the universe of potential remedial options to a smaller group of viable ones, from which a final remedy may be selected. These steps include:

- Identifying suitable general classes of response actions, or GRAs, suitable for FBQ (Section 5A.1); and

- Identifying technologies and process options applicable to the GRAs and performing an initial screening for aqueous media (Section 5A.2).

The FRTR has provided guidance for the evaluation of remedial technologies. FRTR provides a screening matrix which assesses the effects potential technologies have on the types of contaminants. This guidance was used as a point of reference throughout this initial screening of technologies.

5.1 GENERAL RESPONSE ACTIONS

This section describes the GRAs and remedial technologies that are potentially applicable at FBQ. GRAs are actions that will satisfy the RAOs (Section 3.1) for a specific medium, and may include various process options. GRAs are not remedial alternatives but are potential components of remedial alternatives. Proposed remedial alternatives are not presented in this FS; however, GRAs were selected based on the media of concern (e.g., surface water, groundwater and wet sediment). GRAs include no action, land use controls, monitoring, containment, removal, treatment, and disposal/handling.

5.1.1 No Action

In this GRA, no action would be undertaken to reduce any hazard to human health or the environment. Any current actions, access restrictions, or monitoring would be discontinued. This action complies with the CERCLA requirement to provide an appropriate option or component of a remedial alternative if no unacceptable risks are present and to provide a baseline against which other alternatives can be compared.

5.1.2 Land Use Controls and 5-year Reviews

Generally, land use controls reduce the potential for exposure to contaminants, but do not reduce contaminant volume or toxicity. These controls are utilized to supplement and affect the engineering component(s) of a remedy (e.g., treatment, removal, etc.) during short- and long-term implementation. The primary goal of land use controls is to restrict the use of, or limit access to, real property using physical, legal, and/or administrative mechanisms to ensure protectiveness of the remedy. Particular land use controls under consideration at FBQ include measures that will restrict land use changes over the long-term, such as governmental controls and enforcement tools. Governmental controls could include a facility Master Plan and installation-specific regulations to manage property and enforce management strategies, while enforcement tools may involve administrative orders or consent decrees. Land use controls can be used to supplement engineering controls; however, land use controls are not to be used as the sole remedy at a CERCLA site unless the use of active measures such as treatment and/or containment of source material are determined to not be practicable [(40 CFR § 300.430(a)(1)(iii)(D)].

If land use controls are selected as a component of a remedial alternative achieving restricted land use, the effectiveness of the remedy must undergo 5-year reviews. The primary goal of the 5-year reviews is to evaluate the implementation and performance of a remedy in order to determine if the remedy is or will be protective of human health and the environment. The 5-year reviews may be discontinued upon the AOC achieving preliminary cleanup goals for unlimited use and residential release.

5.1.3 Containment

Containment actions for aqueous media include technologies that protect human health and the environment by physically precluding contact with the impacted media. Containment technologies prevent or alter the natural flow by constructing a low-permeability material barrier (e.g., sheet piles, semi-permeable membrane, slurry walls, jet grouting, soil freezing, and hydraulic barriers) to reduce the migration of COCs and the potential for exposure. For impacted surface water and groundwater, containment would restrict or slow the flow from impacted areas, thereby requiring measures to control inflow into such areas such as the infiltration of surface water. This could be accomplished by surface capping of impacted areas or by removal of groundwater/surface water sources upgradient of the containment barrier.

5.1.4 Removal

Removal of impacted surface water, groundwater and wet sediment would reduce the potential for long-term human exposure. Surface water and groundwater could be removed using conventional pumping (e.g., diaphragm pumps) and extraction well technology (e.g., vertical and/or horizontal wells). Dewatering would minimize direct human contact with impacted material as well as its migration. Wet sediment can be removed using construction equipment (e.g., excavator) or dredges.

5.1.5 Treatment

Physical treatment processes considered for aqueous media include various in situ and ex situ approaches, such as adsorption, air stripping/packed tower, evaporation ponds, crystallization, and permeable treatment walls. Chemical processes use chemical reactions such as flocculation and precipitation treatment processes to remove COCs. Biological treatment such as bioremediation or monitored natural attenuation use microbes to degrade or adsorb aqueous contaminants. Thermal treatment techniques such as steam stripping or supercritical water oxidation uses elevated temperatures to initiate a phase change (e.g., liquid to gas) to remove COCs.

5.1.6 Disposal and Handling

Disposal actions for aqueous media include deep well injection, discharge to surface water, or discharge to a publicly owned treatment works (POTW) or other disposal facility in accordance with required permits. Beneficial reuse (e.g., land spraying/irrigation, reclamation/recycle/reuse) also will be considered for the discharge of groundwater. Transport could be accomplished using various modes of transportation. Truck, railcar, and/or barge transport could be used ship waste materials onsite or offsite.

5.2 INITIAL SCREENING OF TECHNOLOGIES ~ AQUEOUS MEDIA

This section describes the identification and initial screening of potential technologies to achieve RAOs for aqueous media (i.e., groundwater, surface water, and wet sediment) at FBQ (as summarized in Section 3.6). Technology types and process options were selected on the basis of their applicability to the environmental media of interest (e.g., surface water). Process options were either retained or eliminated from further consideration on the basis of technical implementability and effectiveness against listed COCs. For the purposes of this FS, surface water, groundwater, and wet sediment technologies are to be initially screened. However, these technologies will not be further developed or researched in the detailed screening of technologies. Results of the initial technology screening are summarized in Table 5A-1.

5.2.1 No Action

No action would be taken to implement remedial technologies to reduce any hazard to human health or the environment. This action complies with the CERCLA requirement to provide an appropriate option or component of a remedial alternative if no unacceptable risks are present. The No Action technology shall be retained as a process option to be further evaluated.

5.2.2 Land Use Controls and Monitoring

Actions being considered for FBQ include land use controls and 5-year reviews. Land use controls are physical, legal, and administrative mechanisms employed to restrict the use of, or limit access to, real property to prevent or reduce risks to human health and the environment. The implementability of legal and administrative mechanisms depends on an entity assuming responsibility for initiating, implementing, and maintaining the controls. The implementability of legal and administrative controls depends upon arrangements made between property owners in different governmental jurisdictions and the authority of local governments. Specific characteristics of the AOC determine which controls are appropriate. Legal impediments and costs also affect implementability and schedules. The NCP has outlined criteria to evaluate when the use of land use controls would be acceptable as a component of a remedial alternative. Sites containing residual contamination above acceptable concentrations for residential land use require environmental monitoring and 5-year reviews to determine whether the integrity of the controls remains intact. When the AOC achieves a level of contamination that allows for unlimited use and residential exposure, then at that time 5-year reviews may be discontinued.

5.2.3 Containment

Containment technologies for surface water or groundwater prevent or alter the natural groundwater flow through the installation of vertical or horizontal barriers, or injection into a hydraulically isolated unit through wells, thus preventing the migration of COCs. The technology type considered for FBQ is vertical barriers. Vertical barrier walls would be constructed down to a naturally-occurring horizontal barrier (such as a clay zone or bedrock) that significantly retards vertical contaminant migration in the groundwater.

Contaminated groundwater and/or contaminated surface water and associated soils would be effectively isolated from interaction with uncontaminated groundwater and/or surface water through construction of barriers keyed at the base into relatively impermeable clay or bedrock layers at depth. Process options screened included sheet piles, semi-permeable membranes, slurry walls, jet grouting, soil freezing, and hydraulic barriers. These are susceptible to cracking if not properly maintained. Slurry walls are the most common type of subsurface barrier due to their low cost. These walls are constructed in a vertical trench excavated under a slurry. The slurry acts like a drilling fluid by hydraulically shoring the trench to prevent collapse and forming a filter cake on the trench walls to impede fluid losses into the surrounding ground. Sheet piles are metal barriers which are driven into the ground or lake/stream bed to form an impenetrable boundary. Semi-permeable membranes are normally installed in trenches. These membranes normally allow groundwater to flow through them, while filtering out contaminants and containing plume movement.

Containment is a very effective treatment technology of inorganics and explosives. Containment is retained in the initial screening process for the surface water and groundwater scenarios at FBQ. Containment is not applicable of treatment of wet sediment.

5.2.4 Removal

Removal of contaminated surface water, groundwater or wet sediments would reduce the potential for long-term human and environmental exposure. Removal would minimize long-term direct human contact with and the local migration of impacted material. Surface water and groundwater could be removed using conventional pumping (e.g. diaphragm pumps) and extraction well technology (e.g., vertical and/or horizontal wells). Dewatering would minimize direct human contact with impacted material as well as its migration. Wet sediment can be removed using construction equipment (e.g., excavator) or dredges.

5.2.4.1 Surface Pumping

The process options evaluated for removal of surface water and wet sediment include using pumps to remove contaminated surface water or sediment from a water body for treatment or disposal. At FBQ where surface water and wet sediment is considered, surface pumping can be implemented. There is the potential for a significant amount of water to be pumped from the quarry ponds at FBQ; however this option will be retained through the initial screening process.

5.2.4.2 Vertical Wells

The process options evaluated for removal of groundwater includes extraction using vertical wells. Vertical wells remove groundwater from aquifers or perched water zones. The implementability of vertical wells is dependent on the properties of the aquifer and well construction factors. If the source contamination is not removed, continual groundwater extraction may be required to ensure long-term effectiveness.

At this stage, it is assumed groundwater removal is possible by the use of vertical wells; therefore, groundwater removal is retained during the initial screening.

5.2.4.3 Horizontal Wells

The process options evaluated for removal of groundwater also includes extraction using horizontal wells. Systems utilizing horizontal wells generally require fewer wells than vertical well-based networks since horizontal well screens provide greater surface area contact with contaminated soils and groundwater. Horizontal wells may also be installed using directional drilling techniques, allowing wells to be installed underneath buildings and other structures. The implementability of horizontal wells is dependent on the properties of the aquifer and well construction factors. If the source contamination is not removed, continual groundwater extraction may be required to ensure long-term effectiveness.

At this stage, it is assumed groundwater removal is possible by use of horizontal wells; therefore, groundwater removal is retained during the initial screening.

5.2.5 Treatment

Process options screened for the treatment of surface water and groundwater consist of ex situ and in situ processes, including various physical, chemical, biological, and thermal options. Many of these treatments also can be used for treating collected sediment slurry water and will be evaluated accordingly.

5.2.5.1 In Situ Physical/Chemical Treatment

In situ physical/chemical treatment options include air sparging, geochemical immobilization, chelation, directional wells, electrokinetics, hydrofracturing, in-well air stripping, permeable treatment walls, and vacuum extraction/bioslurping.

Air Sparging: Air is introduced to groundwater using wells to volatilize organic contaminants, and is only effective for treatment of VOCs and therefore is not retained.

Geochemical Immobilization: Geochemical immobilization is an in situ process that involves locally adjusting the pH and reduction-oxidation (redox) conditions. This reduces the solubility and/or changes the speciation of contaminants, largely precipitating them in the saturated zone. This process is effective for the treatment of inorganics COCs which would be effective for surface water, and potentially for sediment slurry at FBQ.

Chelation: Chelating molecules exhibit a high degree of selectivity for many metals. Chelating agents are used to enhance the in situ solubility or mobility of target constituents. This process is effective for the treatment of inorganics COCs which would be effective for surface water, and potentially for sediment slurry at FBQ.

Directional Wells (Enhancement): Directional wells are wells installed using drilling techniques horizontally or at an angle, in order to reach contaminated zones unreachable by conventional vertical drilling. This can enhance the utility of other remediation strategies, and is retained as a potential enhancement for contaminated groundwater.

Electrokinetics: Electrokinetics is an electrochemical process involving electrodes and permeable membranes in which cations (such as metals and hydronium ions) are driven through the saturated zone (or interstitial moisture above the water table) to one or more anodes, while anions are forced to the cathode(s). At the anode, metal contaminants cross a semi-permeable membrane and are extracted on the surface for treatment or disposal. This process is retained at the AOCs where water is impacted by inorganics. This would be applicable to surface water and the sediment slurry at FBQ.

Hydrofracturing (Enhancement): Similar to the fracturing enhancement described for soil remediation techniques, hydrofracturing is a pilot level technology that introduces high pressure fluids into a relatively impermeable substrate in order to increase hydraulic conductivity. This is meant to enhance the effectiveness of other remedial technologies, and is retained for all scenarios. This technology is applicable to the groundwater at FBQ, but not surface water or wet sediment.

In-Well Air Stripping: Air is injected into a double-screened well, lifting the water in the well and forcing it out the upper screen. Simultaneously, additional water is drawn in the lower screen. Once in the well, VOCs in the contaminated groundwater are transferred from the dissolved phase to the vapor phase by air bubbles. The contaminated air rises in the well to the water surface where vapors are drawn off and treated by a SVE system. The partially treated groundwater is forced into the vadose zone, and the process is repeated as water follows a hydraulic circulation pattern or cell that allows continuous cycling of groundwater. As groundwater circulates through the treatment system in situ, contaminant concentrations are gradually reduced. This technology is ineffective for treating inorganics and high explosives, and is not retained.

Permeable Treatment Walls: In this process, treatment walls are emplaced to intercept groundwater. As the impacted water flows through the wall, the contaminants (specifically VOCs, SVOCs, and inorganics) are decomposed or bound as a result of chemical reactions. This option is adaptable to a variety of sites when used in conjunction with funnel and gate systems. Depth of the contaminated groundwater is a major constraint on applicability. This technology is best applied where there is a well-characterized contamination plume and flow gradient. It is retained where groundwater needs to be addressed. This process is not retained as a method of treatment for surface water.

Vacuum Extraction/Bioslurping: This process option involves the use of vacuum pumps to remove contaminants from groundwater. It is used to treat volatile organics, and is ineffective at treating explosives or inorganics, therefore it is not retained.

5.2.5.2 Ex Situ Physical/Chemical Treatment

Ex situ physical/chemical process options evaluated included adsorption, advanced oxidation, air stripping/packed tower, crystallization, dissolved air flotation, evaporation ponds, flocculation/precipitation, granulated activated carbon, ion exchange, physical catalysis, reverse osmosis, sedimentation, sprinkler irrigation, and ultra/micro/nanofiltration.

Adsorption: Adsorption processes involve the displacement of contaminants from one medium to another. Some inorganics have shown good to excellent adsorption potential using activated carbon (see granulated activated carbon, below), alumina, or other media developed for water and wastewater treatment. Spent adsorption media may be regenerated and reused until efficiency declines to a predetermined level. This process option is applicable for inorganic COCs in water but ineffective for explosive COCs. Therefore, this process is retained for surface water and sediment slurry water at FBQ.

Advance Oxidation: Advanced oxidation processes including ultraviolet (UV) radiation, ozone, and/or hydrogen peroxide are used to destroy organic contaminants as water flows into a treatment tank. If ozone is used as the oxidizer, an ozone destruction unit is used to treat collected off gases from the treatment tank and downstream units where ozone gas may collect, or escape. This technology may be effective for explosives but is generally inapplicable to inorganic COCs. This process is retained for groundwater at FBQ. This process is not retained for wet sediment.

Air Stripping/Packed Tower: Air stripping involves the addition of large volumes of air to the fluid to be treated. Air stripping is most frequently used for removal of volatile organics and radon gas and is not applicable to surface, groundwater, or wet sediment COCs, so it is not retained.

Crystallization: In crystallization, solutes are crystallized from a saturated solution when the solvent is cooled, or water is separated from solution by cooling it until ice crystals form. The process is primarily applicable as a pretreatment or post-treatment process to remove contaminants. It is a poor treatment for explosives and only moderately effective for inorganic COCs and is therefore not retained.

Dissolved Air Flotation: In dissolved air flotation, air is injected while the contaminated water is under pressure. Fine bubbles are released and attach to suspended solids, reducing their specific gravity and aiding their rise to the surface. This technology is not applicable to dissolved contaminants, so it is not retained.

Evaporation Ponds: Evaporation ponds involve the evaporation of water and consequent concentration of organic and inorganic wastes. The process is dependent upon climatic conditions and is not practical in non-arid and cold regions, so it is not retained.

Flocculation/Precipitation: Several different precipitants have been shown to effectively remove metals from groundwater. Flocculation is a physical process that agglomerates particles that are too small for gravitational settling. Flocculation results from aggregation due to the random thermal motion of fluid molecules and by velocity gradients in the fluid. This process is retained.

Granulated Active Carbon: Contaminated water is passed ex situ through a filter pack containing granulated activated carbon, which is highly effective at absorbing organic molecules. The carbon filter can be disposed of or "regenerated" for reuse by rinsing with solvents. This process is effective at removing explosives from water. This process is retained for groundwater at FBQ.

Ion Exchange: Ion exchange has been widely used for the treatment of inorganic wastes. Ion exchange is effective in treating dilute concentrations of contaminants. Exchangers can be produced to remove low concentrations of toxic metals from a wastewater containing a high background concentration of other non-toxic contaminants. This process is retained for inorganic contaminated surface water and wet sediment slurry water at FBQ.

Physical Catalysis: The use of a suitable physical catalyst process allows a substance to be dehalogenated or otherwise reacted from one phase to another. Physical catalysis is generally not feasible for metals, and is mostly applicable to halogenated organics. This process is not retained.

Reverse Osmosis: In reverse osmosis, pressure is applied to the solution to force the solvent flow from the more concentrated solution to the more dilute solution. The membrane through which the solvent flows is impermeable to the dissolved ions. This process is typically used to separate water from inorganic ions. This process is retained for surface water at and wet sediment slurry water at FBQ.

Sedimentation: Sedimentation is a post-treatment step that will be retained for possible use in conjunction with flocculation/precipitation. This process is retained for all scenarios evaluated in this initial screening.

Sprinkler Irrigation: Sprinkler irrigation passes contaminated water through a standard sprinkler system, which forces VOCs from the dissolved phase into the gaseous. This is not effective at treating metals or explosives, and is not retained.

Ultra/Micro/Nano-Filtration: These filtration techniques use pressure and a semi-permeable membrane to separate nonionic materials from a solvent. This is generally used for suspended solids, oil and grease, large organic molecules, and complex heavy metals, and is not retained.

5.2.5.3 Biological Treatment

Biological treatment involves using microbes in situ to degrade or adsorb groundwater contaminants.

Bioremediation: Bioremediation technologies are destruction or transformation techniques directed towards stimulating microorganisms growth and their consumption of the contaminants as a food or energy source. Bioremediation has been successfully used for some heavy metals and is retained for further consideration in surface water and sediment slurry water at FBQ.

Biological Sorption: In biological sorption, various active and inactive microorganisms, such as algae and fungi, capable of adsorbing metallic ions are used to remove heavy metals from aqueous solutions. The process takes advantage of the natural affinity for heavy metal ions exhibited by algae cell structures. When the adsorptive capacity of the microorganisms is reached, the metals can be removed and concentrated for subsequent recovery. Biological sorption has been successfully used for some heavy metals and is retained for further consideration in surface water and sediment slurry water at FBQ.

Constructed Wetlands: Constructed wetlands use natural geochemical and biological processes inherent in an artificial wetland ecosystem in order to accumulate and remove metals, explosives, and other contaminants from influent waters. The process can use a filtration or degradation process. Although the technology incorporates principal components of wetland ecosystems; including organic soils, microbial fauna, algae, and vascular plants; microbial activity is responsible for most of the remediation. Influent water with explosive residues or other contaminants flows through and beneath the gravel surface of a gravel-based wetland. The wetland, using emergent plants, is a coupled anaerobic-aerobic system. The anaerobic cell uses plants in concert with natural microbes to degrade the contaminant. The aerobic, also known as the reciprocating cell, further improves water quality through continued exposure to the plants and the movement of water between cell compartments (FRTR 2005). This process option is retained.

Monitored Natural Attenuation: MNA is a passive remedial measure that relies on natural processes to reduce the contaminant concentration over time. MNA is a viable remedial process option if it can reduce contamination within a reasonable time frame, given the particular circumstances of the AOC, and if it can result in the achievement of remediation objectives. Use of MNA as a component of a remedial alternative is appropriate along with the use of other measures, such as source control or containment measures. MNA has been retained.

5.2.5.4 Thermal Treatment

Thermal treatment uses temperature elevation to initiate a phase change (e.g., liquid to gas) to remove contaminants from groundwater and include incineration and distillation, steam stripping, super critical water oxidation, and wet air oxidation.

Incineration and distillation: Contaminated waters are subjected to very high heat, volatilizing the water and combusting organic contaminants. Inorganic contaminants are typically left as a residue, while the steam and volatilization products are passed through an air filter. This process is potentially applicable for the treatment of explosives; therefore this process is retained for groundwater at FBQ.

Steam Stripping: Similar to air stripping, except that high temperature steam is bubbled through the contaminated water to trap volatiles and remove them. This process is used mostly for the removal of VOCs and SVOCs and is not retained for further consideration.

Super Critical Water Oxidation: Converts the water into a supercritical fluid using high temperature and pressure. Under these conditions, oxygen is readily dissolved and oxidation processes are greatly enhanced, resulting in near total oxidation of contaminants. This process is potentially applicable for the treatment of explosives; therefore this process is retained for groundwater at FBQ.

Wet Air Oxidation: Similar to supercritical water oxidation, but involves slightly lower temperatures that do not result in the water becoming a supercritical fluid. This process is potentially applicable for the treatment of explosives; therefore this process is retained for groundwater at FBQ.

5.2.6 Discharge

Onsite and offsite disposal and discharge options, as well as beneficial reuse, were considered for groundwater. The process options screened included: discharge to surface water, deep well injection, disposal to a POTW or other disposal facility, land spraying/irrigation, and reclamation/recycle/reuse.

5.2.6.1 Onsite Disposal/Discharge

Discharge to surface water and deep well injection were screened. Discharge to surface water could be used as a post-treatment step for treated water and thus the treated water would not need to be transported offsite. Under CERCLA, an NPDES permit is not required for discharge to surface waters; however, the substantive requirements of a permit must be met. Deep well injection involves the injection of either treated or untreated water into an isolated underground zone. This option may be subject to meeting the substantive requirements of permitting. Both options are viable for the AOC and are retained for further consideration at all scenarios evaluated in this initial screening.

5.2.6.2 Offsite Disposal/Discharge

Among the offsite disposal/discharge options are the use of existing POTWs or other commercial wastewater disposal facilities. Under this option, either treated or untreated water could be sent to these facilities, provided it is in compliance with the facility's permits and waste acceptance criteria. This option is retained for further consideration for scenarios, but not further evaluated in this FS. Both options are viable for the AOC and are retained for further consideration at all scenarios evaluated in this initial screening.

5.2.7 Process Options Retained from Initial Screening

The process options retained through the initial screening are summarized in Table 5-2 to support future considerations regarding the need for remedial action either on an AOC-specific or a facility-wide basis.

Table 5-2. Summary of Process Options Retained from Initial Screening for Groundwater, Surface Water, and Wet Sediment

Process Option	Surface Water/Groundwater	Wet Sediment
No Action	√	√
Land Use Controls and 5-year Reviews	√	√
Vertical Barriers		
Sheet Piles	√	--
Semi-permeable Membranes	√	--
Slurry Walls	√	--
Pumping		
Surface Pumping	√	√
Vertical Wells	√	--
Horizontal Wells	√	--
In Situ Physical/Chemical		
Geochemical Immobilization	√	√
Chelation	√	√
Directional Wells	√	--
Electrokinetics	√	√
Hydrofracturing	√	--
Permeable Treatment Wells	√	--
Ex Situ Physical/Chemical		
Adsorption	√	√
Advanced Oxidation	√	--
Flocculation/Precipitation	√	√
Granulated Activated Carbon	√	--
Ion Exchange	√	√
Reverse Osmosis	√	√
Sedimentation	√	√
Biological		
Bioremediation	√	√
Biological Sorption	√	√
Constructed Wetlands	√	√
MNA	√	√
Thermal Treatment		
Incineration and Distillation	√	--
Supercritical Water Oxidation	√	--
Wet Air Oxidation	√	--
Onsite		
Discharge to Surface Water	√	√
Deep Well Injection	√	√
Offsite		
Existing POTWs	√	√
Other CommWW Disposal Facilities	√	√

-- not applicable MNA = monitored natural attenuation
√ retained POTW = Publicly owned treatment works

5.3 RETAINED PROCESS OPTIONS FOR AQUEOUS MEDIA

COCs identified in impacted groundwater and surface water at FBQ were screened to identify potential remedial options to support future considerations regarding the need for remedial action either on an AOC-specific or a facility-wide basis. Table 5-3 summarizes the process options retained through the initial screening process for impacted groundwater and surface water at FBQ.

Table 5-3. Retained Process Options for Groundwater and Surface Water

General Response Action	Technology Type	Process Option
Land Use Controls and 5-year Reviews	Controls	Government, Enforcement, Informational, Legal Mechanisms
		Physical Mechanism
	Environmental Monitoring	Groundwater, Surface Water
Containment	Vertical Barriers	Sheet Piles, Semi-permeable Membranes, Slurry Walls
Removal	Pumping	Surface Pumping, Vertical Wells, Horizontal Wells
Treatment	In Situ Physical/Chemical	Geochemical Immobilization, Chelation, Directional Wells, Electrokinetics, Hydrofracturing, Permeable Treatment Wells
	Ex Situ Physical/Chemical	Adsorption, Advanced Oxidation, Flocculation/Precipitation, Granulated Activated Carbon, Ion Exchange, Reverse Osmosis, Sedimentation
	Biological	Bioremediation, Biological Sorption, Constructed Wetlands, MNA
	Thermal Treatment	Incineration and Distillation, Supercritical Water Oxidation, Wet Air Oxidation
Discharge	Onsite	Discharge to Surface Water, Deep Well Injection
	Offsite	Existing POTWs, Other Commercial Wastewater Disposal Facilities

MNA = monitored natural attenuation
POTW = publicly owned treatment works

COCs identified in impacted wet sediment at FBQ were screened to identify potential remedial options to support future considerations regarding the need for remedial action. Table 5-4 summarizes the process options identified during the initial screening process for impacted wet sediment at FBQ.

Table 5-4. Retained Process Options for Wet Sediment

General Response Action	Technology Type	Process Option
Land Use Controls and 5-year Reviews	Controls	Government, Enforcement, Informational, Legal Mechanisms
		Physical Mechanism
	Environmental Monitoring	Groundwater, Surface Water
Containment	Vertical Barriers	None
Removal	Pumping	Surface Pumping
Treatment	In Situ Physical/Chemical	Geochemical Immobilization, Chelation, Electrokinetics
	Ex Situ Physical/Chemical	Adsorption, Flocculation/Precipitation, Ion Exchange, Reverse Osmosis, Sedimentation
	Biological	Bioremediation, Biological Sorption, Constructed Wetlands, MNA
	Thermal Treatment	None
Discharge	Onsite	Discharge to Surface Water, Deep Well Injection
	Offsite	Existing POTWs, Other Commercial Wastewater Disposal Facilities

MNA = monitored natural attenuation
POTW = publicly owned treatment works

Table 5-1. Initial Screening of Technology Types and Process Options for Groundwater, Surface Water, and Wet Sediment

General Response Action	Technology Type	Process Options	Description	Screening Comments for Groundwater/Surface Water	Screening Comments for Wet Sediment
No Action	None	None	No remedial technologies implemented to reduce hazards to potential human or ecological receptors.	Required to be carried through CERCLA analysis.	Required to be carried through CERCLA analysis.
Land Use Controls and 5-year Reviews	Controls	Government Controls (land use restrictions)	The managing authority could include a Facility Master Plan and installation-specific regulations to manage property and enforce management strategies.	Potentially applicable. May limit future land, groundwater and surface water use options, depending on alternative chosen and the amount of contamination remaining.	Potentially applicable. May limit future land use, depending on alternative chosen and the amount of contamination remaining.
		Enforcement Tools (administrative order, consent decrees)	Administrative orders and consent decrees available under CERCLA, can prohibit certain land uses by a party or require proprietary controls be put in place.		
		Informational Devices (registries, advisories)	Registries or advisories put in place to provide information that residual contamination is onsite.		
		Legal Mechanisms (contractual mechanisms based on property law)	Easements, deed restrictions, etc. placed on a property as part of a contractual mechanism.		
		Physical Mechanisms (fences, berms, warning signs)	Fences, berms, warning signs, and security personnel put in place to prevent contact with contaminated media.	Potentially applicable. Used in conjunction with other alternatives to prevent incidental exposure to contaminated groundwater/surface water.	Potentially applicable. Used in conjunction with other alternatives to prevent incidental exposure to contaminated wet sediment.
	Environmental Monitoring	Groundwater	Periodic monitoring of groundwater to keep track of contaminant plumes and concentrations.	Potentially applicable. Used to assist with contaminant control during remedial actions and to monitor performance of treatment alternatives.	Potentially applicable. Used to assist in monitoring the effects wet sediment has on GW/SW.
		Surface Water	Periodic monitoring of surface waters to ensure that contaminant concentrations remain within acceptable limits.		

Table 5-1. Initial Screening of Technology Types and Process Options for Groundwater, Surface Water, and Wet Sediment (continued)

General Response Action	Technology Type	Process Options	Description	Screening Comments for Groundwater/Surface Water	Screening Comments for Wet Sediment
Containment	Vertical Barriers	Sheet Piles	Sheet piling is driven into the bed of the stream or lake in order to create a physical barrier to contain contaminated surface waters.	Potentially applicable. Containment technologies do not reduce the volume or toxicity of contaminants, but limit mobility.	Not applicable treatment for wet sediment.
		Semi-permeable Membranes	Membranes used as barriers to groundwater movement, containing the spread of a contaminant plume.		
		Slurry Walls	Trenches or directionally drilled tunnels filled with slurry to contain groundwater movement.		
Removal	Pumping	Surface Pumping	Traditional pumps used to remove contaminated surface water from a water body for treatment or disposal.	Not applicable for groundwater. Potentially applicable for surface water.	Potentially applicable. Wet sediment may be able to be removed via surface pumping.
		Vertical Wells	Traditionally drilled wells to remove groundwater from easily accessible aquifers.	Potentially applicable for groundwater. Not applicable for surface water.	Not applicable treatment for wet sediment.
		Horizontal Wells	Directionally drilled wells to remove water from hydraulically isolated water tables, or to avoid surface damage in undesirable locations.	Potentially applicable for groundwater. Not applicable for surface water.	Not applicable treatment for wet sediment.
Treatment	In Situ Physical/ Chemical	Air Sparging	Air is introduced to groundwater using wells to volatilize organic contaminants.	Not applicable. Not effective for inorganic or explosive COCs.	Not applicable. Not effective for inorganic COCs.
		Geochemical Immobilization	Involves locally adjusting the pH and reduction-oxidation (redox) conditions. This reduces the solubility and/or changes the speciation of contaminants, largely precipitating them in the saturated zone.	Potentially applicable for inorganic COCs.	Potentially applicable. Effective for removing inorganics in sediment slurry water.
		Chelation	Chelating agents are used to enhance the in situ solubility or mobility of target constituents.	Potentially applicable for inorganic COCs.	Potentially applicable. Effective for removing inorganics in sediment slurry water.

Table 5-1. Initial Screening of Technology Types and Process Options for Groundwater, Surface Water, and Wet Sediment (continued)

General Response Action	Technology Type	Process Options	Description	Screening Comments for Groundwater/Surface Water	Screening Comments for Wet Sediment
Treatment (continued)	In Situ Physical/ Chemical	Directional Wells	Drilling techniques are used to position wells horizontally, or at an angle, to reach contaminants not accessible by direct vertical drilling.	Potentially applicable for groundwater. Not applicable for surface water.	Not applicable treatment for wet sediment.
		Electrokinetics	Electrodes are installed and electrical power used to drive contaminants to the anode for collection in an electrolyte solution.	Potentially applicable for inorganics contamination. Not highly effective for explosive contamination.	Potentially Applicable.
		Hydrofracturing	Enhancement method involving pressurized water injection through wells to fracture low permeability and over-consolidated sediments. Fractures are filled with porous media that serve as substrates for bioremediation or to improve pumping efficiency.	Potentially applicable for groundwater. Not applicable for surface water.	Not applicable treatment for wet sediment.
		In-Well Air Stripping	Air is injected into a double screened well, lifting the water in the well and forcing it out the upper screen. Simultaneously, additional water is drawn in the lower screen. Once in the well, some of the VOCs in the contaminated ground water are transferred from the dissolved phase to the vapor phase by air bubbles. The contaminated air rises in the well to the water surface where vapors are drawn off and treated by a soil vapor extraction system.	Not applicable. Not effective for inorganic and high explosive COCs.	Not applicable treatment for wet sediment.
		Permeable Treatment Walls	These barriers allow the passage of water while causing the degradation or removal of contaminants.	Potentially applicable. Generally intended to control the long term migration of contaminants in groundwater. Technology can be used treating inorganics in groundwater. May be capable of treating high explosive COCs.	Not applicable treatment for wet sediment.
		Vacuum Extraction/ Bioslurping	This process option involves the use of vacuum pumps to remove contaminants from groundwater. Bioventing stimulates the aerobic bioremediation of hydrocarbon-contaminated soils.	Not applicable. Technology addresses hydrocarbon-contaminated AOC s.	Not applicable treatment for wet sediment or inorganic constituents.

Table 5-1. Initial Screening of Technology Types and Process Options for Groundwater, Surface Water, and Wet Sediment (continued)

General Response Action	Technology Type	Process Options	Description	Screening Comments for Groundwater/Surface Water	Screening Comments for Wet Sediment
Treatment (continued)	Ex Situ Physical/ Chemical	Adsorption	In liquid adsorption, solutes concentrate at the surface of a sorbent, thereby reducing their concentration in the bulk liquid phase.	Potentially applicable for inorganic COCs. Ineffective for high explosive COCs.	Potentially applicable. Effective for removing inorganics in sediment slurry water.
		Advanced Oxidation	Oxidation chemically converts hazardous contaminants to non-hazardous or less toxic compounds that are more stable, less mobile, and/or inert. The oxidizing agents most commonly used are ozone, hydrogen peroxide, hypochlorites, chlorine, and chlorine dioxide.	Potentially applicable. May be effective for high explosive COCs.	Not applicable. Not effective for inorganic COCs.
		Air Stripping	Large volumes of air are mixed with water in a packed tower to promote partitioning of VOCs to air.	Not applicable. Not effective for inorganic or high explosive COCs.	Not applicable. Not effective for inorganic COCs.
		Crystallization	Process in which certain solutes crystallize out from a saturated solution when the solvent is cooled.	Not applicable. Separation/crystallization is primarily applicable as a pretreatment or post-treatment process to remove contaminants. Poor treatment results for high explosive COCs. Moderately effective for inorganic COCs.	Not applicable. Separation/crystallization primary used as a pretreatment or post-treatment process to remove contaminants. Only moderately effective for inorganic COCs.
		Dissolved Air Flotation	Air bubbles are introduced by pressurization/depressurization means, rise to the surface carrying low-density solids.	Not applicable. Not effective for inorganic or explosive COCs.	Not applicable. Not effective for inorganic COCs.
		Evaporation Ponds	Water is evaporated to concentrate contaminants present in liquid.	Not applicable to cold climate regions.	Not applicable to cold climate regions.
		Flocculation/ Precipitation	Flocculation is a physical process that agglomerates particles that are too small for gravitational settling. Flocculation results from aggregation due to the random thermal motion of fluid molecules and by velocity gradients in the fluid	Potentially applicable. Flocculation/precipitation is effective in removing inorganics in groundwater.	Potentially applicable. Potentially can be used to remove inorganics in sediment slurry.
		Granulated Activated Carbon	Contaminated water is passed ex situ through a filter pack containing granulated activated carbon, which is highly effective at absorbing organic molecules.	Potentially applicable. Effective at removing high explosive COCs. Multiple contaminants can impact process performance.	Not applicable. Not effective for inorganic COCs.

Table 5-1. Initial Screening of Technology Types and Process Options for Groundwater, Surface Water, and Wet Sediment (continued)

General Response Action	Technology Type	Process Options	Description	Screening Comments for Groundwater/Surface Water	Screening Comments for Wet Sediment
Treatment (continued)	Ex Situ Physical/ Chemical (continued)	Ion Exchange	Contaminated water is passed through a resin bed where ions are exchanged between resin and water.	Potentially applicable. Effective for removing inorganics in recovered surface water and groundwater.	Potentially applicable. Effective for removing inorganics in sediment slurry water.
		Physical Catalysis	A physical process used to accelerate a chemical change of contaminant.	Not applicable. Physical catalysis is generally not feasible for inorganics and explosives. Option most applicable for halogenated organics.	Not applicable. Physical catalysis is generally not feasible for inorganics and explosives. Option most applicable for halogenated organics.
		Reverse Osmosis	Pressure is applied to force flow from the more concentrated to the more dilute solution through a membrane that is impermeable to a solute (dissolved ions).	Potentially applicable. Typically used to separate water from inorganic ions.	Potentially applicable. Typically used to separate water from inorganic ions. May be used to treat slurry water of collected sediment.
		Sedimentation	Suspended particles are allowed to settle depending on the particle diameter and specific gravity in a basin pond or pond enclosure.	Potentially applicable. Sedimentation is a post-treatment step that will be retained for possible use in conjunction with flocculation/precipitation.	Potentially applicable. Sedimentation is a post-treatment step that will be retained for possible use in conjunction with flocculation/precipitation for sediment slurry water.
		Sprinkler Irrigation	Sprinkler irrigation passes contaminated water through a standard sprinkler system, which forces VOCs from the dissolved phase into the gaseous.	Not applicable. Not effective at treating inorganic or high explosive COCs.	Not applicable. Not effective at treating inorganic COCs.
		Ultra/Micro/Nano-filtration	These filtration techniques use pressure and a semi-permeable membrane to separate nonionic materials from a solvent.	Not applicable. Ineffective for inorganic and explosive COCs.	Not applicable. Ineffective for inorganic COCs.

Table 5-1. Initial Screening of Technology Types and Process Options for Groundwater, Surface Water, and Wet Sediment (continued)

General Response Action	Technology Type	Process Options	Description	Screening Comments for Groundwater/Surface Water	Screening Comments for Wet Sediment
Treatment (continued)	Biological	Bioremediation	Microbiological processes are used to degrade or transform contaminants to less toxic or nontoxic forms, thereby remedying or eliminating environmental contamination.	Potentially applicable. Bioremediation successfully used for treating some heavy metals.	Potentially applicable. Bioremediation successfully used for treating some heavy metals.
		Biological Sorption	Various active and inactive microorganisms, such as algae and fungi, capable of adsorbing metallic ions are used to remove heavy metals from aqueous solutions. The process takes advantage of the natural affinity for heavy metal ions exhibited by algae cell structures.	Potentially applicable. Inorganic COCs in surface water and groundwater can be removed and concentrated for subsequent recovery.	Potentially applicable. Inorganic COCs in sediment slurry can be removed and concentrated for subsequent recovery.
		Constructed Wetlands	The constructed wetlands-based treatment technology uses natural geochemical and biological processes inherent in an artificial wetland ecosystem to accumulate and remove metals, explosives, and other contaminants from influent waters.	Potentially applicable. Effective in treating inorganic and high explosive COCs.	Potentially applicable. Effective in treating inorganic COCs in sediment slurry.
		MNA	MNA is a passive remedial measure that relies on natural processes to reduce the contaminant concentration over time.	Potentially applicable.	Potentially applicable.
	Thermal Treatment	Incineration and Distillation	Contaminated waters are subjected to very high heat, volatilizing the water and combusting organic contaminants.	Potentially applicable to high explosive COCs. Not effective at treating inorganic COCs.	Not applicable. Ineffective at treating inorganic COCs.
		Steam Stripping	High temperature steam is bubbled through the contaminated water to trap volatiles and remove them.	Process not applicable. Mostly used from removal of VOCs and SVOCs.	Process not applicable. Mostly used from removal of VOCs and SVOCs.
		Supercritical Water Oxidation	Converts the water into a supercritical fluid using high temperature and pressure. Under these conditions, oxygen is readily dissolved and oxidation processes are greatly enhanced, resulting in near total oxidation of contaminants.	Potentially applicable for high explosive COCs. Not effective for inorganic COCs.	Not applicable. Not effective for inorganic COCs.
		Wet Air Oxidation	Similar to supercritical water oxidation, but involves slightly lower temperatures that do not result in the water becoming a supercritical fluid.	Potentially applicable for high explosive COCs. Not effective for inorganic COCs.	Not applicable. Not effective for inorganic COCs.

Table 5-1. Initial Screening of Technology Types and Process Options for Groundwater, Surface Water, and Wet Sediment (continued)

General Response Action	Technology Type	Process Options	Description	Screening Comments for Groundwater/Surface Water	Screening Comments for Wet Sediment
Discharge	Onsite	Discharge to Surface Water	Discharges treated or untreated water into a suitable receiving body. May require discharge permits, etc.	Potentially applicable.	Potentially applicable. May be acceptable treatment for sediment slurry with pretreatment.
		Deep Well Injection	Injects treated or untreated water into a hydraulically isolated deep well for permanent storage. Requires the appropriate geology.	Potentially applicable.	Potentially applicable. May be acceptable treatment for sediment slurry.
	Offsite	Existing POTWs	Use existing POTW facilities to accept and treat the water. Water can be transported by truck.	Potentially applicable.	Potentially applicable. May be acceptable treatment for sediment slurry. Pretreatment may be required.
		Other Commercial Wastewater Disposal Facilities	Water is transported to a commercial wastewater disposal facility for treatment and disposition.	Potentially applicable.	Potentially applicable. May be acceptable treatment for sediment slurry.

AOC = area of concern
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act
COC = constituent of concern
POTW = publicly owned treatment works
SVOC = semivolatile organic compound
VOC = volatile organic compound

Appendix 7
Detailed Cost Estimate

Feasibility Study for Six High Priority AOCs

Fuze and Booster Quarry - Ravenna Army Ammunition Plant (RVAAP), Ravenna, Ohio

Summary of Alternatives

	Fuze and Booster Quarry Alternatives	Duration	Non Discounted Cost		
			Soils and Sediment		
			Capital Cost	O&M Cost	Total
1	No Action	0	$0	$0	$0
2	Limited Action	30 yr	$18,392	$191,741	$210,133
3	Excavation of Soils/Dry Sediments with Offsite Disposal ~ National Guard Trainee	<1 yr	$66,688	$0	$66,688
4	Excavation of Soils/Dry Sediments with Offsite Disposal ~ Resident Subsistence Farmer	<1 yr	$61,650	$0	$61,650

	Fuze and Booster Quarry Alternatives	Duration	Discounted Cost (3.1%)		
			Soils and Sediment		
			Capital Cost	O&M Cost	Total
1	No Action	0	$0	$0	$0
2	Limited Action	30 yr	$18,392	$141,669	$160,061
3	Excavation of Soils/Dry Sediments with Offsite Disposal ~ National Guard Trainee	<1 yr	$66,688	$0	$66,688
4	Excavation of Soils/Dry Sediments with Offsite Disposal ~ Resident Subsistence Farmer	<1 yr	$61,650	$0	$61,650

Notes:

1. The base year of comparison and cost data will be CY2005. The "real" discounted rates used to calculate present values will be based on OMB Circular No. A-94 memorandum dated January 31, 2005.

2. Costs were estimated for comparison purposes only and are believed to be accurate within a range of -30% to +50%. Use of these costs for other purposes, including but not limited to, budgetary or construction cost estimating is not appropriate.

Feasibility Study for Six High Priority AOCs
Fuze and Booster Quarry - Ravenna Army Ammunition Plant (RVAAP), Ravenna, Ohio
Summary of AOC Areas and Volumes

	Alternatives	Surface Area (sq ft)	*In situ*		*In situ with Constructability* [a]		*Ex situ* [a,b]		Total Volume (cy)
			Soil (cy)	Sediment (cy)	Soil (cy)	Sediment (cy)	Soil (cy)	Sediment (cy)	
1	No Action		Not Applicable						
2	Limited Action	1,380	Not Applicable						
3	Excavation of Soils/Dry Sediments with Offsite Disposal ~ National Guard Trainee	1,380	0	68	0	85	0	102	102
4	Excavation of Soils/Dry Sediments with Offsite Disposal ~ Resident Subsistence Farmer	750	0	37	0	46	0	56	56

[a] Includes 25% constructability factor
[b] Includes 20% swell factor

Fuze and Booster Quarry Soil and Sediment
Alternative 2 - Limited Action
Key Parameters and Assumptions

Key Parameters and Assumptions:

Item	Unit	Value	Notes
Capital Cost			
Land Use Controls			
Base Master Planning Documents	hrs	80	Assume 80 hrs to review and revise BMP documents.
Legal/Technical Labor	$/hr	80	
Site Work			
Site Area	sf	1,380	
Civil Survey	day	1.0	Survey AOC areas and set monuments. RSMeans 011077001200.
Civil Survey	$/day	885	
Civil Survey Monuments	ea	2	Assume 2 monuments around perimeter of AOC. RSMeans 011077000600.
Civil Survey Monuments	$/ea	162	
As Built Drawings	hours	8	Develop plat map for incorporation into the Base Master Plan.
As Built Drawings	$/hr	60	
Install Signs on Posts	ea	2	Assume warning signs located around AOC perimeter at 100 ft centers. RSMeans 028907000100 & 1500. Add 50% for custom letters. Furnish, place, and install.
Install Signs on Posts	$/ea	185.25	
Plans and Reports			
Corrective Action Completion Report	hrs	40	Includes Construction QC data and preparing report.
Technical Labor	$/hr	70	
O&M Cost (Years 0 to 30)			
Sampling & Analysis	events	5	
Sampling & Analysis	years	5	Includes annual sampling for first 5 years. There are 5 total events. Assume 4 existing wells will be sampled and 3 soil/sediment samples collected in 1 day plus 1 day travel. Assumes 2 sampling technicians at 10 hours/day. Samples will be collected and analyzed for metals.
Annual Sampling Labor	days/event	2	
Annual Sampling Labor	hrs/event	40	
Annual Sampling Labor	$/hr	55	
Annual Per Diem	$/event	460	2 people x $115/day
Annual Truck Rental / Gas	$/event	280	1 truck x $90/day. Add $100 for gas.
Sample materials	ea/event	9	Reference ECHOS 33020401/0402 for disposable sampling and decon materials.
Sample materials	$/ea	21	
Annual Sample equipment	$/event	1,500	Water quality parameter equipment, pumps, misc tools, drums, and sampling equipment rental. Based on RACER model.
Analytical Cost	$/event	900	Analyze samples from 4 wells for metals (6 @ 100). Analyze 3 soil samples for metals (3 @ 100). Includes 10% duplicate and 5% rinsate.
Sample Shipment	$/event	50	1 cooler @ $50 ea.
Data Management	hrs	9	Data validation
Data Management	$/hr	60	
IDW Water Disposal	$/lot	700	Includes labor and travel to return IDW water to site after analysis.

Fuze and Booster Quarry Soil and Sediment
Alternative 2 - Limited Action
Key Parameters and Assumptions

Key Parameters and Assumptions:

Item	Unit	Value	Notes
O&M Cost (Continued)			
Site Inspection and Maintenance	years	30	
Site Inspection	events	60	
Site Inspections	hrs	4	Inspect site semi-annually for disturbance/erosion, warning signs, and complete checklist for annual report.
Field Labor	$/hr	60	
Site Maintenance	events	30	Assume signs are replaced every 10 years. Assume AOC area is overseeded and fertilized every 5 years. Costs have been annualized.
Site Maintenance	$/yr	100	
Annual O&M Report			
Sampling and Analysis Reports	event	5	
Sampling and Analysis Reports	$/event	2,800	Assume 40 hours @ $70/hr for report.
Annual O&M Report	event	30	
Annual O&M Report	$/year	560	Assume 8 hours @ $70/hr for letter report.
CERCLA Reviews			
CERCLA 5-Year Reviews	events	6	Assume 5 year reviews for 30 years.
CERCLA 5-Year Reviews	$/event	6,600	Assume 80 hours/review @ $70/hr. Add $1,000 misc expenses.

Fuze and Booster Quarry Soil and Sediment
Alternative 2 - Limited Action
Cost Estimate

CAPITAL COST	$18,392

Activity (unit)	Quantity	Unit Cost	Total
Land Use Controls			
Base Master Planning Documents (hr)	80	$80.00	$6,400
Site Work			
Civil Survey (day)	1	$885.00	$885
Civil Survey Monuments (ea)	2	$162.00	$324
As Built Drawings (hrs)	8	$60.00	$480
Install Signs on Posts (ea)	2	$185.25	$371
Plans and Reports			
Corrective Action Completion Report (ea)	40	$70.00	$2,800
Subtotal			$11,260
Design		15%	$1,689
Office Overhead		5%	$563
Field Overhead		15%	$1,689
Subtotal			$15,200
Profit		6%	$912
Contingency		15%	$2,280
Total			$18,392

Fuze and Booster Quarry Soil and Sediment
Alternative 2 - Limited Action
Cost Estimate

OPERATION AND MAINTENANCE	$191,741

Activity (unit)	Quantity	Unit Cost	Total Cost	Present Value (3.1%)
O&M Sampling & Analysis				
Sampling Labor (events)	5	$2,200	$11,000	$10,047
Per Diem (events)	5	$460	$2,300	$2,101
Cargo Van Rental / Gas (events)	5	$280	$1,400	$1,279
Sample materials (events)	5	$189	$945	$863
Sample equipment (events)	5	$1,500	$7,500	$6,850
Analytical Cost (events)	5	$900	$4,500	$4,110
Sample Shipment (events)	5	$50	$250	$228
Data Management (events)	5	$540	$2,700	$2,466
IDW Water Disposal (events)	5	$700	$3,500	$3,197
Site Inspection and Maintenance				
Site Inspection (ea)	60	$240	$14,400	$9,359
Site Maintenance (ea)	30	$100	$3,000	$1,935
Annual O&M Report				
Sampling and Analysis Reports (ea)	5	$2,800	$14,000	$12,787
Annual O&M Report (ea)	30	$560	$16,800	$10,836
CERCLA Reviews				
CERCLA 5-Year Reviews (ea)	6	$6,600	$39,600	$24,006
Subtotal O&M			$121,895	$90,063
Design		10%	$12,190	$9,006
Office Overhead		5%	$6,095	$4,503
Field Overhead		15%	$18,284	$13,509
Subtotal			$158,464	$117,081
Profit		6%	$9,508	$7,025
Contingency		15%	$23,770	$17,562
Total			$191,741	$141,669

TOTAL ALTERNATIVE CAPITAL AND O&M COST (Non Discounted Cost)	$210,133

Fuze and Booster Quarry Soil and Sediment
Alternative 3 - Excavation of Soils/Dry Sediments with Offsite Disposal ~ National Guard Trainee
Key Parameters and Assumptions

Key Parameters and Assumptions:

Item	Unit	Value	Notes
Capital Cost			
Additional Site Characterization			
Delineation Sampling	ea	10	Assume 10 additional soil/sediment samples will be required to further define the limits of contamination. Assume hand sampling.
Sampling Labor	hrs	40	Assumes 2 sampling technicians at 10 hours/day for 2 days. Includes sampling, documentation, and travel.
Sampling Labor	$/hr	60	
Per Diem	$/event	460	2 people x $115/day
Truck Rental / Gas	$/event	280	1 truck x $90/day. Add $100 for gas.
Confirmation Sample Materials	ea	24	Reference ECHOS 33020401/0402 for disposable sampling and decontamination materials.
Confirmation Sample Materials	$/ea	21	
Sample Analysis	$/ea	7,200	Analyze samples for metals (12 @ $100) and TCLP (12 @ $500). Includes 10% duplicate and 5% rinsate.
Data Management	hrs	12	Data validation
Data Management	$/hr	60	
Site Work			
Site Area	sf	1,380	
Civil Survey	day	2.0	Survey AOC for additional characterization samples, limits of excavation, and as-builts. RSMeans 011077001200.
Civil Survey	$/day	885	
Civil Survey Monuments	ea	2	Assume 2 monuments around perimeter of AOC. RSMeans 01107 700 0600.
Civil Survey Monuments	$/ea	162	
Install Signs on Posts	ea	2	Assume warning signs located around AOC perimeter at 100 ft centers. RSMeans 028907000100 & 1500. Add 50% for custom letters. Furnish, place, and install.
Install Signs on Posts	$/ea	185.25	
As Built Drawings	hours	8	Develop as-built drawings.
As Built Drawings	$/hr	60	
Clearing	acre	0.10	Assume trees/brush cleared, chipped, and left onsite.
Clearing	$/acre	4,025	RSMeans 022302000200. Clear and chip medium trees to 12" dia.
Soil Excavation			Includes excavation of the AOC areas based on the areas and depths presented in the summary table. Ex situ volumes include a 25% constructability factor and 20% swell factor.
Soil Excavation Volume (In situ)	cy	85	
Soil Excavation Volume (Ex situ)	cy	102	Includes soil volume to be transported and disposed.
Soil Excavation Mass	tons	112	Includes soil mass to be transported and disposed.
Soil Excavation Surface Area	sf	1,380	
Volume to Weight Conversion	tons/cy	1.10	Exsitu or loose soil conversion.
Mobilization/Demobilization	ls	5,000	Includes mob/demob of excavation equipment and preparing submittals.
Excavate Soils	$/cy	28.19	Assumes 1 day minimum. Includes 3/4 cy excavator, 1 O.E., 1 L.S. spotter, 2 L.S. to prep trucks/and misc. Reduced productivity by 40% for loading trucks, small precise excavations, and security/S&H requirements. Average 160 cy/day. RSMeans Crew B12-F.
Transport and Offsite Disposal			
Transport and Offsite Disposal	tons	112	Based on escalated 2004 vendor pricing.
Transport and Offsite Disposal	$/ton	34.80	

Fuze and Booster Quarry Soil and Sediment
Alternative 3 - Excavation of Soils/Dry Sediments with Offsite Disposal ~ National Guard Trainee
Key Parameters and Assumptions

Key Parameters and Assumptions:

Item	Unit	Value	Notes
Confirmational Sampling & Analysis			
Confirmation Samples	ea	7	Assume average of 1 sample per 2000 sf and 4 sidewall samples. Includes 10% duplicate and 5% rinsate.
Sampling Labor	hrs	10	Includes confirmation sampling. Assumes 1 sampling technician at 10 hours/day for 1 days.
Sampling Labor	$/hr	60	
Per Diem	$/event	115	1 person x $115/day
Truck Rental / Gas	$/event	190	1 truck x $90/day. Add $100 for gas.
Confirmation Sample Materials	ea	7	Reference ECHOS 33 02 0401/0402 for disposable sampling and decontamination materials.
Confirmation Sample Materials	$/ea	21	
Sample Analysis	$/ea	700	Analyze samples for metals (7 @ $100). Includes 10% duplicate and 5% rinsate.
Data Management	hrs	4	Data validation
Data Management	$/hr	60	
Restoration			Includes native soil backfill. Assume productivity has been reduced by 25% to account for security and safety requirements. Add 20% premium for small job.
Native Soil Backfill	cy	102	ECHOS 17030422, Unclassified Fill, 6" Lifts, Onsite Source, Includes Delivery, Spreading, and Compaction.
Native Soil Backfill	$/cy	10.76	
Seeding, Vegetative Cover	MSF	22	RSMeans 029203200200. Seeding with mulch and fertilizer. Assume 0.5 acres are revegetated for excavation areas and equipment damage.
Seeding, Vegetative Cover	$/MSF	69.75	
Plans and Reports			
Corrective Action Completion Report	hrs	120	Includes Construction QC data and preparing report.
Technical Labor	$/hr	70	

Fuze and Booster Quarry Soil and Sediment
Alternative 3 - Excavation of Soils/Dry Sediments with Offsite Disposal ~ National Guard Trainee
Cost Estimate

CAPITAL COST	$66,688

Activity (unit)	Quantity	Unit Cost	Total
Additional Site Characterization			
Sampling Labor (hrs)	40	$60.00	$2,400
Per Diem (event)	1	$460.00	$460
Truck Rental / Gas (event)	1	$280.00	$280
Confirmation Sample Materials (ea)	24	$21.00	$504
Sample Analysis (event)	1	$7,200.00	$7,200
Data Management (hrs)	12	$60.00	$720
Site Work			
Civil Survey (day)	2.0	$885.00	$1,770
Civil Survey Monuments (ea)	2	$162.00	$324
Install Signs on Posts (ea)	2	$185.25	$371
As Built Drawings (hrs)	8	$60.00	$480
Clearing (acre)	0.1	$4,025.00	$403
Soil Excavation			
Mobilization/Demobilization (ls)	1	$5,000.00	$5,000
Excavate Soil (cy)	85	$28.19	$2,396
Transport and Offsite Disposal (tons)	112	$34.80	$3,905
Confirmational Sampling & Analysis			
Sampling Labor (hrs)	10	$60.00	$600
Per Diem (event)	1	$115.00	$115
Truck Rental / Gas (event)	1	$190.00	$190
Confirmation Sample Materials (ea)	7	$21.00	$147
Sample Analysis (lot)	1	$700.00	$700
Data Management (hrs)	4	$60.00	$210
Restoration			
Native Soil Backfill (cy)	102	$10.76	$1,097
Seeding, Vegetative Cover (MSF)	22	$69.75	$1,535
Plans and Reports			
Corrective Action Completion Report (ea)	120	$70.00	$8,400
Subtotal			$39,205
Design		15%	$5,881
Office Overhead		5%	$1,960
Field Overhead		15%	$5,881
Subtotal			$52,927
Profit		6%	$3,176
Contingency		20%	$10,585
Total			$66,688

Fuze and Booster Quarry Soil and Sediment
Alternative 4 - Excavation of Soils/Dry Sediments with Offsite Disposal ~ Resident Subsistence Farmer
Key Parameters and Assumptions

Key Parameters and Assumptions:

Item	Unit	Value	Notes
Capital Cost			
Additional Site Characterization			
Delineation Sampling	ea	10	Assume 10 additional soil/sediment samples will be required to further define the limits of contamination. Assume hand sampling.
Sampling Labor	hrs	40	Assumes 2 sampling technicians at 10 hours/day for 2 days. Includes sampling, documentation, and travel.
Sampling Labor	$/hr	60	
Per Diem	$/event	460	2 people x $115/day
Truck Rental / Gas	$/event	280	1 truck x $90/day. Add $100 for gas.
Confirmation Sample Materials	ea	24	Reference ECHOS 33020401/0402 for disposable sampling and decontamination materials.
Confirmation Sample Materials	$/ea	21	
Sample Analysis	$/ea	7,200	Analyze samples for metals (12 @ $100) and TCLP (12 @ $500). Includes 10% duplicate and 5% rinsate.
Data Management	hrs	12	Data validation
Data Management	$/hr	60	
Site Work			
Site Area	sf	750	
Civil Survey	day	2.0	Survey AOC for additional characterization samples, limits of excavation, and as-builts. RSMeans 011077001200.
Civil Survey	$/day	885	
As Built Drawings	hours	8	Develop as-built drawings.
As Built Drawings	$/hr	60	
Clearing	acre	0.10	Assume trees/brush cleared, chipped, and left onsite.
Clearing	$/acre	4,025	RSMeans 022302000200. Clear and chip medium trees to 12" dia.
Soil Excavation			Includes excavation of the AOC areas based on the areas and depths presented in the summary table. Ex situ volumes include a 25% constructability factor and 20% swell factor.
Soil Excavation Volume (In situ)	cy	46	
Soil Excavation Volume (Ex situ)	cy	56	Includes soil volume to be transported and disposed.
Soil Excavation Mass	tons	61	Includes soil mass to be transported and disposed.
Soil Excavation Surface Area	sf	750	
Volume to Weight Conversion	tons/cy	1.10	Exsitu or loose soil conversion.
Mobilization/Demobilization	ls	5,000	Includes mob/demob of excavation equipment and preparing submittals.
Excavate Soils	$/cy	52.09	Assumes 1 day minimum. Includes 3/4 cy excavator, 1 O.E., 1 L.S. spotter, 2 L.S. to prep trucks/and misc. Reduced productivity by 40% for loading trucks, small precise excavations, and security/S&H requirements. Average 160 cy/day. RSMeans Crew B12-F.
Transport and Offsite Disposal			
Transport and Offsite Disposal	tons	61	Based on escalated 2004 vendor pricing.
Transport and Offsite Disposal	$/ton	34.80	

Fuze and Booster Quarry Soil and Sediment
Alternative 4 - Excavation of Soils/Dry Sediments with Offsite Disposal ~ Resident Subsistence Farmer
Key Parameters and Assumptions

Key Parameters and Assumptions:

Item	Unit	Value	Notes
Confirmational Sampling & Analysis			
Confirmation Samples	ea	7	Assume average of 1 sample per 2000 sf and 4 sidewall samples. Includes 10% duplicate and 5% rinsate.
Sampling Labor	hrs	10	Includes confirmation sampling. Assumes 1 sampling technician at 10 hours/day for 1 day.
Sampling Labor	$/hr	60	
Per Diem	$/event	115	1 person x $115/day
Truck Rental / Gas	$/event	190	1 truck x $90/day. Add $100 for gas.
Confirmation Sample Materials	ea	7	Reference ECHOS 33020401/0402 for disposable sampling and decontamination materials.
Confirmation Sample Materials	$/ea	21	
Sample Analysis	$/ea	700	Analyze samples for metals (7 @ $100). Includes 10% duplicate and 5% rinsate.
Data Management	hrs	4	Data validation
Data Management	$/hr	60	
Restoration			Includes native soil backfill. Assume productivity has been reduced by 25% to account for security and safety requirements. Add 20% premium for small job.
Native Soil Backfill	cy	56	ECHOS 17030422, Unclassified Fill, 6" Lifts, Onsite Source, Includes Delivery, Spreading, and Compaction.
Native Soil Backfill	$/cy	10.76	
Seeding, Vegetative Cover	MSF	22	RSMeans 029203200200. Seeding with mulch and fertilizer. Assume 0.5 acres are revegetated for excavation areas and equipment damage.
Seeding, Vegetative Cover	$/MSF	69.75	
Plans and Reports			
Corrective Action Completion Report	hrs	120	Includes Construction QC data and preparing report.
Technical Labor	$/hr	70	

Fuze and Booster Quarry Soil and Sediment
Alternative 4 - Excavation of Soils/Dry Sediments with Offsite Disposal ~ Resident Subsistence Farmer
Cost Estimate

CAPITAL COST	$61,650

Activity (unit)	Quantity	Unit Cost	Total
Additional Site Characterization			
Sampling Labor (hrs)	40	$60.00	$2,400
Per Diem (event)	1	$460.00	$460
Truck Rental / Gas (event)	1	$280.00	$280
Confirmation Sample Materials (ea)	24	$21.00	$504
Sample Analysis (event)	1	$7,200.00	$7,200
Data Management (hrs)	12	$60.00	$720
Site Work			
Civil Survey (day)	2.0	$885.00	$1,770
As Built Drawings (hrs)	8	$60.00	$480
Clearing (acre)	0.1	$4,025.00	$403
Soil Excavation			
Mobilization/Demobilization (ls)	1	$5,000.00	$5,000
Excavate Soil (cy)	46	$52.09	$2,409
Transport and Offsite Disposal (tons)	61	$34.80	$2,125
Confirmational Sampling & Analysis			
Sampling Labor (hrs)	10	$60.00	$600
Per Diem (event)	1	$115.00	$115
Truck Rental / Gas (event)	1	$190.00	$190
Confirmation Sample Materials (ea)	7	$21.00	$147
Sample Analysis (lot)	1	$700.00	$700
Data Management (hrs)	4	$60.00	$210
Restoration			
Native Soil Backfill (cy)	56	$10.76	$597
Seeding, Vegetative Cover (MSF)	22	$69.75	$1,535
Plans and Reports			
Corrective Action Completion Report (ea)	120	$70.00	$8,400
Subtotal			$36,243
Design		15%	$5,437
Office Overhead		5%	$1,812
Field Overhead		15%	$5,437
Subtotal			$48,929
Profit		6%	$2,936
Contingency		20%	$9,786
Total			$61,650