FINAL

PHASE I/PHASE II REMEDIAL INVESTIGATION

OF THE

FUZE AND BOOSTER QUARRY LANDFILL/PONDS (RVAAP-16)

VOLUME ONE - MAIN REPORT

RAVENNA ARMY AMMUNITION PLANT RAVENNA, OHIO

November 2005

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Final Phase I/Phase II Remedial Investigation of the Fuze and Booster Quarry Landfill/Ponds (RVAAP-16)

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Ravenna Army Ammunition Plant
Ravenna, Ohio

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LIST OF ACRONYMS

ALM	adult lead methodology
AMSL	above mean sea level
AOC	Area of Concern
AUF	area use factor
BAF	bioaccumulation factor
BGS	below ground surface
cPAH	carcinogenic polycyclic aromatic hydrocarbon
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CSF	cancer slope factor
CSM	conceptual site model
DAD	dermally absorbed dose
DAF	dilution attenuation factor
DCE	dichloroethene
DDD	dichlorodiphenyldichloroethane
DNB	dinitrobenzene
DNT	dinitrotoluene
DoD	U. S. Department of Defense
DQO	data quality objective
DQSR	Data Quality Summary Report
EPA	U. S. Environmental Protection Agency
EPC	exposure point concentration
ESA	Endangered Species Act
ESV	ecological screening value
EU	exposure unit
FBQ	Fuze and Booster Quarry Landfill/Ponds
FS	feasibility study
FSA	Field Storage Area
GAF	gastrointestinal absorption factor
GSSL	generic soil screening level
HEAST	Health Effects Assessment Summary Tables
HHRA	human health risk assessment
HI	hazard index
HMX	octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine
HQ	hazard quotient
IDW	investigation-derived waste
IEUBK	Integrated Exposure Uptake Biokinetic model
ILCR	incremental lifetime cancer risk
IRIS	Integrated Risk Information System
IRP	Installation Restoration Program
LOAEL	lowest observed adverse effect level
LUP	land use plan
MS/MSD	matrix spike/matrix spike duplicate
MCL	maximum contaminant level
MDC	maximum detected concentration
MDL	method detection limit
NEPA	National Environmental Policy Act
NOAEL	no observed adverse effect level
ODNR	Ohio Department of Natural Resources

LIST OF ACRONYMS (CONTINUED)

OE	ordnance and explosives
Ohio EPA	Ohio Environmental Protection Agency
OHARNG	Ohio Army National Guard
OVA	organic vapor analyzer
PAH	polycyclic aromatic hydrocarbon
PbB	blood lead level
PCB	polychlorinated biphenyl
PCE	tetrachloroethene
PRG	preliminary remediation goal
PVC	polyvinyl chloride
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
RBC	risk-based concentration
RDA	recommended daily allowance
RDI	recommended daily intake
RDX	hexahydro-1,3,5-trinitro-1,3,5-triazine
RfC	reference concentration
RfD	reference dose
RI	Remedial Investigation
RRSE	Relative Risk Site Evaluations
RTLS	Ravenna Training and Logistics Site
RVAAP	Ravenna Army Ammunition Plant
SAP	Sampling and Analysis Plan
SESOIL	Seasonal Soil Compartment Model
SMDP	Scientific Management Decision Point
SRC	site related contaminant
SRV	sediment reference value
SVOC	semivolatile organic compound
T&E	threatened and endangered
TCA	trichloroethane
TCE	trichloroethene
THI	target hazard index
TNB	trinitrobenzene
TNT	trinitrotoluene
TOC	total organic carbon
TUF	temporal use factor
USACE	U. S. Army Corps of Engineers
USCS	Unified Soil Classification System
UXO	unexploded ordnance
VOC	volatile organic compound
WBG	Winklepeck Burning Grounds
WOE	weight-of-evidence
WQC	water quality criteria

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EXECUTIVE SUMMARY

This report documents the results of the Phase I/Phase II Remedial Investigation (RI) at the Fuze and Booster Quarry Landfill/Ponds (FBQ) and the nearby 40-mm Firing Range at the Ravenna Army Ammunition Plant (RVAAP), Ravenna, Ohio (Figures 1-1 and 1-2). The Phase I/Phase II RI was conducted under the U. S. Department of Defense Installation Restoration Program by SpecPro, Inc., and its subcontractors, under contract number DAAA09-01-G-0009, Delivery Order No. 0012 with the Joint Munitions Command. The Phase I/Phase II RI was conducted in compliance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 following work plans reviewed by the U. S. Army Corps of Engineers (USACE) and the Ohio Environmental Protection Agency. The RI is being completed on behalf of USACE in accordance with U. S. General Services Administration Environmental Advisory Services Contract GS-10-F-0076J (Delivery Order W912QR-05-F-0033) under a Performance-Based Contract.

The scope of this investigation is to determine the extent of contamination in affected media (e.g., soils, sediments, surface water, and groundwater) identified during the Phase I/Phase II RI at FBQ and the 40-mm Firing Range. The primary objectives of this Phase I/Phase II RI are as follows:

- Determine the boundaries of the FBQ area of concern (AOC).
- Measure the AOC physical characteristics.
- Identify the sources of contamination.
- Characterize the nature and extent of contamination at FBQ.
- Characterize the nature and extent of contamination at the adjacent 40-mm Firing Range for subsequent analysis in a separate report.
- Establish a system to monitor potential off-site migration of contaminants.
- Collect data for a future risk screening analysis (Baseline Risk Assessment) for human health and the environment.

STUDY AREA A INVESTIGATION

The data collected under this Phase I/Phase II RI include the following:

Soil samples for chemical analyses were collected from a total of 100 stations located throughout FBQ and the nearby 40-mm Firing Range and include:

- Sixty surface soil samples from FBQ.
- Forty surface soil samples from the 40-mm Firing Range area.
- Thirty-seven subsurface soil samples from FBQ.
- Twenty-six subsurface soil samples from the 40-mm Firing Range area.
- Forty sediment samples (including wet and dry sediment from ditch lines and low-lying areas).

- Fifteen surface water samples from the three ponds and each of the other settling basins (co-located with sediment sample locations).

- Twelve groundwater samples.

NATURE AND EXTENT OF CONTAMINATION

Surface Soil

Fuze and Booster Quarry Landfill/Ponds

Nine explosive/propellant compounds were detected at least once in surface soil samples collected during the Phase II RI. The following compounds were detected: nitrocellulose (6 of 8 samples); 2,4,6-trinitrotoluene (TNT) (11 of 60 samples); nitrobenzene (4 of 60 samples); 2-amino-4,6-dinitrotoluene (DNT) (9 of 60 samples); 4-amino-2,6-DNT (9 of 60 samples); 1,3,5-trinitrobenzene (6 of 60 samples); 2,4-DNT (4 of 60 samples); 2,6-DNT (2 of 60 samples); and hexahydro-1,3,5-trinitro-1,3,5-triazine (1 of 60 samples). The sample locations with the most detected explosive/propellant compounds (FBQ-039, -042, -046, -050, and -052) are located in the higher elevations northeast of the Quarry Ponds.

Seventeen inorganic compounds were detected above background in surface soil samples collected from FBQ. These compounds are: antimony, arsenic, barium, beryllium, cadmium, chromium, hexavalent chromium, cobalt, copper, lead, mercury, manganese, nickel, selenium, silver, vanadium, and zinc.

The following surface soil sample locations had ten or more surface soil inorganic site-related contaminants (SRCs) above background: FBQ-002, -044, and -045. 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.

The following semivolatile organic compounds (SVOCs) were detected at FBQ:

- Benzo(*a*)anthracene, benzo(*a*)pyrene, benzo(*b*)fluoranthrene, benzo(*k*)fluoranthrene, and chrysene were detected only at FBQ-060.

- Fluoranthene was detected at FBQ-017 and FBQ-060.

- Pyrene was detected at FBQ-060.

40-mm Firing Range

Seven explosive/propellant compounds were detected at least once in surface soil samples collected during the Phase II RI. The following compounds were detected: nitrocellulose (4 of 4 samples); 2,4,6-TNT (1 of 40 samples); nitrobenzene (4 of 40 samples); 2-amino-4,6-DNT (2 of 40 samples); 4-amino-2,6-DNT (2 of 40 samples); 1,3,5-TNB (1 of 40 samples); 2,4-DNT (1 of 40 samples); tetryl (1 of 30 samples), and octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX) and 3-nitrotoluene (each at 1 of 40 samples). FBQ-98 had the greatest number (six) of detected explosive/propellant compounds in surface soil samples at the 40-mm Firing Range area.

Thirteen inorganics were detected above background in surface soil samples collected from the 40-mm Firing Range area. These compounds are: aluminum, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, lead, nickel, thallium, vanadium, and zinc.

FBQ-066, -078, -079, -086, -087, and -091 had the greatest number of surface soil inorganic SRCs above background in the 40-mm Firing Range area. These sample locations are located throughout the central portion of the 40-mm Firing Range area.

The only SVOCs detected in the 40-mm Firing Range area were detected at FBQ-098 [bis(2-ethylhexyl) phthalate and diethyl phthalate].

VOCs

A total of 37 volatile organic compounds (VOCs) were analyzed for in 12 surface soil samples collected during the Phase I/II RI. Methylene chloride and acetone were detected in one of four samples. TCE (two of eight samples); toluene (one of four samples); carbon disulfide (one of eight samples); 1,1,1-trichloethane (one of four samples); and 1,1-dichloethene (DCE) (one of three samples) were also detected.

Pesticides and PCBs

A total of 22 pesticides and 7 polychlorinated biphenyl (PCB) compounds (Aroclors) were analyzed for in 12 surface soil samples collected from FBQ and the 40-mm Firing Range. No PCB compounds were detected in these samples.

The following pesticides were detected in this investigation:

- 4,4-DDE at FBQ-009 and -029, and -083 (40-mm Firing Range); and
- aldrin, endrin, endrin aldehyde, endrin ketone, gamma-BHC (Lindane), and heptachlor at FBQ-083 (40-mm Firing Range).

Subsurface Soil

Subsurface soil samples were collected from 37 locations at FBQ and 26 locations at the 40-mm Firing Range area and analyzed for explosives and propellants during the FBQ Phase I/II RI.

Fuze and Booster Quarry Landfill/Ponds

At FBQ, two explosive/propellant compounds (nitrobenzene and nitrocellulose) were detected at three locations (FBQ-003, -009, and -019).

Thirteen inorganic compounds were detected above background in subsurface soil samples collected from FBQ. These compounds are: aluminum, antimony, arsenic, barium, beryllium, cadmium, chromium, hexavalent chromium, lead, mercury, selenium, vanadium, and zinc. The following sample locations had four or more subsurface soil inorganic SRCs above background: FBQ- 017, -019, -021, -026, -028, -040, and -059.

The following VOCs were detected in subsurface soil samples collected from FBQ: methylene chloride (FBQ-017, -018, -019, -051, and -060); carbon disulfide (FBQ-019); m,p-xylenes, 1,2-dimethylbenzene, and toluene (all at FBQ-083); and trichloroethene (TCE) (FBQ-003).

40-mm Firing Range

At the 40-mm Firing Range, either 3-nitrotoluene (1 of 26 samples), nitrobenzene (3 of 26 samples), or nitrocellulose (3 of 3 samples) was detected at least once at five sample locations (FBQ-067, -079, -082, -083, and -086).

Nine inorganics were detected above background in subsurface soil samples collected from the 40-mm Firing Range. These compounds are: aluminum, arsenic, beryllium, cadmium, chromium, cobalt, copper, lead, and thallium. The following sample locations had four or more subsurface soil inorganic SRCs above background in the 40-mm Firing Range area: FBQ- 062, -063, -077, and -095.

VOCs were detected at two sample locations from the 40-mm Firing Range:

- FBQ-083 – acetone; carbon disulfide; m,p-xylenes; o-xylene; and toluene; and
- FBQ-086 – 2-butanone and acetone.

No SVOCs, PCBs, or pesticides were detected in the subsurface soil samples collected from either FBQ or the 40-mm Firing Range area.

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. A summary of the detected explosive/propellant compounds in sediment samples with the number of times the compound was detected and the location of the highest concentration is as follows:

- 1,3,5-Trinitrobenzene – 1, FBQ-134 (98 µg/kg);
- 1,3-Dinitrobenzene – 1, FBQ-134 (110 µg/kg);
- 2,4,6-TNT – 5, FBQ-146 (300 µg/kg);
- 2,6-DNT – 1, FBQ-139 (85 µg/kg);
- 2-Amino-4,6-DNT – 1, FBQ-155 (73 µg/kg);
- 4-Amino-2,6-DNT – 3, FBQ-146 (390 µg/kg);
- HMX – 2, FBQ-146 (160 µg/kg);
- 3-nitrotoluene – 3, FBQ-162 (150 µg/kg);
- Nitrobenzene – 7, FBQ-144 (110 µg/kg);
- Nitrocellulose – 23, FBQ-129 (110 µg/kg); and
- Nitroglycerine – 1, FBQ-156 (459,000 µg/kg.

Explosive/propellant compounds were detected in every sediment sample collected from the Quarry Ponds, with the exception of FBQ-147. 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 SRCs were detected in every sediment sample collected. FBQ-126, collected from sediment located in the southwestern-most corner of the AOC, had the highest number of inorganic SRCs detected (15). The highest concentrations of inorganic SRCs above background are found at the following locations:

- Aluminum – 22,100 mg/kg at FBQ-132;
- Antimony – 128 mg/kg at FBQ-146;
- Arsenic – 33.3 mg/kg at FBQ-143;
- Barium – 976 mg/kg at FBQ-155;
- Beryllium – 1.2 mg/kg at FBQ-130;
- Cadmium – 18.9 mg/kg at FBQ-148;
- Chromium – 1,140 mg/kg at FBQ-126;

- Hexavalent chromium – 33 mg/kg at FBQ-148;
- Cobalt – 18 mg/kg at FBQ-155;
- Copper – 660 mg/kg atFBQ-091;
- Lead – 31.3 mg/kg at FBQ-097;
- Manganese – 4,100 mg/kg at FBQ-141;
- Mercury – 35 mg/kg at FBQ-146;
- Nickel – 80.5 mg/kg at FBQ-158;
- Selenium – 8.2 mg/kg at FBQ-155;
- Silver – 12.4 mg/kg at FBQ-146;
- Vanadium – 42 mg/kg at FBQ-140; and
- Zinc – 3,620 mg/kg at FBQ-148.

The sediment sample locations that had 14 or more inorganic SRCs above background are FBQ-126, -127, -140, -142, -148, and -155.

SVOCs

The SVOC SRCs in sediment are as follows:

- 2-Methylnaphthalene was detected at 5 of the 40 sample locations. The highest concentration detected was 1,600 μg/kg at FBQ-141.

- Anthracene was detected at FBQ-145 (102 μg/kg), FBQ-148 (230 μg/kg), and FBQ-163 (460 μg/kg).

- Benzo(*a*)anthracene was detected at 12 of the 40 sample locations. The highest concentration detected was 2,100 μg/kg at FBQ-148.

- Benzo(*a*)pyrene was detected at 16 of the 40 sample locations. The highest concentration detected was 2,000 μg/kg at FBQ-148.

- Benzo(*b*)fluoranthene was detected at 16 of the 40 sample locations. The highest concentration detected was 2,300 μg/kg at FBQ-148.

- Benzo(*ghi*)perylene was detected at 4 of the 40 sample locations. The highest concentration detected was 1,200 μg/kg at FBQ-148.

- Benzo(*k*)fluoranthene was detected at 3 of the 40 sample locations. The highest concentration detected was 950 μg/kg at FBQ-148.

- Bis(2-ethylhexyl) phthalate was detected at 4 of the 40 sediment sample locations. The highest concentration measured was 100 μg/kg at FBQ-156.

- Carbazole was detected at FBQ-163 (230 μg/kg), FBQ-145 (129 μg/kg), and FBQ-148 (110 μg/kg).

- Chrysene was detected at 15 of 40 sample locations. The highest concentration measured was 1,300 μg/kg at FBQ-148.

- Dibenzofuran was detected at FBQ-141 (430 μg/kg) and FBQ-163 (110 μg/kg).

- Fluoranthene was detected at 18 of 40 locations sampled. The highest concentration measured was 3,200 μg/kg at FBQ-148.

- Ideno(*1,2,3-cd*)pyrene was detected at 6 of 40 sample locations. The highest concentration measured was 1,000 μg/kg at FBQ-148.

- Naphthalene was detected in 4 of 40 samples. The highest concentration measured was 970 μg/kg at FBQ-141.

- Phenanthrene was detected in 11 of 40 samples. The highest concentration measured was 1,700 μg/kg at FBQ-141.

- Pyrene was detected in 14 of 40 sediment samples. The highest concentration measured was 2,300 μg/kg at FBQ 148.

The VOC SRCs in sediment are as follows:

- 2-Butanone was detected in 11 of 40 samples. The highest concentration measured was 43 μg/kg at FBQ-156.

- Acetone was detected in 5 of 40 samples. The highest concentration measured was 180 μg/kg at FBQ-156.

- Carbon disulfide was detected at FBQ-142 (2.3 μg/kg), FBQ-143 (3.6 μg/kg), and FBQ-156 (2.9 μg/kg).

- Methylene chloride was detected in 6 of 40 sediment samples. The highest concentration measured was 37 μg/kg at FBQ-145.

- Toluene was detected in 6 of 40 samples. The highest measured at FBQ-139 (90 μg/kg).

No PCB compounds were detected in the sediment samples. Eleven pesticides were detected in the sediment samples. Endosulfan I, beta-BHC, gamma-BHC (Lindane), and heptachlor epoxide (all detected at FBQ-139); 4-4'-DDT (detected at FBQ-132); and endrin (detected at FBQ-139 and FBQ-153) 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 (FBQ-165) because other pesticides were detected there as well. 4,4-DDD was detected at 5 of 40 sample locations; the highest concentration was 13 μg/kg at FBQ-143. Endrin was detected at FBQ-139 (0.55 μg/kg) and FBQ-153 (0.71 μg/kg). 4,4-DDE was detected at 6 of 40 sample locations; the highest concentration was 1.5 μg/kg at FBQ-150. Methoxychlor was detected at 4 of 40 sample locations; the highest concentration was measured at 3 μg/kg (FBQ-148).

The greatest number of SVOC, VOC, and pesticide SRCs detected in surface water were collected from FBQ-145, -148, and -156 (Quarry Ponds), and FBQ-141 and –163 (collected from a drainage channel west of the southern-most Quarry Pond).

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 at FBQ-134, obtained from one of the smaller settling basins.

- Nitrocellulose, which was detected at 12 of the 15 stations, the highest concentration measured, was 1.1 µg/L at FBQ-145.

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 site background occurred in surface water at station FBQ-130, which was 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 was detected at 3 locations: FBQ-131 (5.1 µg/L), FBQ-132 (5 µg/L), and FBQ-134 (3.4 µg/L).

- carbon disulfide was detected at 3 locations: FBQ-134 (1.7 µg/L), FBQ-139 (0.94 µg/L), and FBQ-141 (1.8 µg/L).

- methylene chloride was detected at 2 sample locations: FBQ-145 (4.5 µg/L) and FBQ-147 (4.7 µg/L).

- styrene was only detected at FBQ-132 (1.1 µg/L).

- toluene was detected at ten sample locations; the highest concentration measured was 20 µg/L at FBQ-131.

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 site generally have a greater number of SRC compounds than the surface water sampled from the upgradient Quarry Ponds located to the east.

Groundwater

Wells Screened in Unconsolidated Materials

Explosives/propellants were detected in five of the six monitoring wells screened in the unconsolidated materials at FBQ. The following explosives/propellants were detected:

- 2-Amino-4,6-DNT was detected in FBQ-168.
- 4-amino-2,6-DNT was detected in FBQ-168.
- Nitrocellulose was detected FBQ-167, -168, -169, -176, and -177.

Inorganic SRCs detected above background in all six unconsolidated monitoring wells were barium and manganese. Aluminum and nickel were detected in three, zinc and cobalt in two, and copper and cadmium in one. FBQ-169 had the most inorganic SRCs at the maximum concentration detected in groundwater sampled from the unconsolidated materials.

The SVOCs caprolactum (three of six samples) and bis(2-ethylhexyl) phthalate (three of six samples) were detected in the monitoring well samples. The following VOCs were detected in groundwater samples collected from the unconsolidated materials:

- 1,1,1-Trichloethane was detected at FBQ-167.
- 1,1-DCE was detected at FBQ-167 and -169.
- Acetone was detected at FBQ-167, -168, and -169.
- Carbon disulfide was detected at FBQ-177.

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

Wells Screened in Sandstone Bedrock

Six explosive/propellant compounds were detected in the monitoring wells screened in bedrock at FBQ. These compounds are as follows:

- 2,4,6-TNT was detected at FBQ-173 and -174.
- 2,4-DNT was detected in FBQ-174.
- 2-Amino-4,6-DNT was detected at FBQ-173 and -174.
- 4-Amino-2,6-DNT was detected at FBQ-173 and -174.
- Nitrobenzene was detected at FBQ-173.
- Nitrocellulose was detected in five of the six wells screened in bedrock; the highest concentration measured was at FBQ-175 (0.32 μg/L). Nitrocellulose was not detected in FBQ-166.

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 samples, nickel in two of the samples, and aluminum and hexavalent chromium in one of the samples. FBQ-173 had the most inorganic SRCs detected (i.e., aluminum, cobalt, copper, lead, manganese, and nickel).

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. The following VOCs were detected in groundwater samples collected from bedrock:

- Acetone was detected in two of three samples; the highest concentration measured was at FBQ-175 (6.2 μg/L).
- TCE was detected at FBQ-170 (12 μg/L) and FBQ-171 (7.1 μg/L).

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, FBQ-173. The monitoring wells with the lowest number of SRCs are the downgradient wells, FBQ-166, -177, and -176.

RECOMMENDATIONS

Nature and Extent of Contamination

It is recommended that a Feasibility Study (FS) be performed for FBQ. The future land use and controls of this AOC should be determined prior to developing plans for an FS. Identification of future land uses provides the basic information necessary to select the appropriate remedial response needed to achieve protection of human health and the environment, allows development of appropriate remedial action objectives, and allows finalization and application of remedial goals for appropriate potential receptors identified in the risk assessments.

The lateral and vertical extent of contamination was not determined in all cases for each media. The following uncertainties should be addressed to allow for a complete evaluation of possible remedial actions:

1. Determine the lateral and horizontal limits of inorganic compounds in the surface and subsurface soil at FBQ. A Supplemental Phase II sampling at FBQ will be implemented to 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. In addition, one location exceeds background for manganese (1,450 mg/kg) that is only partially bounded, for which an additional sample will be collected to define the extent in that area.

2. The unnamed tributary near Greenleaf Road receives much of the surface water runoff from FBQ and ultimately flows into Hinckley Creek. Sediment samples were collected from the unnamed tributary near Greenleaf Road, however, surface water was not present and samples could not be collected to evaluate potential impacts to surface water leaving FBQ. Sediment and surface water samples were collected from the up-gradient settling basins, drainage ditches and quarry ponds as well as from the up-gradient surface soils that may contribute to the unnamed tributary. Nature, extent, and potential risk from exposures at these up-gradient areas were characterized and evaluated in this RI Report. In addition to the evaluation performed in this RI, no biological impairment associated with chemical contaminants was observed based on sampling results from Hinckley Creek as noted in the FWSW Report (USACE 2005). Thus potential surface water impacts have been sufficiently characterized at FBQ.

3. Perchlorate was detected in two of ten surface water samples collected in 2003. Perchlorate was not detected in subsequent surface water and sediment samples collected in 2004. U. S. Environmental Protection Agency Method 314.0 was used to analyze these samples and has been demonstrated to indicate false positives as a result of sediment or dissolved ions commonly found in surface water. Agreement on the method and potential refinements in the methodology and interpretation of the data need to occur before further perchlorate analysis is conducted at RVAAP.

Human Health Risk Assessment

Arsenic and manganese were identified as chemicals of concern (COCs) in soil and sediment for the National Guard Trainee at FBQ; however, the EPCs for arsenic and manganese in soil are less than surface soil background and the exposure point concentrations 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. It is recommended that decision makers carefully consider the need for further investigation or remedial action based on the risk assessment results for this receptor taken at face value.

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. Therefore, as with the soil and sediment results, it is recommended that decision makers carefully consider the need for further investigation or remedial action based on the calculated risks using these data.

Ecological Risk Assessment

The screening ecological risk assessment (ERA) identified the presence of multiple contaminants of potential ecological concern (COPECs) in soil, sediment, and surface water, as well as the presence of site-specific ecological receptors and complete exposure pathways to those COPECs at the FBQ site. A recommendation is made to move to a Sample Management Decision Plan (SMDP). The most likely outcomes associated with the SMDP for the ERA, as mentioned in Chapters 7 and 8, are: (1) risk management of the ecological resources based on the military land use or other reasons that many include development of remedial goal options (RGOs) or weight-of-evidence (WOE) analysis that no RGOs are required; (2) remediation of some of the source material, if required, to reduce ecological risks; or (3) conduct of more investigation, such as a Level III. In the FS, a WOE approach to the COPECs involved at FBQ would assist in defining the best outcome or decision. Thus, the information in this Level II screening ERA presented in this report can be used to assist risk managers in making their decision associated with the SMDP.

1.0 INTRODUCTION

This report documents the results of the Phase I/Phase II Remedial Investigation (RI) at the Fuze and Booster Quarry Landfill/Ponds (FBQ) at the Ravenna Army Ammunition Plant (RVAAP), Ravenna, Ohio (Figures 1-1 and 1-2). The Phase I/Phase II RI was conducted under the U. S. Department of Defense (DoD) Installation Restoration Program (IRP) by SpecPro, Inc., and its subcontractors, under contract number DAAA09-01-G-0009, Delivery Order No. 0012 with the Joint Munitions Command. The Phase I/Phase II RI was conducted in compliance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980 following work plans reviewed by the U. S. Army Corps of Engineers (USACE) and the Ohio Environmental Protection Agency (Ohio EPA). The RI is being completed on behalf of the USACE in accordance with U. S. General Services Administration Environmental Advisory Services Contract GS-10-F-0076J (Delivery Order W912QR-05-F-0033) under a Performance-Based Contract.

This document summarizes the results of the Phase I/Phase II RI field activities primarily conducted in October, November and December 2003, and July 2004 at FBQ. This report expands on a previous effort to evaluate and characterize the nature and the extent of contamination in shallow and deep soils, groundwater, surface water and sediment resulting from activities at this area of concern (AOC).

1.1 PURPOSE AND SCOPE

Figure 1-3 presents the approach to implementing the CERCLA process under the guidance of the IRP. Priorities for environmental restoration at AOCs at RVAAP are based on their relative potential threat to human health and the environment, derived from Relative Risk Site Evaluations (RRSEs). Thirty-eight AOCs were identified in the *Preliminary Assessment for the Ravenna Army Ammunition Plant*, *Ravenna, Ohio* (USACE 1996). Thirteen new AOCs were identified in 1998 as a result of additional records searches and site walkovers. These were ranked by the U. S. Army Center for Health Promotion and Preventive Medicine and entered into the Operations Support Command database. Those AOCs ranked as high-priority sites (i.e., those with high RRSE scores) have been targeted first for Phase I/Phase II RIs. Medium- and low-priority sites will be characterized in Phase I/Phase II RIs following completion of the high-priority AOCs RIs. Investigations and remedial actions under the CERCLA process are implemented at the AOCs in order of priority as funding is available or unless other priorities surface, such as land use needs.

The purpose of this Phase I/Phase II RI is to determine the nature and extent of contamination in environmental media so that quantitative human health and ecological risk assessments can be performed. Results of the risk assessments will be used to determine whether an AOC requires no further action or will be the subject of a Feasibility Study (FS) to evaluate potential remedies and future actions.

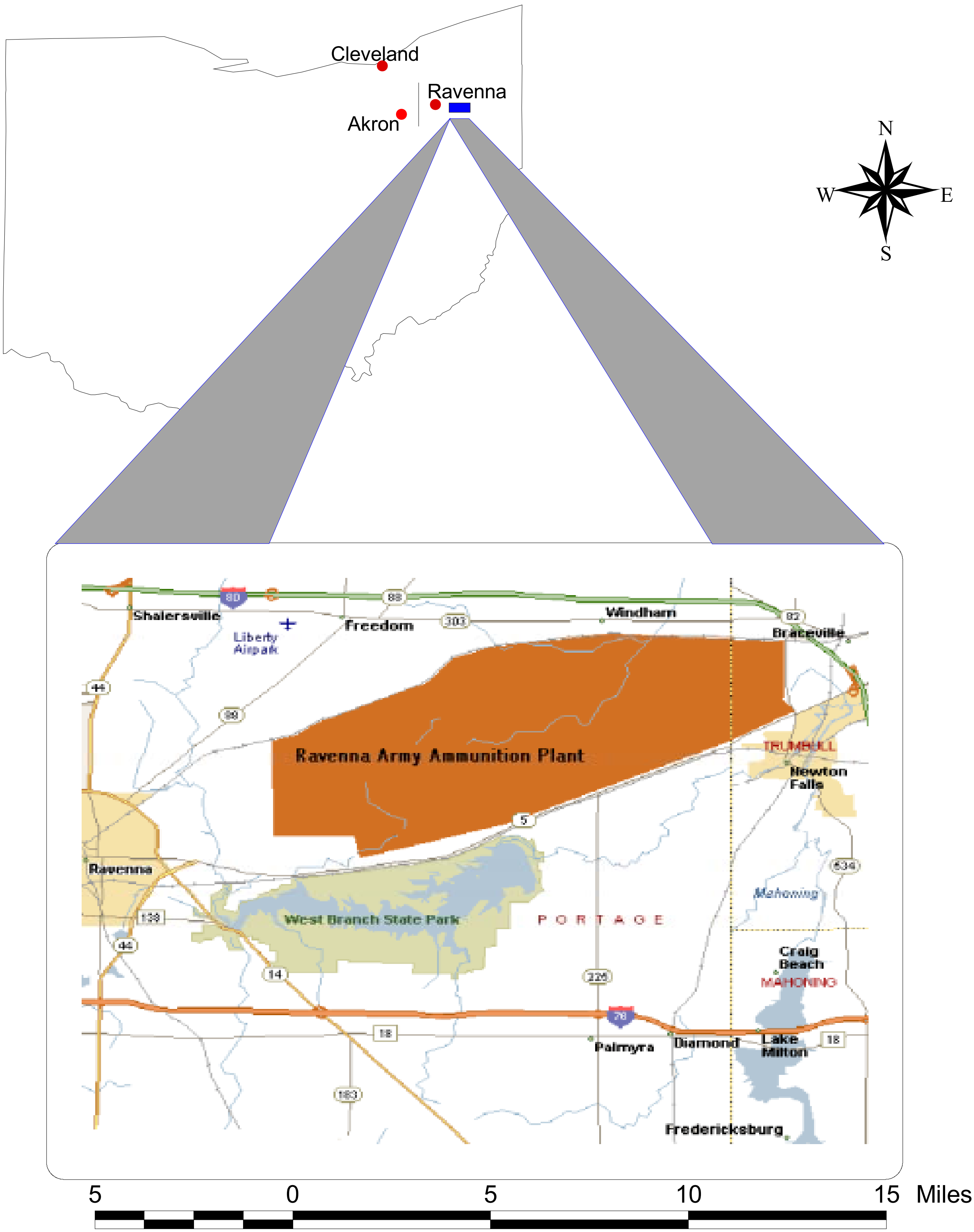
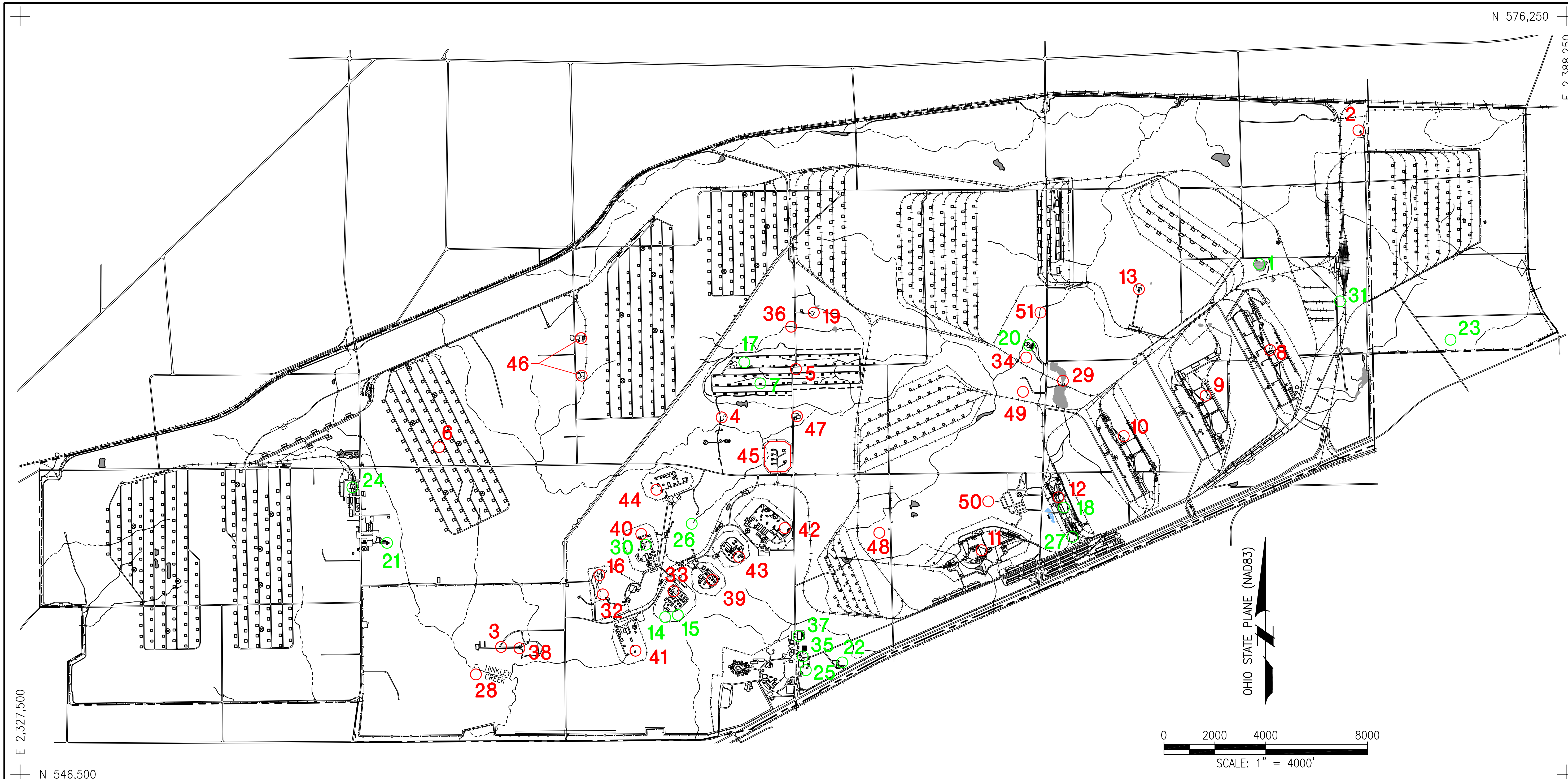


Figure 1-1. General Location Map



LEGEND OF SITES:

1 .... RAMSDELL QUARRY LANDFILL
2 .... **ERIE BURNING GROUNDS**
3 .... DEMOLITION AREA #1
4 .... DEMOLITION AREA #2
5 .... WINKLEPECK BURNING GROUNDS
6 .... C BLOCK QUARRY
7 .... BLDG 1601 HAZARDOUS WASTE STORAGE
8 .... LOAD LINE 1 AND DILUTION/SETTLING POND
9 .... LOAD LINE 2 AND DILUTION/SETTLING POND
10 .... LOAD LINE 3 AND DILUTION/SETTLING POND
11 .... LOAD LINE 4 AND DILUTION/SETTLING POND
12 .... LOAD LINE 12 AND DILUTION/SETTLING POND
13 .... BLDG 1200 AND DILUTION/SETTLING POND
14 .... LOAD LINE 6, EVAPORATION UNIT
15 .... LOAD LINE 6, TREATMENT PLANT
16 .... QUARRY LANDFILL/FORMER FUZE & BOOSTER BURNING PITS
17 .... DEACTIVATION FURNACE
18 .... LOAD LINE 12 PINK WASTE WATER TREATMENT
19 .... LANDFILL NORTH OF WINKLEPECK BURNING GROUND
20 .... SAND CREEK SEWAGE TREATMENT PLANT
21 .... DEPOT SEWAGE TREATMENT PLANT
22 .... GEORGE ROAD SEWAGE TREATMENT PLANT
23 .... UNIT TRAINING SITE WASTE OIL TANK
24 .... RESERVE UNIT MAINTENANCE AREA WASTE OIL TANK
25 .... BLDG 1034 MOTOR POOL WASTE OIL TANK
26 .... FUZE BOOSTER AREA SETTLING TANKS
27 .... BLDG 854-PCB STORAGE
28 .... MUSTARD AGENT BURIAL SITE
29 .... UPPER AND LOWER COBBS POND COMPLEX
30 .... LOAD LINE 7 PINK WASTEWATER TREATMENT PLANT
31 .... ORE PILE RETENTION POND
32 .... 40 AND 60 MM FIRING RANGE
33 .... FIRESTONE TEST FACILITY
34 .... SAND CREEK DISPOSAL ROAD LANDFILL
35 .... 1037 BUILDING-LAUNDRY WASTEWATER SUMP
36 .... PISTOL RANGE
37 .... PESTICIDE STORAGE BUILDING T-4452
38 .... NACA TEST AREA
39 .... LOAD LINE 5 / FUZE LINE 1
40 .... LOAD LINE 7 / BOOSTER LINE 1
41 .... LOAD LINE 8 / BOOSTER LINE 2
42 .... LOAD LINE 9 / DETONATOR LINE
43 .... LOAD LINE 10 / PERCUSSION ELEMENT
44 .... LOAD LINE 11 / ARTILLERY PRIMER
45 .... WET STORAGE AREA
46 .... BUILDINGS F-15 AND F-16
47 .... BUILDING T-5301 DECONTAMINATION
48 .... ANCHOR TEST AREA
49 .... CENTRAL BURN PITS
50 .... ATLAS SCRAP YARD
51 .... DUMP ALONG PARIS-WINDHAM ROAD

○ .... CERCLA
○ .... RCRA
○ .... OTHER REGULATORY

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

US Army Corps of Engineers
Louisville District

RAVENNA ARMY AMMUNITION PLANT
RAVENNA, OHIO
FACILITY MAP

DRAWN BY:	REV. NO./DATE:	CAD FILE:
R. BEELER	0 / 09-02-03	/03025/DWGS/S80RVAP1

Figure 1-2. RVAAP Facility Map

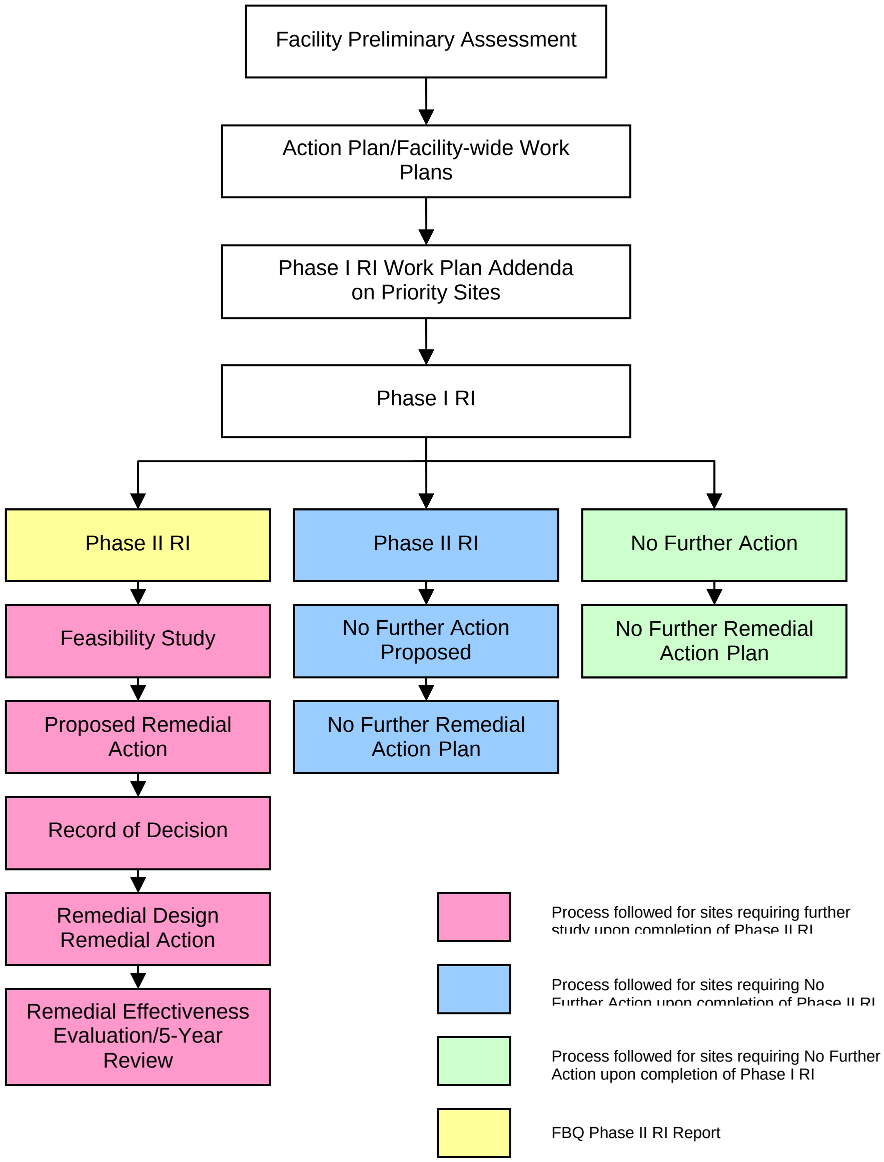


Figure 1-3. RVAAP CERCLA Approach

The scope of this investigation is to determine the extent of contamination in affected media (soils, sediments, surface water, and groundwater) identified during the Phase I/Phase II RI at FBQ and the nearby 40-mm Firing Range. The primary objectives of this Phase I/Phase II RI are as follows:

- Determine the boundaries of the FBQ AOC.
- Measure the AOC physical characteristics.
- Identify the sources of contamination.
- Characterize the nature and extent of contamination at the FBQ and adjacent 40-mm Firing Range.
- Establish a system to monitor potential off-site migration of contaminants.
- Collect data to support a Baseline Risk Assessment for human health and the environment.

To meet the primary project objectives, investigation-specific data quality objectives (DQOs) were developed using the approach presented in the Facility-wide Sampling and Analysis Plan (SAP) (USACE 2001a). The DQOs specific to the FBQ Phase I/Phase II RI are discussed in Section 3.2 of the *Fuze and Booster Quarry Ponds SAP Addenda*, and are summarized in Section 1.8 of this report.

The investigation approach for the Phase I/Phase II RI at FBQ involved a combination of field and laboratory activities to characterize the AOC. Field investigation techniques included soil boring and sampling, as well as surface water, sediment, and groundwater sampling. The field program was conducted in accordance with the Facility-wide SAP (USACE 2001a) and the *Work Plan and Sampling and Analysis Plan Addenda for the Phase I/Phase II RI at the Fuze & Booster Quarry Landfill/Ponds at the Ravenna Army Ammunition Plant, Ravenna, Ohio* (SAP Addendum) (USCAE 2002).

The 40-mm Firing Range (AOC-32) was also investigated during the Phase I/Phase II RI at FBQ. Data collected at the 40-mm Firing Range is included in this RI; however it is not included in Section 6 (HHRA) or Section 7 (ERA). Evaluation of the 40-mm Firing Range data is presented in *Evaluation of Chemical Residuum at the 40-mm Range, Ravenna Army Ammunition Plant, Ravenna, Ohio.*

1.2 GENERAL FACILITY DESCRIPTION

RVAAP is a 1,481-acre portion of the 21,419-acre Ravenna Training and Logistics Site (RTLS) of the Ohio Army National Guard (OHARNG). OHARNG is currently accountable for 19,938 acres of the installation. RVAAP was previously operated as a government-owned, contractor-operated facility. RVAAP and RTLS are located in northeastern Ohio within Portage and Trumbull counties, approximately 4.8 km (3 miles) east-northeast of the town of Ravenna and approximately 1.6 km (1 mile) northwest of the town of Newton Falls. The Installation consists of a 17.7-km (11-mile) long, 5.6-km (3.5-mile)-wide tract bounded by State Route 5, the Michael J. Kirwan Reservoir, and the CSX System Railroad on the south; Garrett, McCormick and Berry roads on the west; State Route 534 to the east, and 04-151(E)/062105 1-6 the Norfolk Southern Railroad on the north (see Figures 1-1 and 1-2). The Installation 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 east, Charlestown to the southwest, and Wayland 4.8 km (3 miles) southeast.

Industrial operations at 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 (2,4,6-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 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 during the Korean Conflict (July 1954 to October 1957) and again during the Vietnam Conflict (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.

In 1992, the status of RVAAP changed from inactive-maintained to modified caretaker. The only activities still being carried out from the wartime era are the infrequent demolition of unexploded ordnance (UXO) found at the Installation. The Army is also overseeing the reclamation of railroad track, telephone line, and steel for re-use or recycling. The Army has completed the demolition of excess buildings at Load Lines 1 and 12, and is currently conducting demolition activities at Load Line 2, which includes the removal of friable asbestos. RVAAP's operations and mission-related activities are directed by the Base Realignment and Closure Office. Environmental restoration activities at RVAAP are conducted under the auspices of the IRP. As of January 2003, oversight and funding responsibilities for the IRP were transferred to the U. S. Army Environmental Center. In addition to Army mission-related and IRP activities, a large portion of RVAAP is currently used by OHARNG for training missions.

1.3 SITE BACKGROUND

Chemicals occur naturally in soil, sediment, surface water, and groundwater. The natural levels of chemicals – called background – must be known in order to determine whether the concentrations measured at the FBQ are higher than would be expected if the quarrying/disposal operations had not occurred. Facility-wide background for inorganic constituents in soil, sediment, surface water, and groundwater were developed as part of a previous Phase II RI conducted at the Winklepeck Burning Grounds at RVAAP (USACE 2001b). Although some organic compounds also occur under ambient conditions [i.e., some polycyclic aromatic hydrocarbons (PAHs)], the organic compounds of primary concern (e.g., explosives) are man-made, and, therefore, comparison to background is not relevant.

In the facility-wide background study, a background was calculated for each inorganic constituent detected for each environmental medium of interest. The background is the 95% upper tolerance limit of the 95th percentile of the distribution of background concentrations. This means that if a sample is taken from an area with concentrations of inorganics that are not elevated above background, the measured concentration will be below the background criteria 95% of the time. If a measured concentration is above the background criteria, it is likely that it comes from an area with concentrations above background.

Background criteria were set to zero for inorganics that were not detected in the facility-wide background samples. For inorganics that were not detected in background samples, any detected result from the FBQ was considered to be above background. RVAAP facility-wide background criteria for each medium are listed in Table 1-1.

1.4 DEMOGRAPHY AND LAND USE

RVAAP consists of 8,998.3 ha (21,419 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.

Until May 1999, about 364 ha (900 acres) of land and some existing facilities at RVAAP were used by the National Guard Bureau for training purposes administered by OHARNG. Training and related activities included field operations and bivouac training, convoy training, equipment maintenance, and storage of heavy equipment. In May 1999, the National Guard Bureau assumed operational control of 16,164 acres of RVAAP and licensed OHARNG to use the facility for training and other activities. In December of 2001, operational control of an additional 3,774 acres of RVAAP was transferred to the National Guard Bureau.

1.5 FUZE AND BOOSTER QUARRY LANDFILLS/PONDS SITE DESCRIPTION AND HISTORY

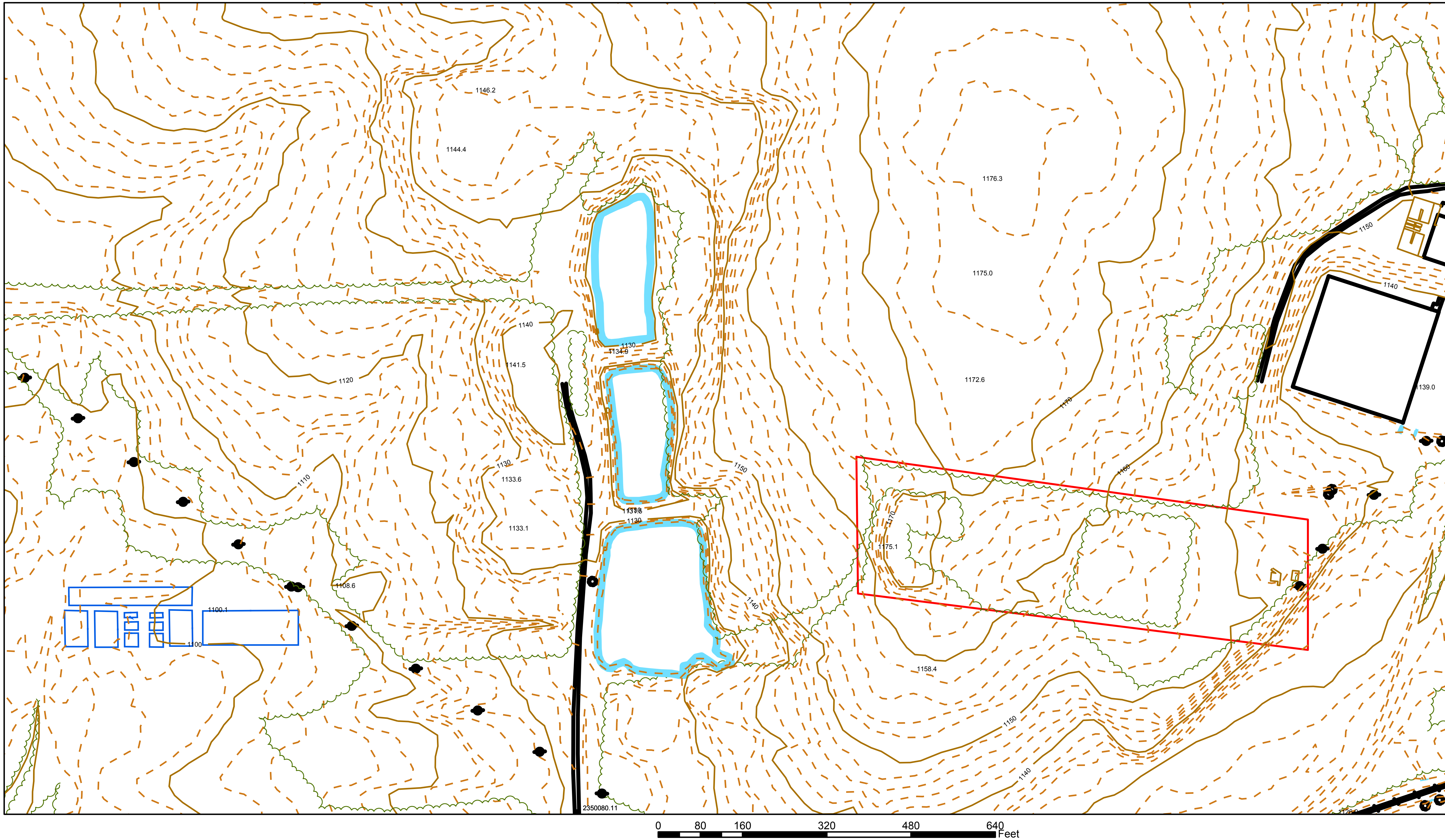
A detailed history of process operations and waste processes for the original 38 identified AOCs at RVAAP, including FBQ, is presented in the *Preliminary Assessment for the Ravenna Army Ammunition Plant, Ravenna, Ohio* (USACE 1996). The following is a summary of the history and related contaminants for FBQ.

The FBQ AOC operated during the period 1945 through 1993. The eastern part of the AOC consists of three larger ponds located in an abandoned rock quarry. The ponds are 20 to 30 ft deep and are separated by earthen berms. The western part of the AOC consists of 11 smaller, shallow settling basins. Prior to 1976, the quarry was reportedly used for open burning and as a landfill. The resultant debris from the burning and from the landfill operation was reported to have been removed during construction of the ponds. From 1976 through 1993, spent brine regenerate and sand filtration backwash water from one of the RVAAP drinking water treatment plants was discharged into the ponds. This discharge was regulated under a National Pollutant Discharge Elimination System permit. In 1998, this AOC was expanded to include three other shallow settling ponds and two debris piles bringing the AOC to approximately 45 acres in size. Based on the operational history for FBQ, waste constituents and potential contaminants at this AOC include explosive compounds; propellants; and inorganics. The lands adjacent to the quarry were utilized as an impact area to test 40-mm projectiles. Figure 1-4 presents a map of the site.

Table 1-1. RVAAP Facility-wide Background Criteria

Media (Units)	Surface Soil (mg/kg)	Subsurface Soil (mg/kg)	Sediment (mg/kg)	Surface Water (μg/L)	Groundwater Bedrock Zone Filtered (μg/L)	Groundwater Bedrock Zone Unfiltered (μg/L)	Groundwater Unconsolidated Zone Filtered (μg/L)	Groundwater Unconsolidated Unfiltered (μg/L)
Analyte								
Cyanide	0	0	0	0	0	0	0	0
Aluminum	17,700	19,500	13,900	3,370	0	9,410	0	48,000
Antimony	0.96	0.96	0	0	0	0	0	4.3
Arsenic	15.4	19.8	19.5	3.2	0	19.1	11.7	215
Barium	88.4	124	123	47.5	256	241	82.1	327
Beryllium	0.88	0.88	0.38	0	0	0	0	0
Cadmium	0	0	0	0	0	0	0	0
Calcium	15,800	35,500	5,510	41,400	53,100	48,200	115,000	194,000
Chromium	17.4	27.2	18.1	0	0	19.5	7.3	85.2
Cobalt	10.4	23.2	9.1	0	0	0	0	46.3
Copper	17.7	32.3	27.6	7.9	0	17	0	289
Iron	23,100	35,200	28,200	2,560	1,430	21,500	279	195,000
Lead	26.1	19.1	27.4	0	0	23	0	18.3
Magnesium	3,030	8,790	2,760	10,800	15,000	13,700	43,300	58,400
Manganese	1,450	3,030	1,950	391	1,340	1,260	1,020	2,860
Mercury	0.036	0.044	0.059	0	0	0	0	0.25
Nickel	21.1	60.7	17.7	0	83.4	85.3	0	117
Potassium	927	3,350	1,950	3,170	5,770	6,060	2,890	7,480
Selenium	104	105	107	0	0	0	0	5.7
Silver	0	0	0	0	0	0	0	0
Sodium	123	145	112	21,300	51,400	49,700	45,700	44,700
Thallium	0	0.91	0.89	0	0	0	0	2.4
Vanadium	31.1	37.6	26.1	0	0	15.5	0	98.1
Zinc	61.8	93.3	532	42	52.3	193	60.9	888

RVAAP = Ravenna Army Ammunition Plant.



Legend

- Roads
- Water
- Vegetation
- 2 Ft. Contour
- 10 Ft. Contour
- 40mm Firing Range
- Basin Ponds
- Telephone Pole

SpecPro

Figure 1-4 Fuze and Booster Quarry Landfill/Ponds and the 40mm Firing Range.

N

	Site Map
	Drawn By: gharris
Figure 1.4	**CAD Files: R31718/R31617/R21718/R21617**
	Date: January 22, 2005

1.6 PREVIOUS INVESTIGATIONS

A limited environmental investigation was previously performed at FBQ (USACHPPM 1996). This previous investigation recorded surface water and sediment were of high concern within the Quarry Ponds due to the presence of inorganics. The results of this investigation are provided in Appendix A.

1.7 REGULATORY STATUS OF THE FUZE AND BOOSTER QUARRY LANDFILL/PONDS

The FBQ and nearby 40-mm Firing Range are CERCLA AOCs.

1.8 REMEDIAL INVESTIGATION DATA QUALITY OBJECTIVES

The facility-wide conceptual site model (CSM), operational information, historical data and records, and data collected during the previous investigation at FBQ were used to design the Phase I/II RI sampling effort using the DQO approach presented in the Facility-wide SAP (USACE 2001a).

1.8.1 Conceptual Site Model

The facility-wide hydrogeologic CSM for RVAAP, presented in the Facility-wide SAP, is applicable to the FBQ for this Phase I/Phase II RI, based on current knowledge. The CSM for RVAAP, operational information, analytical data collected during historical environmental investigations, and applicable data collected during previous investigations at FBQ have been used to refine the CSM specific to the project area as outlined in Section 2.7 of this report.

1.8.2 Problem Definition

Past open detonation, open burning, and disposal activities at FBQ have impacted surface and subsurface soils, sediments, and groundwater. Known contaminants include explosives, propellants, and inorganics. Because surface drainage features represent the most probable contaminant exit pathways beyond the boundaries of FBQ, surface water and associated sediment media are specific focuses of the Phase I/Phase II RI. The likelihood of contaminant migration to groundwater via leaching of soil or infiltration of surface water in areas outside of the FBQ unit is currently unknown.

Contaminant migration potential to groundwater at FBQ will be evaluated based on SESOIL vadose zone leaching modeling (Chapter 5).

1.8.3 Remedial Action Objectives

Section 3.2.3 of the Facility-wide SAP describes the process for identifying remedial action objectives for RVAAP under the CERCLA process.

1.8.4 Identify Decisions

The key decisions for all investigations at RVAAP have been identified in Section 3.2.4 and in Table 3-1 of the Facility-wide SAP. Phase I/Phase II RI data inclusive of the risk assessment results are necessary for sound remedial decision making and to determine whether additional investigation is needed or what types of response actions are most appropriate.

1.8.5 Define the Study Boundaries

The investigation area boundaries for the Phase I/Phase II RI at FBQ encompass all known or reported historical operations areas, adjacent support areas, and potential surface water exit pathways. The AOC area is shown on Figure 1-4.

1.8.6 Identify Decision Rules

Decision rules used to guide remediation decisions are provided in Section 3.2.6 of the Facility-wide SAP. Previously collected environmental data were not sufficient to fully define the nature and extent of contamination; therefore, risk of exposure to contaminants could not be fully ascertained. The purpose of the Phase I/Phase II RI data is to more clearly determine the presence, type, concentration, and extent of contamination. The data generated from the field investigation will be used to conduct a quantitative baseline human health and ecological screening risk assessment to identify areas requiring remediation and areas where additional characterization may be needed.

1.8.7 Identify Inputs to the Decisions

Inputs to the decision process are the analytical results, risk-assessment results, and the refined site-specific conceptual model developed from field observations and environmental data. This report will provide the analytical results and a refinement of the site-specific conceptual model.

1.8.8 Specify Limits on Decision Error

Limits on decision errors are addressed in Section 3.2.8 of the Facility-wide SAP.

1.8.9 Sample Design

The sample design for the Phase I/Phase II RI of FBQ is described in detail in Chapter 4.0 of the SAP Addendum. Those source areas having confirmed contamination in the previous investigation, uncharacterized potential source areas, and contaminant accumulation points represent specific focus areas for sampling. Surface water exit pathways are also specifically targeted. Groundwater adjacent to known or potential source areas and along suspected exit pathways were also characterized. A minimal number of contingency samples were planned for suspected source areas or exit points identified during the field effort.

1.9 REPORT ORGANIZATION

This Phase II RI Report is organized to meet Ohio EPA requirements in accordance with U. S. Environmental Protection Agency (EPA), CERCLA Superfund process, and USACE guidance. The report consists of an Executive Summary, Chapters 1.0 through 8, and supporting appendices. The sections are organized as follows:

- Chapter 1.0 describes the purpose, objectives, and organization of this report and provides a description and history of FBQ.
- Chapter 2.0 describes the environmental setting at RVAAP and FBQ, including the geology, hydrogeology, climate, population, and ecological resources.

- Chapter 3.0 describes the specific Phase II RI methods used for field data collection and the approach to analytical data management and laboratory programs.
- Chapter 4.0 presents the data generated during the Phase I/II RI and discusses the occurrence and distribution of contamination at FBQ.
- Chapter 5.0 presents the contaminant fate and transport evaluation.
- Chapter 6.0 includes the methodology and results of the human health risk assessment (HHRA).
- Chapter 7.0 summarizes the screening ecological risk assessment (ERA).
- Chapter 8.0 provides results and conclusions of this study.
- Chapter 9.0 presents the recommendations.
- Chapter 10.0 provides a list of referenced documents used to support this Phase I/II RI.

Appendices (A through N) to this Phase I/II RI Report for FBQ contain supporting data collected during the Phase I/II RI and are consist of the following:

- Appendix A contains the results of previous investigations at FBQ.
- Appendix B presents the Geotechnical Laboratory Report.
- Appendix C consists of monitoring well logs, and well development records.
- Appendix D presents soil sampling logs
- Appendix E presents investigation-derived waste (IDW) information.
- Appendix F presents sediment, surface water, and test pit sampling logs.
- Appendix G contains the survey report.
- Appendix H contains the laboratory analytical data.
- Appendix I contains the project quality assurance (QA) summary.
- Appendix J contains the Data Quality Control Summary Report.
- Appendix K – Slug test results.
- Appendix L – Contaminant fate and transport.
- Appendix M – HHRA.
- Appendix N –ERA.

2.0 ENVIRONMENTAL SETTING

This chapter describes the physical characteristics of FBQ and the nearby 40-mm Firing Range and the surrounding environment that are factors in understanding potential contaminant transport pathways, receptors, and exposure scenarios for human health and ecological risks. The geology, hydrology, climate, and ecological characteristics of RVAAP were originally presented in Chapter 3.0 of the *Phase I Remedial Investigation Report for High-Priority Areas of Concern at RVAAP* (USACE 1998a). The preliminary CSM for FBQ presented at the end of this chapter is refined and updated in Chapter 5 based on site-specific data from the Phase I/II RI and local and regional information.

2.1 RVAAP PHYSIOGRAPHIC SETTING

RVAAP is located within the Southern New York Section of the Appalachian Plateaus physiographic province (USGS 1968). This province is characterized by elevated uplands underlain primarily by Mississippian and Pennsylvanian age bedrock units that are horizontal or gently dipping. The province is characterized by its rolling topography with incised streams having dendritic drainage patterns. The Southern New York Section has been modified by glaciation, which rounded ridges and 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 developed.

2.2 SURFACE FEATURES AND SITE TOPOGRAPHY

The FBQ and nearby 40-mm Firing Range are located in the central portion of the RVAAP facility, as shown in Figure 1-2. AOCs are characterized by gently sloping to relatively flat-lying topography on a weathered sandstone bedrock surface. Topography was mapped by the USACE in 1998 on a 0.6-m (2-ft) contour interval, with an accuracy of 0.006 m (0.02 ft), from aerial photographs taken in 1997. This survey is the basis for the topographic features presented in the figures in this Phase I/Phase II RI report. Elevations across the areas vary from approximately 335 m on the eastern portion of the AOC, to 353 m (1,088 to 1,160 ft) above mean sea level (AMSL) on the western portion.

Cultural features of FBQ include gravel access roads and 14 man-made ponds. There are three larger ponds on the eastern portion of the site. Eleven smaller and shallower ponds are located in the western portion of FBQ. Surface soils adjacent to the ponds and in the central area of FBQ were removed during quarrying operations. Portions of FBQ generally to the north and west were not disturbed and remain as mature hardwood forest. The disturbed areas are characterized by scrub vegetation and immature hardwood trees. Wetland areas are found in the shallow ponds and shallow areas of the deeper ponds. An unnamed tributary to Hinkley Creek generally flows from north to south just to the west of the 11 shallow ponds.

2.3 SOILS AND GEOLOGY

2.3.1 Regional Geology

The regional geology at RVAAP consists of horizontal to gently dipping bedrock strata of Mississippian and Pennsylvanian age overlain by varying thicknesses of unconsolidated glacial deposits. The bedrock and unconsolidated geology at RVAAP and geology specific to FBQ are presented in the following subsections.

2.3.1.1 Soils and glacial deposits

Bedrock at RVAAP is overlain by deposits of the Wisconsin-aged Lavery Till in the western portion of the facility and the younger Hiram Till and associated outwash deposits in the eastern portion of the facility (Figure 2-1). Unconsolidated glacial deposits vary considerably in their character and thickness across RVAAP, from zero in some of the eastern portion of the facility to an estimated 46 m (150 ft) in the south-central portion.

Thin coverings of glacial materials have been completely removed as a consequence of human activities at locations such as Ramsdell Quarry, and bedrock is present at or near the ground surface in many locations, such as at Load Line 1 and the Erie Burning Grounds (USACE 2001c). The character and distribution of the glacial material indicate that the material is ground moraine. These tills consist of laterally discontinuous assemblages of yellow-brown, brown, and gray silty clays to clayey silts, with sand and rock fragments. Deposits from bodies of glacial-age standing water may also have been encountered, in the form of >15-m (50-ft) -thick deposits of uniform light gray silt (USACE 2001c).

Soils at RVAAP are generally derived from the Wisconsin-age silty clay glacial till. Distributions of soil types are discussed and mapped in the Soil Survey of Portage County, Ohio (USDA 1978). Much of the native soil at RVAAP was reworked or removed during construction activities in operational areas of the installation.

According to the Portage County soil survey, the major soil types found in the high-priority AOCs are silt or clay loams with permeabilities ranging from 6.0×10^{-7} to 1.4×10^{-3} cm/sec.

2.3.1.2 Bedrock stratigraphy

Bedrock occurrence at RVAAP consists of Mississippian and Pennsylvanian Age sedimentary rocks that lie stratigraphically beneath the glacial deposits of the Lavery and Hiram Tills (Figure 2-2). The oldest bedrock that outcrops within the facility is the Cuyahoga Group of Mississippian Age. The Cuyahoga outcrops in the far northeastern corner of the facility, and generally consists of blue-gray silty shale with interbedded sandstone (Figure 2-3). The remainder of the facility is underlain by bedrock associated with the Pottsville Formation of Pennsylvanian Age. The Sharon Member of the Pennsylvanian Pottsville Formation unconformably overlies the eroded Cuyahoga Group throughout the eastern half of RVAAP. The Sharon Member consists of two units: sandstone/conglomerate and shale. The Sharon Conglomerate unit of the Sharon Member is highly porous, permeable, cross-bedded, and frequently fractured and weathered. The Sharon Shale unit is a light to dark-gray fissile shale, which has been eroded in many locations. The Connoquenessing Sandstone Member of the Pottsville Formation unconformably overlies the Sharon Member and is a medium- to coarse-grained gray-white sandstone. The Mercer Member of the Pottsville Formation overlies the Connoquenessing and consists of silty to carbonaceous shale. The Homewood Member of the Pottsville Formation unconformably overlies the Mercer Member and consists of coarse-grained cross-bedded sandstones. The Connoquenessing, Mercer, and Homewood Members are present only in the western half of RVAAP. The regional dip of the Pottsville Formation strata is between 1.5 and 3 m (5 to 10 ft) per mile to the south.

2.3.2 Geologic Setting of the Fuze and Booster Quarry Landfill/Ponds

Subsurface characterization at FBQ during the Phase I/II RIs was performed in the unconsolidated materials and underlying bedrock. The most thorough characterization was performed by continuous sampling during the drilling of monitoring well borings. Core holes into bedrock were drilled at seven monitoring well borings during the Phase I/II RI.

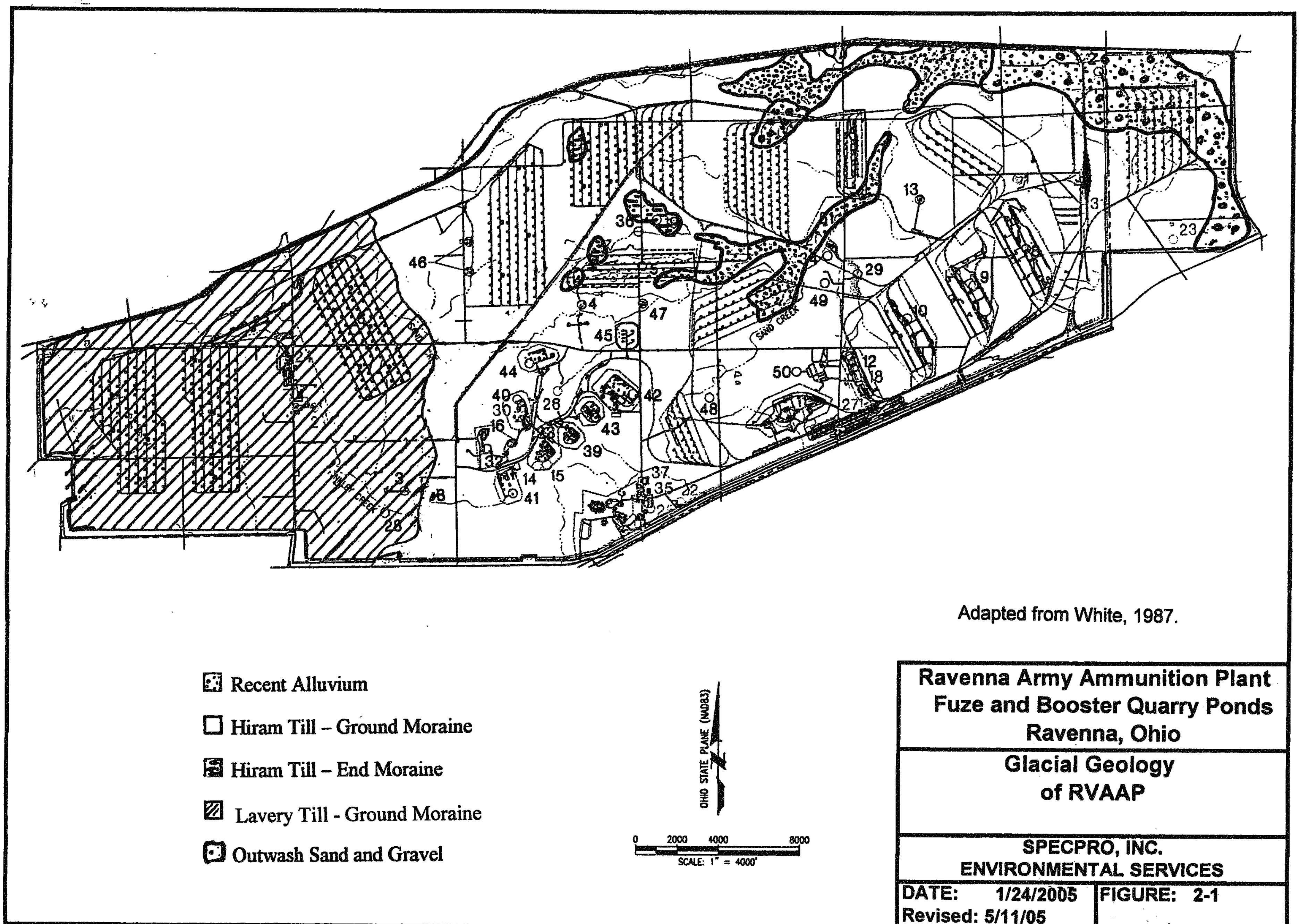


Figure 2-1. Glacial Geology of RVAAP

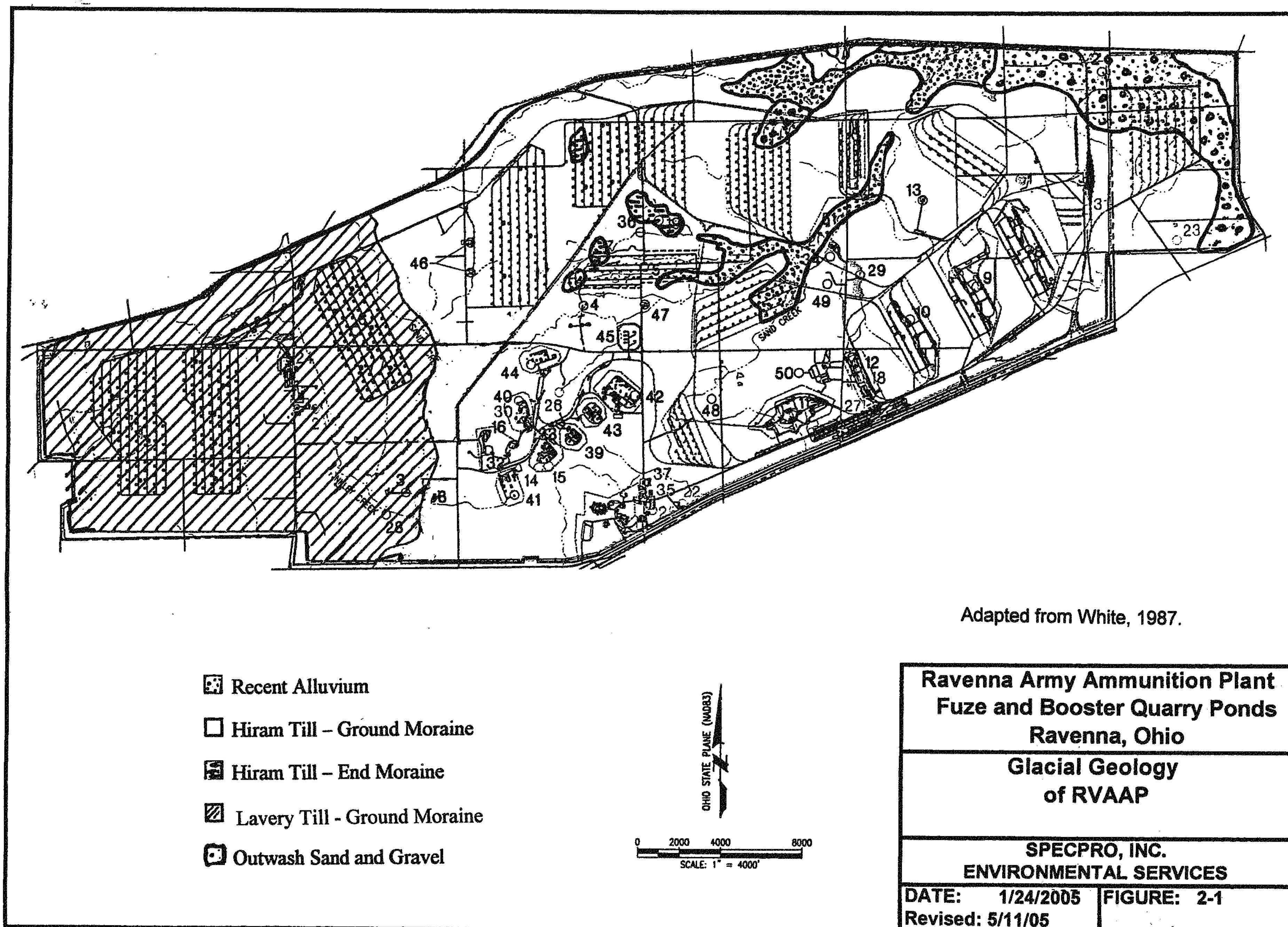


Figure 2-1. Glacial Geology of RVAAP

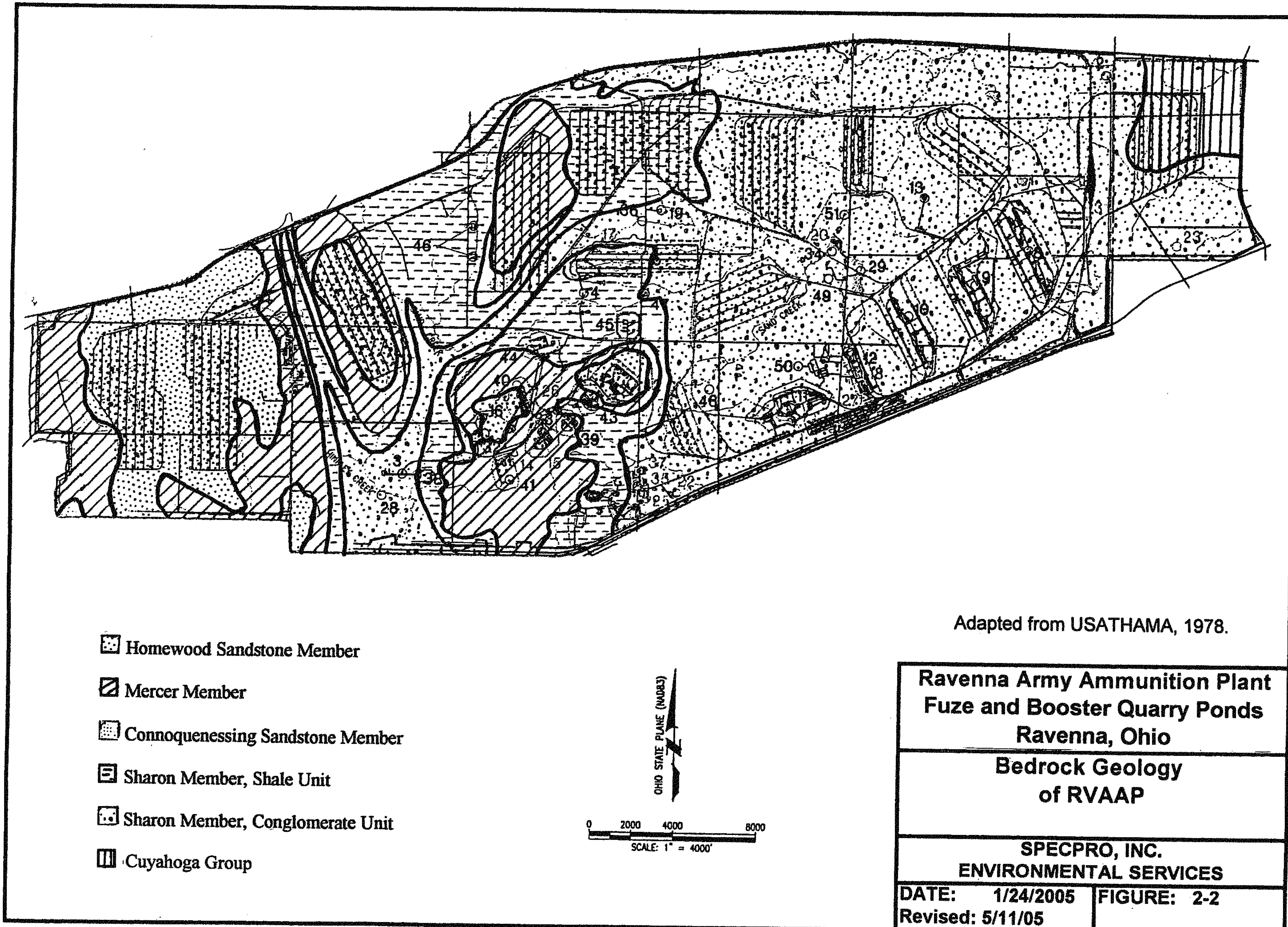


Figure 2-2. Bedrock Geology of RVAAP

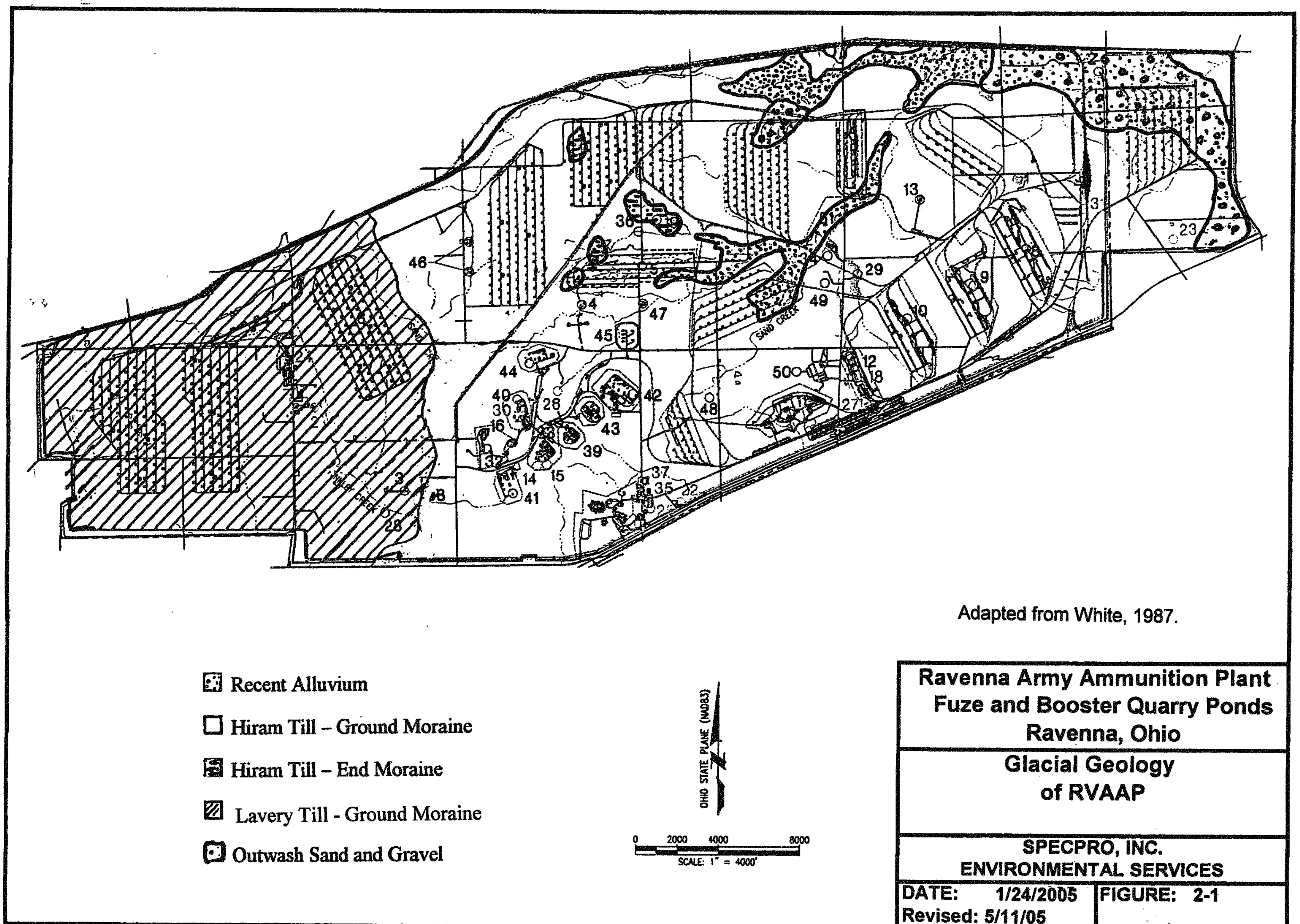


Figure 2-1. Glacial Geology of RVAAP

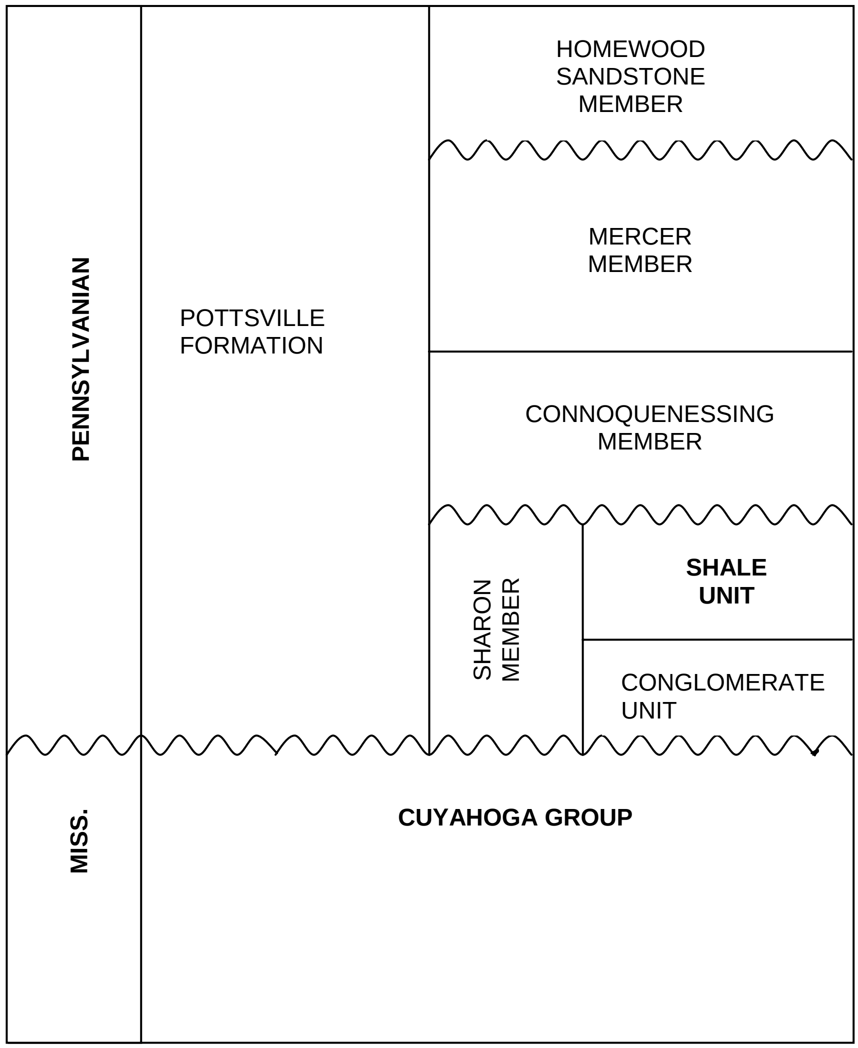


Figure 2-3. Bedrock Stratigraphy of RVAAP (compiled from USGS 1966)

2.3.2.1 Soils

Soils of the Mitiwanga series are prevalent in the eastern portion of the AOC, and Mahoning series soils are prevalent in the central and western part of the AOC. Trumbull series soils are common adjacent to the unnamed tributary in the western part of the AOC. The Mitiwanga series soils are typically moderately deep, well drained soils formed in glacial till overlying sandstone bedrock. The Mahoning series soils are typified by poorly drained soil formed in silty clay loam or clay loam glacial till where bedrock is generally greater than 1.8 m (6 ft). Runoff is typically medium to rapid, and the soil is seasonally wet. Permeabilities typically range from 1.52 to 5.08 cm (0.6 to 2.0 in.) per hour. Trumbull series soils are generally deep, poorly drained, nearly level soils formed in silty clay loam, clay loam, or silty clay glacial till (USDA 1978).

Surface soil varies widely in character from one area to another due to site disturbance from past activities. The permeabilities of soil in the subsurface interval were measured in the laboratory from Shelby tube samples collected from depths ranging from the ground surface to 2.5 m (8.3 ft). The permeability values range from 1.03×10^{-6} to 1.11×10^{-8} cm/sec. Additional geotechnical data collected during the Phase I/II RI are presented Chapter 4.0 and in the geotechnical laboratory report provided in Appendix B of this RI Report; geologic logs for monitoring wells are in Appendix C.

Monitoring well borings and test pits provide the generalized geologic characteristics noted below for the unconsolidated zone and underlying bedrock (from shallow to deep stratigraphic zones). A generalized geologic cross-section for the AOC from west to east is provided in Figure 2-4.

At depths beginning at about 0.1 m (.33 ft), based on soil sampling, test pit, and boring data, unconsolidated deposits consist primarily of a brown to yellowish-brown silty clay to clayey silt. This interval typically has a firm to hard consistency, low plasticity, and is dry to moist. In some borings, a gradual color change to olive or gray, increasing clay content, and the presence of mottling was noted. Test pit logs for the Phase I/II RI are presented in Appendix F.

Fine- to medium-grained sand layers containing some gravel were found in the following monitoring well borings:

- 0.6 to 1.5 m (2 to 5 ft) and 4.3 to 6.7 m (14 to 22 ft) in FBQmw-167,
- 2.1 to 5.9 m (7 to 19.5 ft) in FBQmw-168,
- 0.6 to 2.4 m (2 to 8 ft) in FBQmw-170,
- 0.90 to 2.4 m (3 to 8 ft) in FBQmw-171,
- 0 to 1.2 m (0 to 4 ft) and 1.5 to 3.0 m (5 to 10 ft) in FBQmw-172,
- 0.6 to 1.5 m (2 to 5 ft) in FBQmw-175,
- 3.6 to 5.5 m (12 to 18 ft) in FBQmw-176, and
- 3.3 to 6.7 m (11 to 22 ft) in FBQmw-177.

2.3.2.2 Bedrock geology

The borings at FBQmw-170, -171, -172, -173, -174, and -175 encountered sandstone bedrock at depths ranging from 2 ft (FBQmw-174) to 18 ft (FBQmw-172). Shale was encountered in FBQmw-176 at a depth of 17.5 ft. Bedrock was not encountered in FBQmw-166, -167, -168, -169, and -177, which were generally drilled in the western portion of the site. The borings that encountered bedrock were drilled on the higher elevations of the eastern portion of the site. The sandstone encountered in the borings was

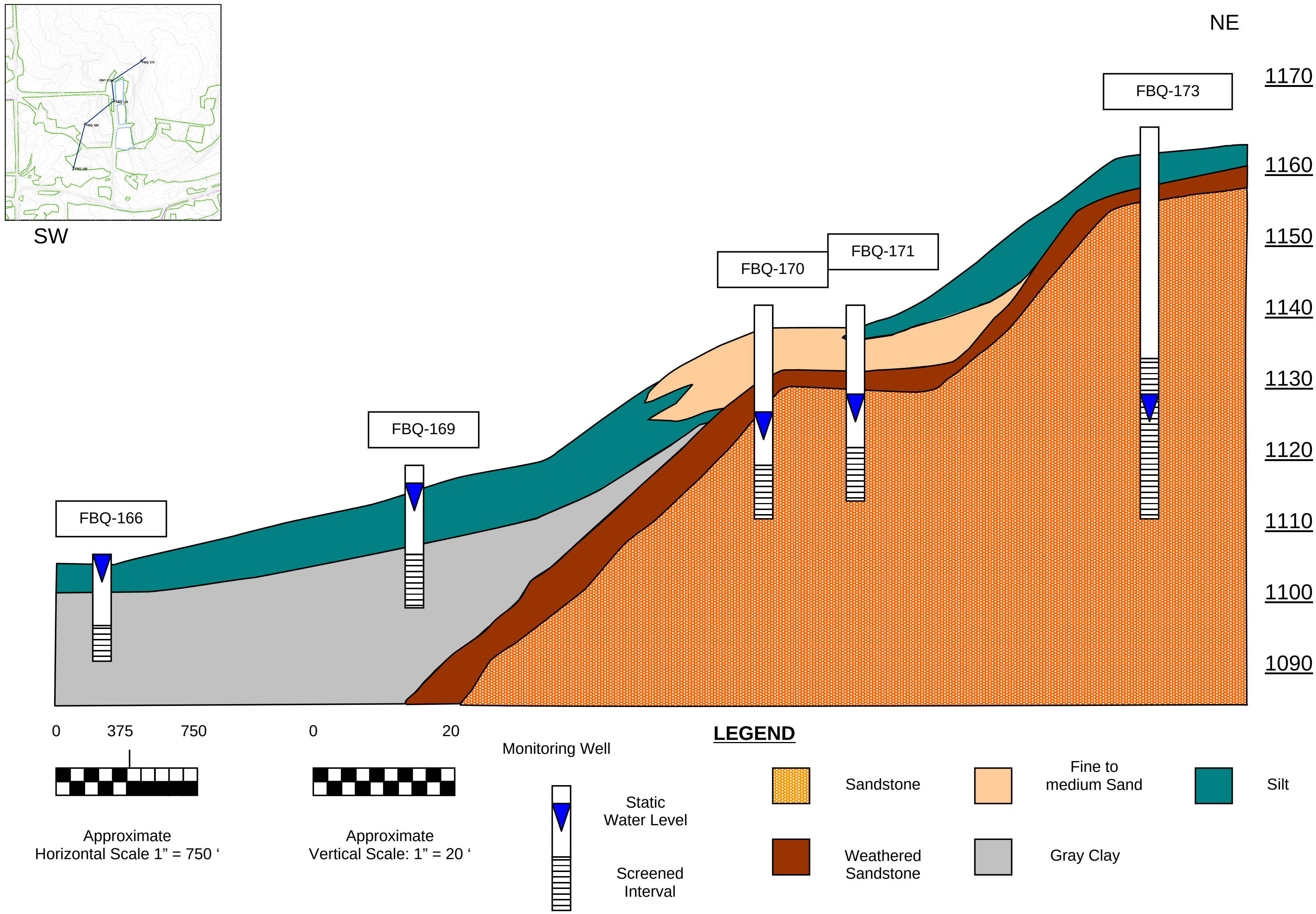


Figure 2-4. Geologic Cross-section of Fuze and Booster Quarry Ponds (AOC-16)

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observed to be dark red and tan sandstone consistent with descriptions of the Homewood Sandstone member of the Pottsville Formation. The dark gray fissile shale encountered in FBQmw-176 is most likely part of the Mercer member of the Pottsville Formation.

2.4 HYDROLOGY

2.4.1 Regional Hydrogeology

Sand and gravel aquifers are present in the buried-valley and outwash deposits in Portage County as described in the *Phase I Remedial Investigation Report for High-Priority Areas of Concern at RVAAP* (USACE 1998). Generally these saturated zones are too thin and localized to provide large quantities of water for industrial or public water supplies; however, yields are sufficient for residential water supplies. Lateral continuity of these aquifers is not known. Recharge of these units comes from surface water infiltration of precipitation and surface streams. Specific groundwater recharge and discharge areas at RVAAP have not been delineated.

2.4.1.1 Unconsolidated material

The thickness of the unconsolidated interval at RVAAP ranges from thin to absent in the eastern and northeastern portion of RVAAP to an estimated 45 m (150 ft) in the central portion of the installation. The groundwater table occurs within the unconsolidated zone in many areas of the installation. Because of the very heterogeneous nature of the unconsolidated glacial materials, groundwater flow patterns are difficult to determine with a high degree of accuracy. Vertical recharge from precipitation likely occurs via infiltration along root zones and desiccation cracks and partings within the soil column. Laterally, most groundwater flow likely occurs along preferential pathways (e.g., sand seams, channel deposits, or other stratigraphic discontinuities) having higher permeabilities than surrounding clay or silt-rich materials.

2.4.1.2 Bedrock hydrogeology

The sandstone facies of the Sharon Member, and in particular the Sharon Conglomerate, were the primary sources of groundwater during RVAAP's active phase, although some wells were completed in the Sharon Shale. Past studies of the Sharon Conglomerate indicate that the highest yields come from the quartzite pebble conglomerate facies and from jointed and fractured zones. Where it is present, the overlying Sharon Shale acts as a relatively impermeable confining layer for the sandstone. Monitoring wells completed in the Sharon Sandstone at Load Line 1 in 1999 typically had hydraulic conductivities of 2.35×10^{-5} to 7.3×10^{-4} cm/sec (USACE 2001c). Hydraulic conductivities in wells completed in the Sharon Shale generally are much lower than those in the sandstone.

2.4.1.3 Surface water system

The entire RVAAP facility is situated within the Ohio River Basin, with the West Branch of the Mahoning River representing the major surface stream in the area. This stream flows adjacent to the western end of the facility, generally from north to south, before flowing into the M.J. Kirwan Reservoir that is located to the south of State Route 5. The West Branch flows out of the reservoir along the southern facility boundary before joining the Mahoning River east of RVAAP.

The western and northern portions of RVAAP display low hills and dendritic surface drainage. The eastern and southern portions are characterized by an undulating to moderately level surface, with less dissection by surface drainage. The facility is marked with marshy areas and flowing and intermittent streams, with headwaters located in the higher regions of the site. Three primary watercourses drain RVAAP: the South Fork of Eagle Creek, Sand Creek, and Hinkley Creek.

Sand Creek, with a drainage area of 36 km^2 (13.9 $miles^2$), flows generally northeast to its confluence with the South Fork of Eagle Creek. In turn, the South Fork of Eagle Creek then continues in a northerly direction for 7 km (2.7 miles) to its confluence with Eagle Creek. The drainage area of the South Fork of Eagle Creek is 67.9 km^2 (26.2 $miles^2$), including the area drained by Sand Creek. Hinkley Creek, with a drainage area of 28.5 km^2 (11.0 $miles^2$), flows in a southerly direction through the installation to its confluence with the West Branch of the Mahoning River south of the facility.

Approximately 50 ponds are scattered throughout the installation. Many were built within natural drainageways to function as settling ponds or basins for process effluent and runoff. Others are natural glacial depressions or result from beaver activity. All water bodies at RVAAP support an abundance of aquatic vegetation and are well stocked with fish. None of the ponds within the installation are used as water supply sources. Storm water runoff is controlled primarily by natural drainage.

2.4.2 Fuze and Booster Quarry Landfill/Ponds Hydrologic/Hydrogeologic Setting

Results of slug tests performed at the 12 monitoring wells during December 2003 reveal moderate hydraulic conductivities in the unconsolidated materials. Geotechnical laboratory results are presented in Appendix B and summarized in Table 2-1. Hydraulic conductivity for wells screened in the unconsolidated materials ranged from 2.5×10^{-5} to 3.3×10^{-3} cm/sec. Hydraulic conductivities for wells screened in sandstone ranged from 8.0×10^{-6} to 5.7×10^{-4} cm/sec. Hydraulic conductivities for FBQmw-176, which was screened in the unconsolidated materials and shale, were 1.2×10^{-3} to 1.1×10^{-3} cm/sec (Table 2-1). Hydraulic conductivity tests were also conducted in the laboratory on 0.6-m (2-ft) Shelby tube samples collected from various depths within the test pits FBQtr-178, -179, -180, -181, -182, and -183) and from depths down to 8 ft from three of the monitoring well borings (FBQmw-166, -167, and -176). Results ranged from 5.87×10^{-8} to 1.03 x 10^{-6} cm/sec.

Monitoring wells FBQmw-166, -167, -168, -169, and -177 were screened within unconsolidated glacial sediments. Monitoring wells FBQmw-170, -171, -172, -173, -174, and -175, were screened with sandstone. Monitoring well FBQmw-176 was screened within unconsolidated glacial deposits from a depth of 3.35 to 5.33 m (11 to 17.5 ft), and within shale from 5.33 to 6.4 m (17.5 to 21 ft). A potentiometric surface map of FBQ is provided in Figure 2-5. This map was constructed using static water level data from the 12 monitoring wells installed in both unconsolidated materials and bedrock during this investigation and water elevations of the ponds (Table 2-2). Groundwater flow at the site is generally towards the unnamed creek at the western portion of the site.

On the northern, western, and northeastern portions of the AOC, surface water generally drains from east to west towards the unnamed creek in the western portion of the AOC. Surface water generally flows to the south from the southeastern section of the AOC. The three larger ponds in the eastern part of the AOC intersect surface water flow from the east and northeast. Based on the groundwater elevations in surrounding monitoring wells, the ponds are hydraulically connected to the groundwater table. An outlet pipe discharges overflow water from the southern pond towards the west, where it eventually flows to the unnamed creek.

Table 2-1. Hydraulic Conductivities

Monitoring Well/Test Pit ID No.	Screened Interval	Total Depth (ft)	Lithology in Screened/Sample Interval	Slug Test K (cm/sec)	Laboratory K (cm/sec)
FBQmw-166	5.5 to 15.5	16	Unconsolidated Materials (sandy clay and clay)	Slug In: 2.5×10^{-5} Slug Out: 5.6×10^{-5}	3.62×10^{-7} 1.96×10^{-7} 5.67×10^{-7}
FBQmw-167	5 to 15	18	Unconsolidated Materials (sandy clay, silty clay, and clay)	Slug In: 1.5×10^{-4} Slug Out: 1.6×10^{-4}	4.52×10^{-6} 4.15×10^{-7}
FBQmw-168	9 to 19	19.5	Unconsolidated Materials (silty medium sand and medium sand)	Slug In: 1.2×10^{-3} Slug Out: 3.0×10^{-4}	2.51×10^{-6} 1.03×10^{-6}
FBQmw-169	5 to 15	16	Unconsolidated Materials (gravel, clay, sandy clay, silty clay, and clayey sand)	Slug In: 4.0×10^{-4} Slug Out: 6.8×10^{-5}	8.36 × 10-8
FBQmw-170	20 to 30	30.5	Sandstone	Slug In: 1.2×10^{-4} Slug Out: 3.6×10^{-5}	N/A
FBQmw-171	18 to 28	30	Sandstone	Slug In: 2.8×10^{-4} Slug Out: 3.6×10^{-4}	N/A
FBQmw-172	20 to 30	33	Sandstone	Slug In: 8.0×10^{-5} Slug Out: 9.6×10^{-5}	*2.58×10^{-6}
FBQmw-173	29.5 to 49.5	50	Sandstone	N/A Slug Out: 8.0×10^{-6}	*2.52×10^{-6}
FBQmw-174	12 to 22	22.5	Sandstone	Slug In: 6.8×10^{-5} Slug Out: 7.1×10^{-5}	*2.61×10^{-6}
FBQmw-175	12 to 22	22.5	Sandstone	Slug In: 1.8×10^{-4} Slug Out: 1.9×10^{-4}	N/A
FBQmw-176	11 to 21	21.5	Unconsolidated Materials/Shale (silty sand [11-18’] and shale [18-21’])	Slug In: 1.1×10^{-3} Slug Out: 1.2×10^{-3}	1.41×10^{-6}
FBQmw-177	12 to 22	22.5	Unconsolidated Materials (fine to medium sand, silty sand)	Slug In: 2.5×10^{-4} Slug Out: 3.3×10^{-3}	Large rock in sample
FBQmw-178	N/A	11.67	Lean clay with sand Sandy lean clay	N/A	2.39×10^{-8} 3.51×10^{-8}
FBQmw-179	N/A	12	Lean clay with sand Lean clay	N/A	1.34×10^{-8} 5.87×10^{-8}
FBQmw-180	N/A	8.3	Lean clay Lean clay	N/A	1.11×10^{-8} 6.11×10^{-7}
FBQmw-181	N/A	9	Lean clay with sand Silty clayey sand with gravel	N/A	2.05×10^{-7} 1.03×10^{-6}
FBQmw-182	N/A	4.7	Lean clay with sand Silty clayey sand	N/A	2.96×10^{-8} 9.14×10^{-7}
FBQmw-183	N/A	4	Lean clay with sand Sandy lean clay	N/A	2.83×10^{-7} 6.47×10^{-7}

K = Permeability.
N/A = Not applicable.
* = Laboratory permeabilities for FBQmw-172, -173, and -174 were performed on unconsolidated materials from 0 to 2 ft depth.

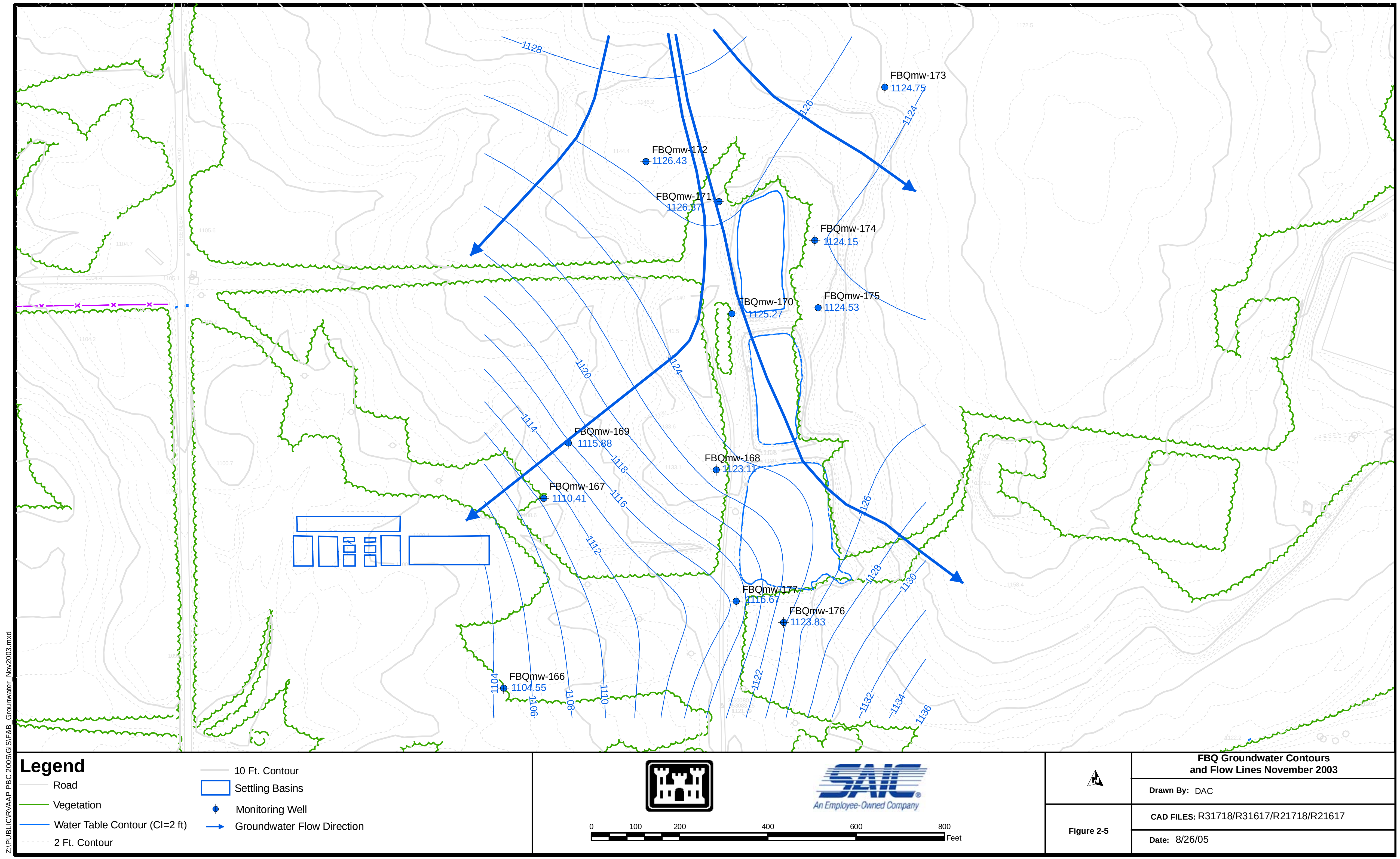

Figure 2-5. Fuze and Booster Quarry Groundwater Contours and Flow Lines, November 2003

Table 2-2. Monitoring Well Groundwater Elevations

Well No.	Ground Surface Elevation (ft)	Reference Elevation (ft)	Depth to Water (ft)		Groundwater Elevation (ft)	
			11/19/03	12/3/03	11/19/03	12/3/03
FBQmw-166	1104.87	1108.86	4.31	4.52	1104.55	1104.34
FBQmw-167	1112.05	1115.90	5.49	3.72	1110.41	1112.18
FBQmw-168	1131.27	1133.91	10.8	10.23	1123.11	1123.68
FBQmw-169	1117.36	1120.58	4.70	4.74	1115.88	1115.84
FBQmw-170	1139.67	1142.26	16.99	17.3	1125.27	1124.96
FBQmw-171	1140.49	1143.55	17.18	17.45	1126.37	1126.10
FBQmw-172	1145.71	1150.09	23.66	23.95	1126.43	1126.14
FBQmw-173	1162.43	1165.94	41.19	41.5	1124.75	1124.44
FBQmw-174	1135.78	1139.97	15.82	14.74	1124.15	1125.23
FBQmw-175	1137.16	1140.73	16.2	16.73	1124.53	1124.00
FBQmw-176	1129.57	1131.91	8.08	7.72	1123.83	1124.19
FBQmw-177	1125.73	1128.57	11.9	10.72	1116.67	1117.85

2.5 CLIMATE

RVAAP has a humid continental climate characterized by warm, humid summers and cold winters. Precipitation varies widely through the year. The driest month is, on average, February, and the wettest month is July. Data from the National Weather Service compiled over the past 47 years indicate that the average rainfall for the area is 0.98 m (38.72 in.) annually. The average snowfall is 1.08 m (42.4 in.) annually. Severe weather, in the form of thunder and hail in summer and snowstorms in winter, is common. Tornadoes are infrequent in Portage County. The Phase I/Phase II RI fieldwork was primarily conducted during July through September. Climate conditions for the year included above-normal temperatures and precipitation values slightly above normal.

2.6 POTENTIAL RECEPTORS

2.6.1 Human Receptors

RVAAP consists of 8,998.3 hectares (21,419 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. Approximately 55% of Portage County, in which the majority of RVAAP is located, consists of either woodland or farm acreage. The Michael J. Kirwan Reservoir (also known as West Branch Reservoir) is the closest major recreational area and is adjacent to the western half of RVAAP south of State Route 5.

The RVAAP facility is located in a rural area, is not accessible to the general public, and is not near any major industrial or developed areas. The facility is currently completely fenced and patrolled by security personnel. Army and full-time operating contractor staff (i.e., security and site operation/maintenance) are located on-site. Additional subcontractor staff is on-site for varying periods of time, to complete specific environmental, demolition, or decommissioning projects. Training activities under OHARNG involve an average of 4,500 personnel during the course of 1 month, who are on-site for periods of 3 days (inactive duty or weekend training) to 2 weeks (annual training).

The FBQ AOC is located in the south-central portion of RVAAP and is not currently used for OHARNG training activities. Grounds keeping activities are limited to infrequent mowing and brush clearing along the gravel access road, ponds, and field west of the access road.

2.6.2 Ecological Receptors

The dominant types of vegetative cover at RVAAP, including portions of FBQ and its immediate surroundings, are forests and old fields of various ages. More than 75% of RVAAP is now in forest. Most of the old-field cover is the result of earlier agricultural practices that left these sites with poor topsoil, which limits forest regeneration. Several thousand acres of agricultural fields were planted in trees during the 1950s and 1960s, but these plantings were not successful in areas with poor topsoil. Some fields, leased for cattle grazing during the same time period, were delayed in their reversion to forest. A few fields have been periodically mowed, maintaining them as old-field. The FBQ area is covered with brush and scrub, forests, and wetland areas, as well as the three larger ponds and eleven smaller ponds.

From one-half to two-thirds [4,406 to 6,070 ha (10,000 to 15,000 acres)] of RVAAP's land area meets the regulatory definition of jurisdictional wetland. Wetland areas at RVAAP include seasonally saturated wetlands, wet fields, and forested wetlands. Most of these wetlands exist because of poorly drained and hydric soils. Beaver impoundments contribute to wetland diversification in some parts of the site.

The flora and fauna at RVAAP are varied and widespread. No federal threatened, endangered, candidate threatened or endangered species have been observed on RVAAP. A list of state endangered, state threatened or potentially threatened, and state special interest species confirmed to be on RVAAP is provided in Table 2-3 (Morgan 2005). Additionally, five rare plant communities/significant natural areas have been identified on RVAAP, including the northern woods, Wadsworth Glen, Group 3 woods, B&O Wye Road area, and South Patrol Road swamp forest.

Restricted land use and sound forest management practices have preserved and enabled large forest tracts to mature. Habitat conversion at RVAAP, unlike most other habitat conversions occurring nationwide, has been toward restoration of the forests that covered the area prior to its being cleared for agriculture. The reversion of these agricultural fields to mature forest provides a diverse habitat from old-field through several successional stages. Overall, the trend toward forest cover enhances the area for use by both plant and animal forest species. Future IRP activities will require consideration of these species to ensure that detrimental effects on threatened or endangered RVAAP flora and fauna do not occur. There are no federal, state, or local parks or protected areas on RVAAP property.

2.7 PRELIMINARY SITE CONCEPTUAL MODEL

2.7.1 Soil

Based on characterization data to date, contaminated soil within and adjacent to the ponds and suspected landfill/deactivation areas are potential secondary sources of contamination in sediment, surface water, and groundwater. Contaminants may be released from soil and migrate in storm runoff either in dissolved phase or adsorbed to particulates and/or colloids. Characterization of suspected areas of soil contamination was conducted during the Phase I/Phase II RI to define contaminant nature and extent and to provide sufficient data for remedial alternatives analysis in a subsequent FS. Subsurface soil characterization was also necessary to determine if leaching processes may be a potential mechanism for contaminant migration to groundwater.

Table 2-3. Rare Species Recorded at RVAAP

Common Name	Scientific Name
State Endangered Species	
American bittern	*Botaurus lentiginosus(migrant)*
Northern harrier	*Circus cyaneus*
Yellow-bellied sapsucker	*Sphyrapicus varius*
Golden-winged warbler	*Vermivora chrysoptera*
Osprey	*Pandion haliaetus (migrant)*
Trumpeter swan	*Cygnus buccinator (migrant)*
Mountain Brook Lamprey	*Ichthyomyzon greeleyi*
Graceful Underwing	*Catocala gracilis*
Ovate Spikerush	*Eleocharis ovata(Blunt spike-rush)*
Tufted Moisture-loving Moss	*Philonotis Fontana var. caespitosa*
Bobcat	*Felis rufus*
State Threatened Species	
Barn owl	*Tyto alba*
Dark-eyed junco	*Junco hyemalis (migrant)*
Hermit thrush	*Catharus guttatus (migrant)*
Least bittern	*Ixobrychus exilis*
Lest flycatcher	*Empidonax minimus*
	Psilotreta indecisa (caddisfly)
Simple willow-herb	*Epilobium strictum*
Woodland Horsetail	*Equisetum sylvaticum*
State Potentially Threatened Plants	
Pale sedge	*Carex pallescens*
Gray Birch	*Betula populifolia*
Butternut	*Juglans cinerea*
Northern rose azalea	*Rhododendron nudiflorum var. roseum*
Hobblebush	*Viburnum alnifolium*
Long Beech Fern	*Phegopteris connectilis*
Straw sedge	*Carex straminea*
Water avens	*Geum rivale*
Tall St. John’s wort	*Hypericum majus*
Swamp oats	*Sphenopholis pensylvanica*
Shining ladies-tresses	*Spiranthes lucida*
Arbor Vitae	*Thuja occidentalis*
American Chestnut	*Castanea dentata*
State Species of Concern	
Pygmy shrew	*Sorex hovi*
Star-nosed mole	*Condylura cristata*
Woodland jumping mouse	*Napaeozapus insignis*
Sharp-shinned hawk	*Accipiter striatus*
Marsh wren	*Cistothorus palustris*
Henslow’s sparrow	*Ammodramus henslowii*
Cerulean warbler	*Dendroica cerulea*
Prothonotary warbler	*Protonotaria citrea*
Bobolink	*Dolichonyx oryzivorus*
Northern bobwhite	*Colinus virginianus*
Common moorhen	*Gallinula chloropus*
Great egret	*Casmerodius albus*
Sora	*Porzana corolina*
Virginia Rail	*Rallus limicola*

Table 2-3. Rare Species Recorded at RVAAP (continued)

Common Name	Scientific Name
Creek heelsplitter	*Lasmigona compressa*
Eastern box turtle	*Terrapene carolina*
Four-toed salamander	*Hemidactylium scutatum*
	Stenoema ithica (mayfly)
	Apamea mixta (moth)
Brachylomia algens (moth)	
State Special Interest Species	
Canada warbler	*Wilsonia canadensis (migrant)*
Little blue heron	*Egretta caerulea*
Magnolia warbler	*Dendroica magnolia*
Northern waterthrush	*Seiurus noveboracensis*
Winter wren	*Troglodytes troglodytes*
Back-throated blue warbler	*Dendroica caerulescens*
Brown creeper	*Certhia americana*
Morning warbler	*Oporornis philadelphia*
Pine siskin	*Carduelis pinus*
Purple finch	*Carpodacus purpureus*
Red-breasted nuthatch	*Sitta Canadensis*
Golden-crowned kinglet	*Regulus satrapa*
Blackburnian warbler	*Dendroica fusca*
Blue grosbeak	*Guiraca caerulea*
Common snipe	*Gallinago gallinago*
American wigeon	*Anas americaca*
Gadwall	*Anas strepera*
Green-winged teal	*Anas crecca*
Northern shoveler	*Anas clypeata*
Redheaded duck	*Aythya americana*
Ruddy duck	*Oxyura jamaicensis*
	Pohlia elongate var. elongate (No common Name, Bryophyte)

RVAAP = Ravenna Army Ammunition Plant.

2.7.2 Sediment

Sediment within ditches and tributaries represents a receptor media for contaminants eroded or leached from soil and transported by storm runoff. In addition, sediment may function as a transport mechanism considering that contaminants adsorbed to particulates may be mobilized by surface water flow. Operational data suggest that the ditches in the vicinity of the former landfill/ponds and suspected treatment areas represent the most likely locations where contaminants may have accumulated through erosional transport.

Site characteristics and available field data show that the primary surface water and sediment exit pathways at FBQ follow topographic lows running southwest from the site. Surface water runoff from the southernmost pond is facilitated by the presence of an overflow pipe discharging to the west. However, the remaining ponds do not have any overflow drainage points. Throughout the AOC, surface water during rain events can flow to the south and west in ditches. Considering the available data and the CSM, both confirmed and additional suspected source areas, as well as the exit pathways, are specifically targeted for biased sediment sampling. Previous sediment sampling data show evidence of inorganic contamination in the surface water and sediment within each of the ponds.

2.7.3 Surface Water

Surface water represents a primary mechanism for mobilization and transport of contamination within and from FBQ, primarily in the southern portion of FBQ. Most chemical transport via surface water is presumed to occur along the ditches within FBQ and is primarily episodic and related to storm events that produce flushing of the surface water system and mobilization of contaminated soil and sediment through erosion.

2.7.4 Groundwater

No hydrogeologic and analytical data existed for groundwater at the AOCs prior to this investigation. For the purposes of DQO development and investigation planning, the CSM presumes the general groundwater flow patterns at FBQ also mimicked the site topography and surface water drainage patterns, following a southwest direction.

Contaminant migration from source areas to groundwater (via leaching or surface water infiltration) was an unknown element of the CSM prior to the investigation. Potential source area site-related contaminants (SRCs) identified to prior to the investigation has low mobility in groundwater. However, previous sampling data and known former land use indicates the potential exists for groundwater contamination at this AOC. Therefore, the presence of groundwater contamination and potential migration pathways were evaluated as part of the Phase I/Phase II RI.

Groundwater characterization efforts included installation of monitoring wells in a configuration that provided data on general hydrogeologic characteristics and groundwater flow patterns. Wells were installed in the vicinity of known and suspected source areas to evaluate whether contaminants are leaching to groundwater. Monitoring wells were also placed in close proximity to the former landfill/ponds to determine whether potential contaminant transport into groundwater and from FBQ is occurring.

3.0 STUDY AREA INVESTIGATION

The scope of the Phase I/II RI field effort included sampling of surface and subsurface soils, sediment, surface water, and groundwater at FBQ and surface and subsurface soils at the 40-mm Firing Range. This chapter 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. Specific notation is made where site conditions required a departure from planned activities in the Phase I/II RI Work Plan and SAP Addenda (2002). 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 2001a) and the Phase I/II RI Work Plan and SAP Addenda.

3.1 SURFACE AND SUBSURFACE SOIL CHARACTERIZATION

Soil samples for chemical analyses were collected from a total of 100 stations located throughout the FBQ AOC. Sixty soil samples were collected at FBQ and 40 soil samples were collected from the 40-mm Firing Range area. Figure 3-1 illustrates the locations for surface soil and subsurface soil sampling. Table 3-1 provides a detailed listing of the soil samples collected during the Phase I/II RI field effort. Surface samples were collected at all of the stations. Subsurface samples were collected at only 63 of the stations because of auger refusal after drilling the surface soil sample in 37 of the sample locations. Soil sampling logs are presented in Appendix C.

Samples for geotechnical analyses were collected from 12 stations (6 monitoring well boring locations and 6 test pit locations). Shelby tube samples were collected from depths ranging from 0 to 2.5 m (8.3 ft) at the test pit locations. Shelby tube samples were also collected from depths ranging from 0 to 2.4 m at the monitoring well locations. One Shelby tube was collected from the screened interval at a monitoring well boring (1.83 to 2.4 m at FBQmw-166). Shelby tube samples were planned for each of the 12 monitoring well boring locations; however encountering bedrock at shallow depths prevented the collection of the samples at six of the locations.

3.1.1 Rationale

Surface soil samples from 0.0 to 0.3 m (0 to 1 ft) were collected during the Phase I/Phase II RI at FBQ and the 40-mm Firing Range to (1) further define contaminant nature and extent of surface soil contamination; and (2) investigate potential source areas. The soil sampling program employed biased sampling (targeted to known or suspected hot spots) to characterize suspected source areas and contaminant accumulation points.

Subsurface soil samples were also collected at the same stations as the surface soil samples to investigate (1) potential subsurface contamination occurring as a result of activities at former operations areas, (2) transport pathways to deeper soil horizons for such contaminants as described in the DQOs (Section 3.2), and (3) determine the vertical extent of contamination.

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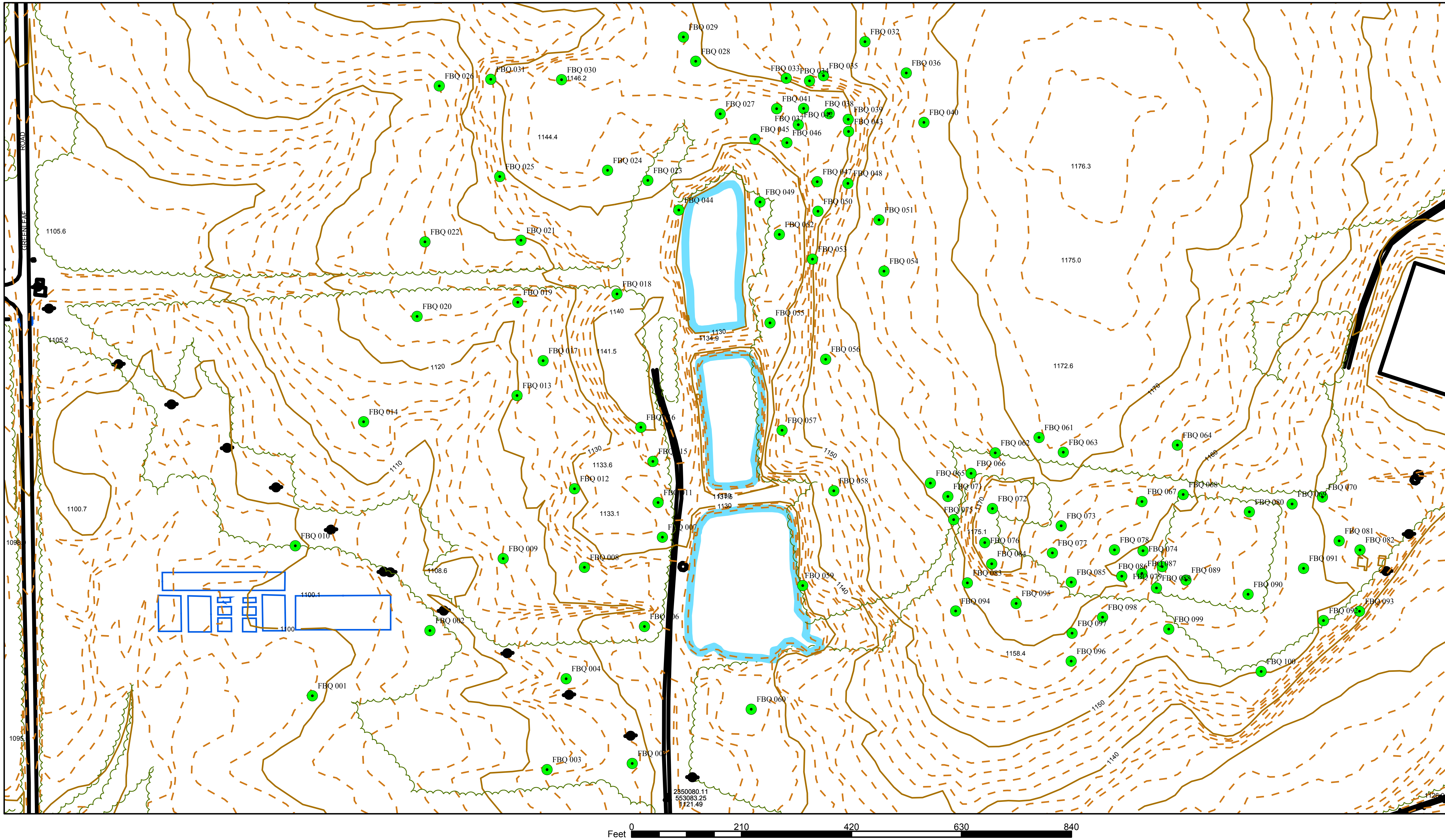


Legend

- Surface and Subsurface Soil
- Roads
- Water
- Telephone Pole
- Vegetation
- 2 Ft. Contour
- 10 Ft. Contour
- Basin Ponds

Surface and Subsurface Soil Locations

Drawn By: gharris

CAD Files: R31718/R31617/R21718/R21617

Date: January 22, 2005

Figure 3-1

SpecPro

Figure 3-1 Surface and Subsurface Soil Locations

Table 3-1. Soil and Test Pit Sample List and Rationales, Fuze and Booster Quarry Landfill/Ponds Phase I/II RI

Area Description	Station ID	Sample Location Rationale	Sample ID	Depth (ft)	Sample Collected (Yes/No)	Comments
FBQ	FBQ-001	Site boundary	FBQss-001-0001-SO	0 to 1	Yes	
FBQ	FBQ-001	Site boundary	FBQso-001-0002-SO	1 to 3	Yes	
FBQ	FBQ-002	Potential source area	FBQss-002-0003-SO	0 to 1	Yes	
FBQ	FBQ-002	Potential source area	FBQso-002-0004-SO	1 to 3	Yes	
FBQ	FBQ-003	Potential source area	FBQss-003-0005-SO	0 to 1	Yes	
FBQ	FBQ-003	Potential source area	FBQso-003-0006-SO	1 to 3	Yes	
FBQ	FBQ-004	Potential source area	FBQss-004-0007-SO	0 to 1	Yes	
FBQ	FBQ-004	Potential source area	FBQso-004-0008-SO	1 to 3	Yes	Auger refusal at 1.8 ft
FBQ	FBQ-005	Potential source area	FBQss-005-0009-SO	0 to 1	Yes	
FBQ	FBQ-005	Potential source area	FBQso-005-0010-SO	1 to 3	Yes	
FBQ	FBQ-006	Potential source area	FBQss-006-0011-SO	0 to 1	Yes	
FBQ	FBQ-006	Potential source area	FBQso-006-0012-SO	1 to 3	Yes	
FBQ	FBQ-007	Potential source area	FBQss-007-0013-SO	0 to 1	Yes	
FBQ	FBQ-007	Potential source area	FBQso-007-0014-SO	1 to 3	Yes	
FBQ	FBQ-008	Potential source area	FBQss-008-0015-SO	0 to 1	Yes	
FBQ	FBQ-008	Potential source area	FBQso-008-0016-SO	1 to -3	Yes	Auger refusal at 2 ft
FBQ	FBQ-009	Potential source area	FBQss-009-0017-SO	0 to 1	Yes	
FBQ	FBQ-009	Potential source area	FBQso-009-0018-SO	1 to 3	Yes	
FBQ	FBQ-010	Site boundary	FBQss-010-0019-SO	0 to 1	Yes	
FBQ	FBQ-010	Site boundary	FBQso-010-0020-SO	1 to 3	Yes	
FBQ	FBQ-011	Potential source area	FBQss-011-0021-SO	0 to 1	Yes	
FBQ	FBQ-011	Potential source area	FBQso-011-0022-SO	1 to 3	Yes	
FBQ	FBQ-012	Potential source area	FBQss-012-0023-SO	0 to 1	Yes	
FBQ	FBQ-012	Potential source area	FBQso-012-0024-SO	1 to 3	Yes	Auger refusal at 2.75 ft
FBQ	FBQ-013	Potential source area	FBQss-013-0025-SO	0 to 1	Yes	
FBQ	FBQ-013	Potential source area	FBQso-013-0026-SO	1 to 3	Yes	
FBQ	FBQ-014	Site boundary	FBQss-014-0027-SO	0 to 1	Yes	
FBQ	FBQ-014	Site boundary	FBQso-014-0028-SO	1 to 3	Yes	
FBQ	FBQ-015	Potential source area	FBQss-015-0029-SO	0 to 1	Yes	
FBQ	FBQ-015	Potential source area	FBQso-015-0030-SO	1 to 3	Yes	Auger refusal at 2.75 ft
FBQ	FBQ-016	Potential source area	FBQss-016-0031-SO	0 to 1	Yes	
FBQ	FBQ-016	Potential source area	FBQso-016-0032-SO	1 to 3	No	Auger refusal at 1 ft
FBQ	FBQ-017	Potential source area	FBQss-017-0033-SO	0 to 1	Yes	
FBQ	FBQ-017	Potential source area	FBQso-017-0034-SO	1 to 3	Yes	

Table 3-1. Soil and Test Pit Sample List and Rationales, Fuze and Booster Quarry Landfill/Ponds Phase I/II RI (continued)

Area Description	Station ID	Sample Location Rationale	Sample ID	Depth (ft)	Sample Collected (Yes/No)	Comments
FBQ	FBQ-018	Potential source area	FBQss-018-0035-SO	0 to 1	Yes	
FBQ	FBQ-018	Potential source area	FBQso-018-0036-SO	1 to 3	No	Auger refusal at 1 ft
FBQ	FBQ-019	Potential source area	FBQss-019-0037-SO	0 to 1	Yes	
FBQ	FBQ-019	Potential source area	FBQso-019-0038-SO	1 to 3	Yes	
FBQ	FBQ-020	Site boundary	FBQss-020-0039-SO	0 to 1	Yes	
FBQ	FBQ-020	Site boundary	FBQso-020-0040-SO	1 to -3	Yes	
FBQ	FBQ-021	Potential source area	FBQss-021-0041-SO	0 to 1	Yes	
FBQ	FBQ-021	Potential source area	FBQso-021-0042-SO	1 to 3	Yes	Auger refusal at 2 ft
FBQ	FBQ-022	Site boundary	FBQss-022-0043-SO	0 to 1	Yes	
FBQ	FBQ-022	Site boundary	FBQso-022-0044-SO	1 to 3	Yes	
FBQ	FBQ-023	Potential source area	FBQss-023-0045-SO	0 to 1	Yes	
FBQ	FBQ-023	Potential source area	FBQso-023-0046-SO	1 to 3	Yes	
FBQ	FBQ-024	Potential source area	FBQss-024-0047-SO	0 to 1	Yes	
FBQ	FBQ-024	Potential source area	FBQso-024-0048-SO	1 to 3	No	Auger refusal at 1 ft
FBQ	FBQ-025	Potential source area	FBQss-025-0049-SO	0 to 1	Yes	
FBQ	FBQ-025	Potential source area	FBQso-025-0050-SO	1 to 3	No	Auger refusal at 1 ft
FBQ	FBQ-026	Site boundary	FBQss-026-0051-SO	0 to 1	Yes	
FBQ	FBQ-026	Site boundary	FBQso-026-0052-SO	1 to 3	Yes	Auger refusal at 2.75 ft
FBQ	FBQ-027	Potential source area	FBQss-027-0053-SO	0 to 1	Yes	Auger refusal at 0.5 ft
FBQ	FBQ-027	Potential source area	FBQso-027-0054-SO	1 to 3	No	Auger refusal at 0.5 ft
FBQ	FBQ-028	Potential source area	FBQss-028-0055-SO	0 to 1	Yes	
FBQ	FBQ-028	Potential source area	FBQso-028-0056-SO	1 to 3	Yes	
FBQ	FBQ-029	Potential source area	FBQss-029-0057-SO	0 to 1	Yes	
FBQ	FBQ-029	Potential source area	FBQso-029-0058-SO	1 to 3	Yes	Auger refusal at 1.8 ft
FBQ	FBQ-030	Site boundary	FBQss-030-0059-SO	0 to 1	Yes	
FBQ	FBQ-030	Site boundary	FBQso-030-0060-SO	1 to 3	Yes	Auger refusal at 1.9 ft
FBQ	FBQ-031	Site boundary	FBQss-031-0061-SO	0 to 1	Yes	Auger refusal at 0.75 ft
FBQ	FBQ-031	Site boundary	FBQso-031-0062-SO	1 to 3	No	Auger refusal at 0.75 ft
FBQ	FBQ-032	Site boundary	FBQss-032-0063-SO	0 to 1	Yes	
FBQ	FBQ-032	Site boundary	FBQso-032-0064-SO	1 to 3	Yes	Auger refusal at 1.9 ft
FBQ	FBQ-033	Site boundary	FBQss-033-0065-SO	0 to 1	Yes	
FBQ	FBQ-033	Site boundary	FBQso-033-0066-SO	1 to 3	Yes	Auger refusal at 2 ft
FBQ	FBQ-034	Site boundary	FBQss-034-0067-SO	0 to 1	Yes	Auger refusal at 0.5 ft

Table 3-1. Soil and Test Pit Sample List and Rationales, Fuze and Booster Quarry Landfill/Ponds Phase I/II RI (continued)

Area Description	Station ID	Sample Location Rationale	Sample ID	Depth (ft)	Sample Collected (Yes/No)	Comments
FBQ	FBQ-034	Site boundary	FBQso-034-0068-SO	1 to 3	No	Auger refusal at 0.5 ft
FBQ	FBQ-035	Site boundary	FBQss-035-0069-SO	0 to 1	Yes	
FBQ	FBQ-035	Site boundary	FBQso-035-0070-SO	1 to 3	No	Auger refusal at 1 ft
FBQ	FBQ-036	Site boundary	FBQss-036-0071-SO	0 to 1	Yes	
FBQ	FBQ-036	Site boundary	FBQso-036-0072-SO	1 to 3	Yes	
FBQ	FBQ-037	Potential source area	FBQss-037-0073-SO	0 to 1	Yes	
FBQ	FBQ-037	Potential source area	FBQso-037-0074-SO	1 to 3	No	Auger refusal at 1 ft
FBQ	FBQ-038	Potential source area	FBQss-038-0075-SO	0 to 1	Yes	
FBQ	FBQ-038	Potential source area	FBQso-038-0076-SO	1 to 3	Yes	Auger refusal at 1.9 ft
FBQ	FBQ-039	Potential source area	FBQss-039-0077-SO	0 to 1	Yes	Auger refusal at 0.75 ft
FBQ	FBQ-039	Potential source area	FBQso-039-0078-SO	1 to 3	No	Auger refusal at 0.75 ft
FBQ	FBQ-040	Site boundary	FBQss-040-0079-SO	0 to 1	Yes	
FBQ	FBQ-040	Site boundary	FBQso-040-0080-SO	1 to 3	Yes	
FBQ	FBQ-041	Potential source area	FBQss-041-0081-SO	0 to 1	Yes	Auger refusal at 0.5 ft
FBQ	FBQ-041	Potential source area	FBQso-041-0082-SO	1 to 3	No	Auger refusal at 0.5 ft
FBQ	FBQ-042	Potential source area	FBQss-042-0083-SO	0 to 1	Yes	Auger refusal at 0.8 ft
FBQ	FBQ-042	Potential source area	FBQso-042-0084-SO	1 to 3	No	Auger refusal at 0.8 ft
FBQ	FBQ-043	Potential source area	FBQss-043-0085-SO	0 to 1	Yes	
FBQ	FBQ-043	Potential source area	FBQso-043-0086-SO	1 to 3	No	Auger refusal at 1 ft
FBQ	FBQ-044	Potential source area	FBQss-044-0087-SO	0 to 1	Yes	
FBQ	FBQ-044	Potential source area	FBQso-044-0088-SO	1 to 3	No	Auger refusal at 1 ft
FBQ	FBQ-045	Potential source area	FBQss-045-0089-SO	0 to 1	Yes	
FBQ	FBQ-045	Potential source area	FBQso-045-0090-SO	1 to 3	No	Auger refusal
FBQ	FBQ-046	Potential source area	FBQss-046-0091-SO	0 to 1	Yes	
FBQ	FBQ-046	Potential source area	FBQso-046-0092-SO	1 to 3	No	Auger refusal at 1 ft
FBQ	FBQ-047	Potential source area	FBQss-047-0093-SO	0 to 1	Yes	Auger refusal at 0.7 ft
FBQ	FBQ-047	Potential source area	FBQso-047-0094-SO	1 to 3	Yes	Auger refusal at 0.7 ft
FBQ	FBQ-048	Site boundary	FBQss-048-0095-SO	0 to 1	Yes	
FBQ	FBQ-048	Site boundary	FBQso-048-0096-SO	1 to 3	Yes	Auger refusal at 2 ft
FBQ	FBQ-049	Potential source area	FBQss-049-0097-SO	0 to 1	Yes	
FBQ	FBQ-049	Potential source area	FBQso-049-0098-SO	1 to 3	No	Auger refusal at 1 ft
FBQ	FBQ-050	Potential source area	FBQss-050-0099-SO	0 to 1	Yes	Auger refusal at 0.7 ft
FBQ	FBQ-050	Potential source area	FBQso-050-0100-SO	1 to 3	No	Auger refusal at 0.7 ft
FBQ	FBQ-051	Site boundary	FBQss-051-0101-SO	0 to 1	Yes	

Table 3-1. Soil and Test Pit Sample List and Rationales, Fuze and Booster Quarry Landfill/Ponds Phase I/II RI (continued)

Area Description	Station ID	Sample Location Rationale	Sample ID	Depth (ft)	Sample Collected (Yes/No)	Comments
FBQ	FBQ-051	Site boundary	FBQso-051-0102-SO	1 to 3	Yes	
FBQ	FBQ-052	Potential source area	FBQss-052-0103-SO	0 to 1	Yes	Auger refusal at 0.7 ft
FBQ	FBQ-052	Potential source area	FBQso-052-0104-SO	1 to 3	No	Auger refusal at 0.7 ft
FBQ	FBQ-053	Potential source area	FBQss-053-0105-SO	0 to 1	Yes	
FBQ	FBQ-053	Potential source area	FBQso-053-0106-SO	1 to 3	No	Auger refusal at 1 ft
FBQ	FBQ-054	Site boundary	FBQss-054-0107-SO	0 to 1	Yes	
FBQ	FBQ-054	Site boundary	FBQso-054-0108-SO	1 to 3	Yes	
FBQ	FBQ-055	Potential source area	FBQss-055-0109-SO	0 to 1	Yes	
FBQ	FBQ-055	Potential source area	FBQso-055-0110-SO	1 to 3	No	Auger refusal at 1 ft
FBQ	FBQ-056	Site boundary	FBQss-056-0111-SO	0 to 1	Yes	
FBQ	FBQ-056	Site boundary	FBQso-056-0112-SO	1 to 3	Yes	Auger refusal at 1.4 ft
FBQ	FBQ-057	Potential source area	FBQss-057-0113-SO	0 to 1	Yes	
FBQ	FBQ-057	Potential source area	FBQso-057-0114-SO	1 to 3	Yes	
FBQ	FBQ-058	Potential source area	FBQss-058-0115-SO	0 to 1	Yes	
FBQ	FBQ-058	Potential source area	FBQso-058-0116-SO	1 to 3	No	Auger refusal at 1 ft
FBQ	FBQ-059	Potential source area	FBQss-059-0117-SO	0 to 1	Yes	
FBQ	FBQ-059	Potential source area	FBQso-059-0118-SO	1 to 3	Yes	Auger refusal at 1.5 ft
FBQ	FBQ-060	Potential source area	FBQss-060-0119-SO	0 to 1	Yes	
FBQ	FBQ-060	Potential source area	FBQso-060-0120-SO	1 to 3	Yes	
40-mm Firing Range	FBQ-061	Potential source area	FBQss-061-0121-SO	0 to 1	Yes	
40-mm Firing Range	FBQ-061	Potential source area	FBQso-061-0122-SO	1 to 3	Yes	
40-mm Firing Range	FBQ-062	Potential source area	FBQss-062-0123-SO	0 to 1	Yes	
40-mm Firing Range	FBQ-062	Potential source area	FBQso-062-0124-SO	1 to 3	Yes	
40-mm Firing Range	FBQ-063	Potential source area	FBQss-063-0125-SO	0 to 1	Yes	
40-mm Firing Range	FBQ-063	Potential source area	FBQso-063-0126-SO	1 to 3	Yes	
40-mm Firing Range	FBQ-064	Potential source area	FBQss-064-0127-SO	0 to 1	Yes	
40-mm Firing Range	FBQ-064	Potential source area	FBQso-064-0128-SO	1 to 3	Yes	Auger refusal at 2.5 ft
40-mm Firing Range	FBQ-065	Potential source area	FBQss-065-0129-SO	0 to 1	Yes	
40-mm Firing Range	FBQ-065	Potential source area	FBQso-065-0130-SO	1 to 3	Yes	Auger refusal at 2.5 ft
40-mm Firing Range	FBQ-066	Potential source area	FBQss-066-0131-SO	0 to 1	Yes	
40-mm Firing Range	FBQ-066	Potential source area	FBQso-066-0132-SO	1 to 3	Yes	Auger refusal at 2.5 ft
40-mm Firing Range	FBQ-067	Potential source area	FBQss-067-0133-SO	0 to 1	Yes	
40-mm Firing Range	FBQ-067	Potential source area	FBQso-067-0134-SO	1 to 3	Yes	Auger refusal at 1.5 ft
40-mm Firing Range	FBQ-068	Potential source area	FBQss-068-0135-SO	0 to 1	Yes	

Table 3-1. Soil and Test Pit Sample List and Rationales, Fuze and Booster Quarry Landfill/Ponds Phase I/II RI (continued)

Area Description	Station ID	Sample Location Rationale	Sample ID	Depth (ft)	Sample Collected (Yes/No)	Comments
40-mm Firing Range	FBQ-068	Potential source area	FBQso-068-0136-SO	1 to 3	Yes	Auger refusal at 1.75 ft
40-mm Firing Range	FBQ-069	Potential source area	FBQss-069-0137-SO	0 to 1	Yes	
40-mm Firing Range	FBQ-069	Potential source area	FBQso-069-0138-SO	1 to 3	No	Auger refusal at 1 ft
40-mm Firing Range	FBQ-070	Potential source area	FBQss-070-0139-SO	0 to 1	Yes	
40-mm Firing Range	FBQ-070	Potential source area	FBQso-070-0140-SO	1 to 3	No	Auger refusal at 1 ft
40-mm Firing Range	FBQ-071	Potential source area	FBQss-071-0141-SO	0 to 1	Yes	
40-mm Firing Range	FBQ-071	Potential source area	FBQso-071-0142-SO	1 to 3	Yes	Auger refusal at 1.5 ft
40-mm Firing Range	FBQ-072	Potential source area	FBQss-072-0143-SO	0 to 1	Yes	
40-mm Firing Range	FBQ-072	Potential source area	FBQso-072-0144-SO	1 to 3	No	Auger refusal at 1 ft
40-mm Firing Range	FBQ-073	Potential source area	FBQss-073-0145-SO	0 to 1	Yes	
40-mm Firing Range	FBQ-073	Potential source area	FBQso-073-0146-SO	1 to 3	Yes	
40-mm Firing Range	FBQ-074	Potential source area	FBQss-074-0147-SO	0 to 1	Yes	
40-mm Firing Range	FBQ-074	Potential source area	FBQso-074-0148-SO	1 to 3	Yes	Auger refusal at 2.3 ft
40-mm Firing Range	FBQ-075	Potential source area	FBQss-075-0149-SO	0 to 1	Yes	
40-mm Firing Range	FBQ-075	Potential source area	FBQso-075-0150-SO	1 to 3	Yes	Auger refusal at 2 ft
40-mm Firing Range	FBQ-076	Potential source area	FBQss-076-0151-SO	0 to 1	Yes	
40-mm Firing Range	FBQ-076	Potential source area	FBQso-076-0152-SO	1 to 3	No	Auger refusal at 1 ft
40-mm Firing Range	FBQ-077	Potential source area	FBQss-077-0153-SO	0 to 1	Yes	
40-mm Firing Range	FBQ-077	Potential source area	FBQso-077-0154-SO	1 to 3	Yes	
40-mm Firing Range	FBQ-078	Potential source area	FBQss-078-0155-SO	0 to 1	Yes	
40-mm Firing Range	FBQ-078	Potential source area	FBQso-078-0156-SO	1 to 3	No	Auger refusal at 1 ft
40-mm Firing Range	FBQ-079	Potential source area	FBQss-079-0157-SO	0 to 1	Yes	
40-mm Firing Range	FBQ-079	Potential source area	FBQso-079-0158-SO	1 to 3	Yes	Auger refusal at 2 ft
40-mm Firing Range	FBQ-080	Potential source area	FBQss-080-0159-SO	0 to 1	Yes	
40-mm Firing Range	FBQ-080	Potential source area	FBQso-080-0160-SO	1 to 3	No	Auger refusal at 1 ft
40-mm Firing Range	FBQ-081	Potential source area	FBQss-081-0161-SO	0 to 1	Yes	
40-mm Firing Range	FBQ-081	Potential source area	FBQso-081-0162-SO	1 to 3	No	Auger refusal at 1 ft
40-mm Firing Range	FBQ-082	Potential source area	FBQss-082-0163-SO	0 to 1	Yes	
40-mm Firing Range	FBQ-082	Potential source area	FBQso-082-0164-SO	1 to 3	Yes	
40-mm Firing Range	FBQ-083	Potential source area	FBQss-083-0165-SO	0 to 1	Yes	
40-mm Firing Range	FBQ-083	Potential source area	FBQso-083-0166-SO	1 to 3	Yes	
40-mm Firing Range	FBQ-084	Potential source area	FBQss-084-0167-SO	0 to 1	Yes	
40-mm Firing Range	FBQ-084	Potential source area	FBQso-084-0168-SO	1 to 3	No	Auger refusal at 1 ft
40-mm Firing Range	FBQ-085	Potential source area	FBQss-085-0169-SO	0 to 1	Yes	

Table 3-1. Soil and Test Pit Sample List and Rationales, Fuze and Booster Quarry Landfill/Ponds Phase I/II RI (continued)

Area Description	Station ID	Sample Location Rationale	Sample ID	Depth (ft)	Sample Collected (Yes/No)	Comments
40-mm Firing Range	FBQ-085	Potential source area	FBQso-085-0170-SO	1 to 3	Yes	
40-mm Firing Range	FBQ-086	Potential source area	FBQss-086-0171-SO	0 to 1	Yes	
40-mm Firing Range	FBQ-086	Potential source area	FBQso-086-0172-SO	1 to 3	Yes	Auger refusal t 2.5 ft
40-mm Firing Range	FBQ-087	Potential source area	FBQss-087-0173-SO	0 to 1	Yes	
40-mm Firing Range	FBQ-087	Potential source area	FBQso-087-0174-SO	1 to 3	Yes	Auger refusal at 2 ft
40-mm Firing Range	FBQ-088	Potential source area	FBQss-088-0175-SO	0 to 1	Yes	
40-mm Firing Range	FBQ-088	Potential source area	FBQso-088-0176-SO	1 to 3	Yes	
40-mm Firing Range	FBQ-089	Potential source area	FBQss-089-0177-SO	0 to 1	Yes	Auger refusal at 0.5 ft
40-mm Firing Range	FBQ-089	Potential source area	FBQso-089-0178-SO	1 to 3	No	Auger refusal at 0.5 ft
40-mm Firing Range	FBQ-090	Potential source area	FBQss-090-0179-SO	0 to 1	Yes	Auger refusal t 0.75 ft
40-mm Firing Range	FBQ-090	Potential source area	FBQso-090-0180-SO	1 to 3	No	Auger refusal at 0.75 ft
40-mm Firing Range	FBQ-091	Potential source area	FBQss-091-0181-SO	0 to 1	Yes	
40-mm Firing Range	FBQ-091	Potential source area	FBQso-091-0182-SO	1 to 3	No	Auger refusal at 1 ft
40-mm Firing Range	FBQ-092	Potential source area	FBQss-092-0183-SO	0 to 1	Yes	Auger refusal at 0.5 ft
40-mm Firing Range	FBQ-092	Potential source area	FBQso-092-0184-SO	1 to 3	No	Auger refusal at 0.5 ft
40-mm Firing Range	FBQ-093	Potential source area	FBQss-093-0185-SO	0 to 1	Yes	Auger refusal at 0.5 ft
40-mm Firing Range	FBQ-093	Potential source area	FBQso-093-0186-SO	1 to 3	No	Auger refusal at 0.5 ft
40-mm Firing Range	FBQ-094	Potential source area	FBQss-094-0187-SO	0 to 1	Yes	
40-mm Firing Range	FBQ-094	Potential source area	FBQso-094-0188-SO	1 to 3	Yes	Auger refusal at 2.5 ft
40-mm Firing Range	FBQ-095	Potential source area	FBQss-095-0189-SO	0 to 1	Yes	
40-mm Firing Range	FBQ-095	Potential source area	FBQso-095-0190-SO	1 to 3	Yes	Auger refusal at 2.5 ft
40-mm Firing Range	FBQ-096	Potential source area	FBQss-096-0191-SO	0 to 1	Yes	
40-mm Firing Range	FBQ-096	Potential source area	FBQso-096-0192-SO	1 to 3	Yes	Auger refusal at 2.5 ft
40-mm Firing Range	FBQ-097	Potential source area	FBQss-097-0193-SO	0 to 1	Yes	
40-mm Firing Range	FBQ-097	Potential source area	FBQso-097-0194-SO	1 to 3	Yes	Auger refusal at 2.5 ft
40-mm Firing Range	FBQ-098	Potential source area	FBQss-098-0195-SO	0 to 1	Yes	
40-mm Firing Range	FBQ-098	Potential source area	FBQso-098-0196-SO	1 to 3	Yes	
40-mm Firing Range	FBQ-099	Potential source area	FBQss-099-0197-SO	0 to 1	Yes	Auger refusal at 0.7 ft
40-mm Firing Range	FBQ-099	Potential source area	FBQso-099-0198-SO	1 to 3	No	Auger refusal at 0.7 ft
40-mm Firing Range	FBQ-100	Potential source area	FBQss-100-0199-SO	0 to 1	Yes	
40-mm Firing Range	FBQ-100	Potential source area	FBQso-100-0200-SO	1 to 3	Yes	Auger refusal at 1.5 ft
Test Pit Sample at FBQ	FBQ-178	Potential source area	FBQtr-178-0354-SO	0 to 1	Yes	
Test Pit Sample at FBQ	FBQ-178	Potential source area	FBQtr-178-0355-SO	3 to 5	Yes	
Test Pit Sample at FBQ	FBQ-179	Potential source area	FBQtr-179-0356-SO	1.5 to 4	Yes	

Table 3-1. Soil and Test Pit Sample List and Rationales, Fuze and Booster Quarry Landfill/Ponds Phase I/II RI (continued)

Area Description	Station ID	Sample Location Rationale	Sample ID	Depth (ft)	Sample Collected (Yes/No)	Comments
Test Pit Sample at FBQ	FBQ-179	Potential source area	FBQtr-179-0357-SO	4 to 7	Yes	
Test Pit Sample at FBQ	FBQ-180	Potential source area	FBQtr-180-0358-SO	0 to 1	Yes	
Test Pit Sample at FBQ	FBQ-180	Potential source area	FBQtr-180-0359-SO	5 to 8	Yes	
Test Pit Sample at FBQ	FBQ-181	Potential source area	FBQtr-181-0360-SO	1.5 to 4	Yes	
Test Pit Sample at FBQ	FBQ-181	Potential source area	FBQtr-181-0361-SO	4 to 6.5	Yes	
Test Pit Sample at FBQ	FBQ-182	Potential source area	FBQtr-182-0362-SO	1 to 3.75	Yes	
Test Pit Sample at FBQ	FBQ-182	Potential source area	FBQtr-182-0363-SO	3.7 to 4.5	Yes	
Test Pit Sample at FBQ	FBQ-183	Potential source area	FBQtr-183-0364-SO	0 to 1	Yes	
Test Pit Sample at FBQ	FBQ-183	Potential source area	FBQtr-183-0365-SO	3.7 to 4	Yes	Sample taken from spoils

FBQ = Fuze and Booster Quarry Landfill/Ponds.
RI = Remedial investigation.

3.1.2 Surface and Subsurface Soil Field Sampling Methods

3.1.2.1 Surface soil

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 to 0.3 m (0 to 1 ft). Where analyses for explosives and propellant compounds were specified, composite samples were collected. Because of the physical characteristics of these 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 (EPA 1998). To collect composite samples for surface soil and dry sediment, three borings were hand augered in an equilateral triangle pattern measuring about 0.9 m (3 ft) on a side. Equal portions of soil from the three subsamples were placed into a large, decontaminated stainless steel bowl and homogenized, and then the samples for explosives and propellant compounds analyses were placed into sample containers and were submitted to the fixed-base laboratory for analysis. Samples for analyses of other contaminants [e.g., inorganics, semivolatile organic compounds (SVOCs), volatile organic compounds (VOCs), etc.] were collected as described for discrete samples from a boring placed in the approximate center of the triangle formed by the three subsamples. Soil for VOC analyses, if required at that station, was placed directly into sample jars from the auger bucket. The remaining soil was placed into a stainless steel bowl and homogenized. Samples for inorganic constituents (metals and cyanide), SVOCs, and other volatiles constituents were collected from the homogenized soil mixture.

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 Phase I/II RI Work Plan and SAP Addenda, 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 in the field logbooks.

Following collection of the sample, excess soil was designated as IDW and placed in a lined roll-off container that was staged at a Field Storage Area (FSA) within the AOC. IDW practices for all media are discussed in Appendix E. Hand-auger borings were backfilled to the ground surface with dry bentonite chips.

3.1.2.2 Subsurface soil sampling methods

To collect subsurface samples for chemical analyses, a decontaminated auger bucket was used to deepen the surface soil boring over the required depth interval. At locations where composite sampling was performed for explosives and propellant compounds analysis, the subsurface sample was obtained by deepening the surface soil boring in the center of the equilateral triangle.

Soil from the subsurface interval was placed into a stainless steel pan or bowl and homogenized, and representative aliquots were placed into the appropriate sample containers. All VOC samples were collected as discrete aliquots from the middle of the interval without homogenization. All samples were submitted to the fixed-base laboratory for analysis.

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 Phase I/II RI Work Plan and SAP Addenda, 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.

Following collection of the samples, excess soil was designated as IDW and placed in a lined, labeled roll-off container that was staged at the FSA within the AOC. IDW practices for all media are discussed in Appendix E. Hand-auger borings were backfilled to the ground surface with dry bentonite chips.

3.1.2.3 Test pits

Six test pits were excavated around the FBQ AOC and perimeter. Test pit locations are shown on Figure 3-2. Test pits were excavated using a Ford backhoe utilizing the trenching protocols presented in FSAP Section 4.4.2.1.3: "Trenching Method." Test pits were excavated according to procedures included in Occupational Safety and Health Administration 29 *Code of Federal Regulations* 1926, Subpart P, "Excavations, Trenching, and Shoring."

The test pits dimensions were approximately 45 to 60 cm (18 to 24 in.) wide and 4.5 m (15 ft) deep or extended to the saturated zone, or to bedrock, whichever came first. The trenches were not excavated below the water table to avoid the potential for contaminating groundwater and the hazard of collapse caused by digging into saturated material. Material from the test pits were logged by a SpecPro geologist using conventional geologic/stratigraphic and geotechnical methods. Soil material in each trench was removed in layers measuring approximately 0.6 to 0.9 m (2.0 to 3.0 ft) in thickness. Test pit logs are presented in Appendix F.

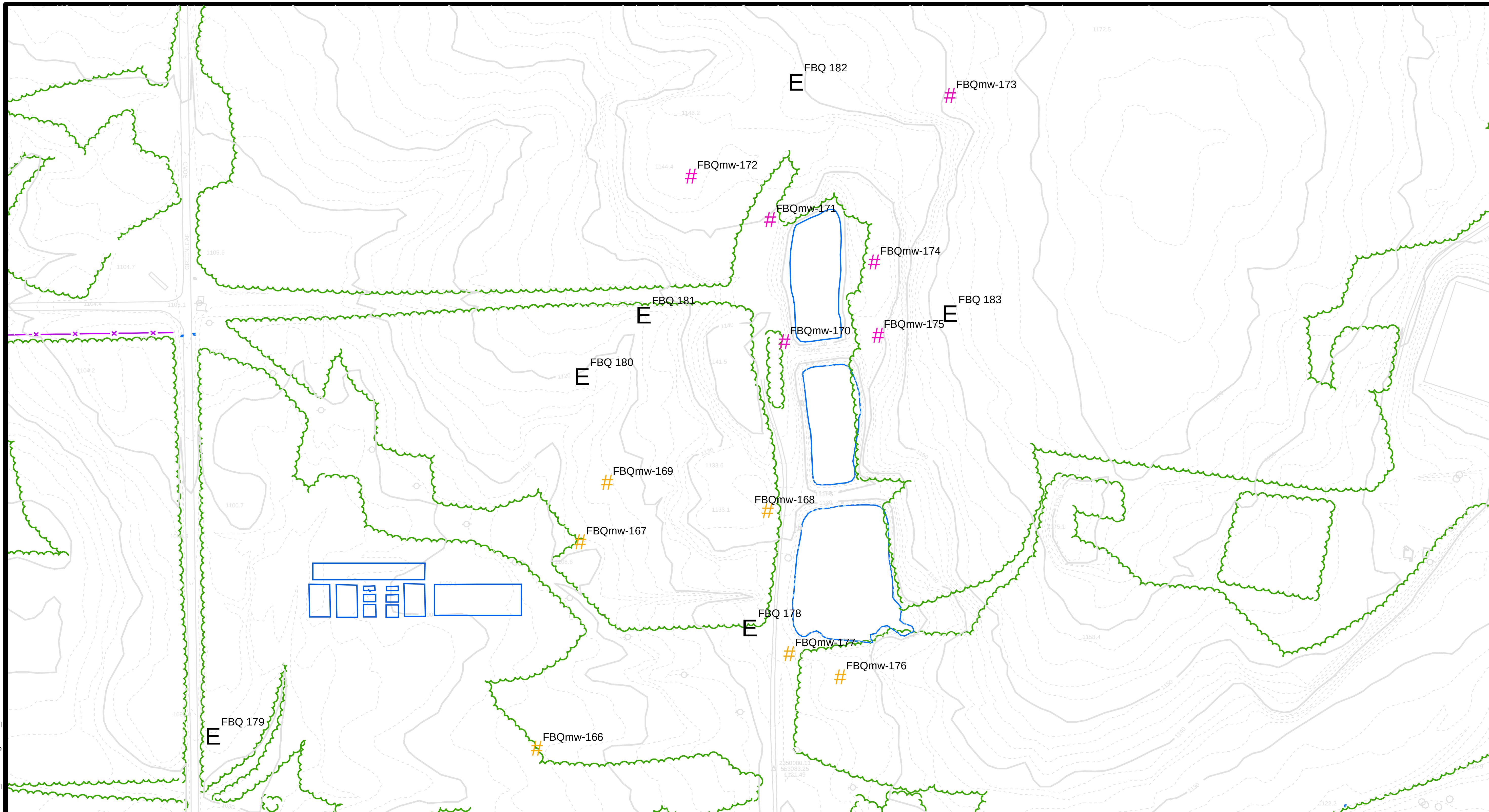
Two Shelby tube samples were collected from each test pit for geotechnical laboratory analysis. Samples for chemical analysis were not planned and were not collected. All soil and solid waste removed from trenches was placed beside each trench on plastic sheeting and segregated by the layer in which was excavated. Upon completion of the excavation and collection of the soil samples, the excavation was filled using the soil stockpiled adjacent to the excavation in reverse order of how it was removed.

3.2 SEDIMENT CHARACTERIZATION

3.2.1 Rationale

Sediment samples were collected from a total of 40 stations located within FBQ (Table 3-2; Figures 3-3 and 3-4). Data from sediment samples collected within FBQ were obtained to identify areas of contaminant accumulation and evaluate potential contaminant migration via erosional processes from surface soil sources. Sediments were sampled from drainage ditches and from each of the quarry ponds in order to (1) assess the potential for contaminant migration via erosion to surface water and sediment; (2) evaluate potential contaminant accumulation areas, such as runoff collection points, to evaluate if residual contamination exists and if these areas could act as secondary sources for contamination; and (3) evaluate potential contaminant exit pathways from the AOC. All planned sediment sample locations were biased in nature, and final locations were determined in the field based on site conditions.

Sediment samples collected included wet and dry sediment from ditch lines and low-lying areas. The collection methods for these types of samples differ as discussed in Sections 4.3.2.1 and 4.3.2.2. All dry sediment stations will be sampled from 0.0 to 0.3 m (0.0 to 1 ft) following the same methods as surface soil stations. Subaqueous sediment samples were sampled from 0.0- to 0.15-m (0.0- to 0.5-ft) depth intervals using either a stainless-steel scoop, sediment core sampler, or remote device (Eckman sampler) as appropriate.



Legend

- Road
- Vegetation
- Water Table Contour (CI=2 ft)
- 2 Ft. Contour
- 10 Ft. Contour
- Settling Basins
- # Monitoring Well Screened in Bedrock
- # Monitoring Well Screened in Unconsolidated Material
- E Test Pit
- Telephone Pole

An Employee-Owned Company

0 100 200 400 600 800 Feet

Monitoring Well and Test Pit	
Drawn By: DAC	
Figure 3-2	**CAD FILES:** R31718/R31617/R21718/R21617
	Date: 10/26/05

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Table 3-2. Sediment and Surface Water Sample List and Rationales, Fuze and Booster Quarry Landfill/Ponds Phase I/II RI

Area Description	Station	Sample Location Rationale	Sample ID	Depth (ft)	Sample Collected (Yes/No)	Comments
Unnamed tributary	FBQ-126		FBQsd-126-0251-SD	0 to 0.5	Yes	
	FBQ-127		FBQsd-127-0252-SD	0 to 0.5	Yes	
	FBQ-128		FBQsd-128-0253-SD	0 to 0.5	Yes	
	FBQ-129		FBQsd-129-0254-SD	0 to 0.5	Yes	
	FBQ-130		FBQsd-130-0255-SD	0 to 0.5	Yes	
	FBQ-130		FBQsw-130-0295-SW	Surface water	Yes	
Small ponds	FBQ-131		FBQsd-131-0256-SD	0 to 0.5	Yes	
	FBQ-130		FBQsw-131-0296-SW	Surface water	Yes	
	FBQ-132		FBQsd-132-0257-SD	0 to 0.5	Yes	
	FBQ-132		FBQsw-132-0297-SW	Surface water	Yes	
	FBQ-132		FBQsw-132-0414-SW	Surface water	Yes	Contingency sample
	FBQ-133		FBQsd-133-0258-SD	0 to 0.5	Yes	
	FBQ-133		FBQsw-133-0299-SW	Surface water	Yes	
	FBQ-134		FBQsd-134-0259-SD	0 to 0.5	Yes	
	FBQ-134		FBQsw-134-0300-SW	Surface water	Yes	
	FBQ-134		FBQsw-134-0410-SW	Surface water	Yes	Contingency sample
	FBQ-135		FBQsd-135-0260-SD	0 to 0.5	Yes	
	FBQ-135		FBQsw-135-0301-SW	Surface water	Yes	
	FBQ-136		FBQsd-136-0261-SD	0 to 0.5	Yes	
	FBQ-136		FBQsw-136-0303-SW	Surface water	Yes	
	FBQ-137		FBQsd-137-0262-SD	0 to 0.5	Yes	
	FBQ-137		FBQsw-137-0303-SW	Surface water	Yes	
	FBQ-138		FBQsd-138-0263-SD	0 to 0.5	Yes	
	FBQ-138		FBQsw-138-0304-SW	Surface water	Yes	
	FBQ-139		FBQsd-139-0264-SD	0 to 0.5	Yes	
	FBQ-139		FBQsw-139-0305-SW	Surface water	Yes	
	FBQ-140		FBQsd-140-0265-SD	0 to 0.5	Yes	
Drainage channel	FBQ-141		FBQsd-141-0266-SD	0 to 0.5	Yes	
	FBQ-141		FBQsw-141-0298-SW	Surface water	Yes	
	FBQ-142		FBQsd-142-0267-SD	0 to 0.5	Yes	
	FBQ-143		FBQsd-143-0268-SD	0 to 0.5	Yes	
Southernmost large quarry pond	FBQ-144		FBQsd-144-0269-SD	0 to 0.5	Yes	
	FBQ-145		FBQsd-145-0270-SD	0 to 0.5	Yes	
	FBQ-145		FBQsw-145-0291-SW	Surface water	Yes	

Table 3-2. Sediment and Surface Water Sample List and Rationales, Fuze and Booster Quarry Landfill/Ponds Phase I/II RI (continued)

Area Description	Station	Sample location Rationale	Sample ID	Depth (ft)	Sample Collected (Yes/No)	Comments
	FBQ-146		FBQsd-146-0271-SD	0 to 0.5	Yes	
	FBQ-147		FBQsd-147-0272-SD	0 to 0.5	Yes	
	FBQ-147		FBQsw-145-0292-SW	Surface water	Yes	
	FBQ-148		FBQsd-148-0273-SD	0 to 0.5	Yes	
	FBQ-149		FBQsd-149-0274-SD	0 to 0.5	Yes	
	FBQ-150		FBQsd-150-0275-SD	0 to 0.5	Yes	
	FBQ-151		FBQsd-151-0276-SD	0 to 0.5	Yes	
	FBQ-152		FBQsd-152-0277-SD	0 to 0.5	Yes	
	FBQ-153		FBQsd-153-0278-SD	0 to 0.5	Yes	
	FBQ-153		FBQsw-153-0294-SW	Surface water	Yes	
	FBQ-154		FBQsd-154-0279-SD	0 to 0.5	Yes	
	FBQ-154		FBQsw-154-0293-SW	Surface water	Yes	
Middle large quarry pond	FBQ-155		FBQsd-155-0280-SD	0 to 0.5	Yes	
	FBQ-156		FBQsd-156-0281-SD	0 to 0.5	Yes	
	FBQ-157		FBQsd-157-0282-SD	0 to 0.5	Yes	
	FBQ-158		FBQsd-158-0283-SD	0 to 0.5	Yes	
	FBQ-159		FBQsd-159-0284-SD	0 to 0.5	Yes	
Northern large quarry pond	FBQ-160		FBQsd-160-0285-SD	0 to 0.5	Yes	
	FBQ-161		FBQsd-161-0286-SD	0 to 0.5	Yes	
	FBQ-162		FBQsd-162-0287-SD	0 to 0.5	Yes	
	FBQ-163		FBQsd-163-0288-SD	0 to 0.5	Yes	
	FBQ-164		FBQsd-164-0289-SD	0 to 0.5	Yes	
Drainage channel	FBQ-165		FBQsd-165-0290-SD	0 to 0.5	Yes	
Small pond	FBQ-184		FBQsd-184-0415-SD	0 to 0.5	Yes	Contingency sample
	FBQ-185		FBQsd-185-0416-SD	0 to 0.5	Yes	Contingency sample
	FBQ-186		FBQsd-186-0418-SD	0 to 0.5	Yes	Contingency sample
	FBQ-187		FBQsd-187-0419-SD	0 to 0.5	Yes	Contingency sample
	FBQ-188		FBQsd-188-0420-SD	0 to 0.5	Yes	Contingency sample
	FBQ-189		FBQsd-189-0422-SD	0 to 0.5	Yes	Contingency sample
	FBQ-190		FBQsd-190-0423-SD	0 to 0.5	Yes	Contingency sample
	FBQ-191		FBQsd-191-0424-SD	0 to 0.5	Yes	Contingency sample
	FBQ-192		FBQsd-192-0425-SD	0 to 0.5	Yes	Contingency sample

RI = Remedial investigation.

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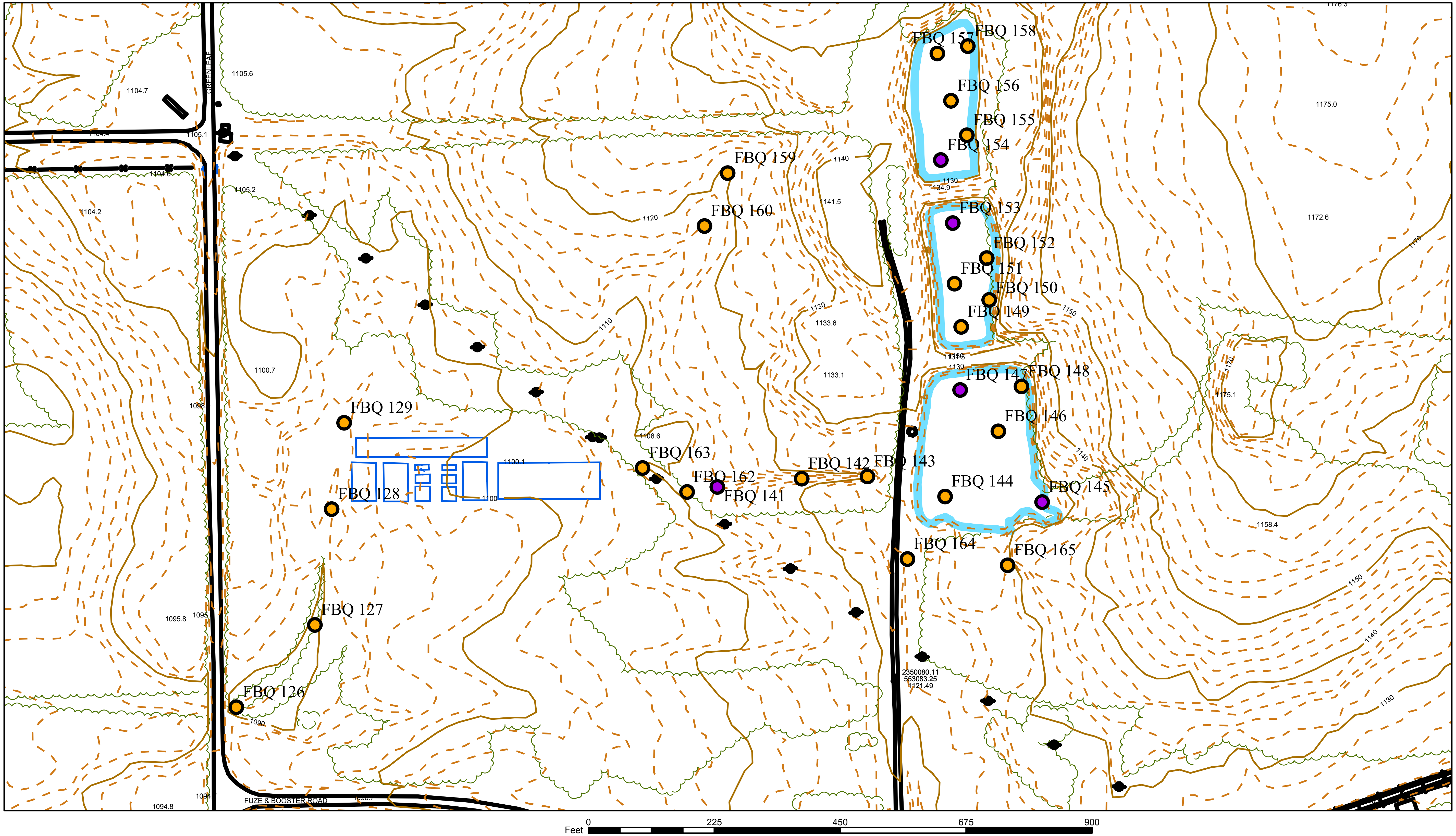

Legend

- Roads
- Water
- Vegetation
- 2 Ft. Contour
- 10 Ft. Contour
- Sediment
- Sediment/SurfaceWater
- Telephone Pole

SpecPro

Figure 3-3 Discrete Sediments and Surface Water Sampling Locations excluding the Basin Ponds.

Figure 3-3	**Discrete Sediments and Surface Water Sampling**
	Drawn By: gharris
	CAD Files: R31718/R31617/R21718/R21617
	Date: January 22, 2005

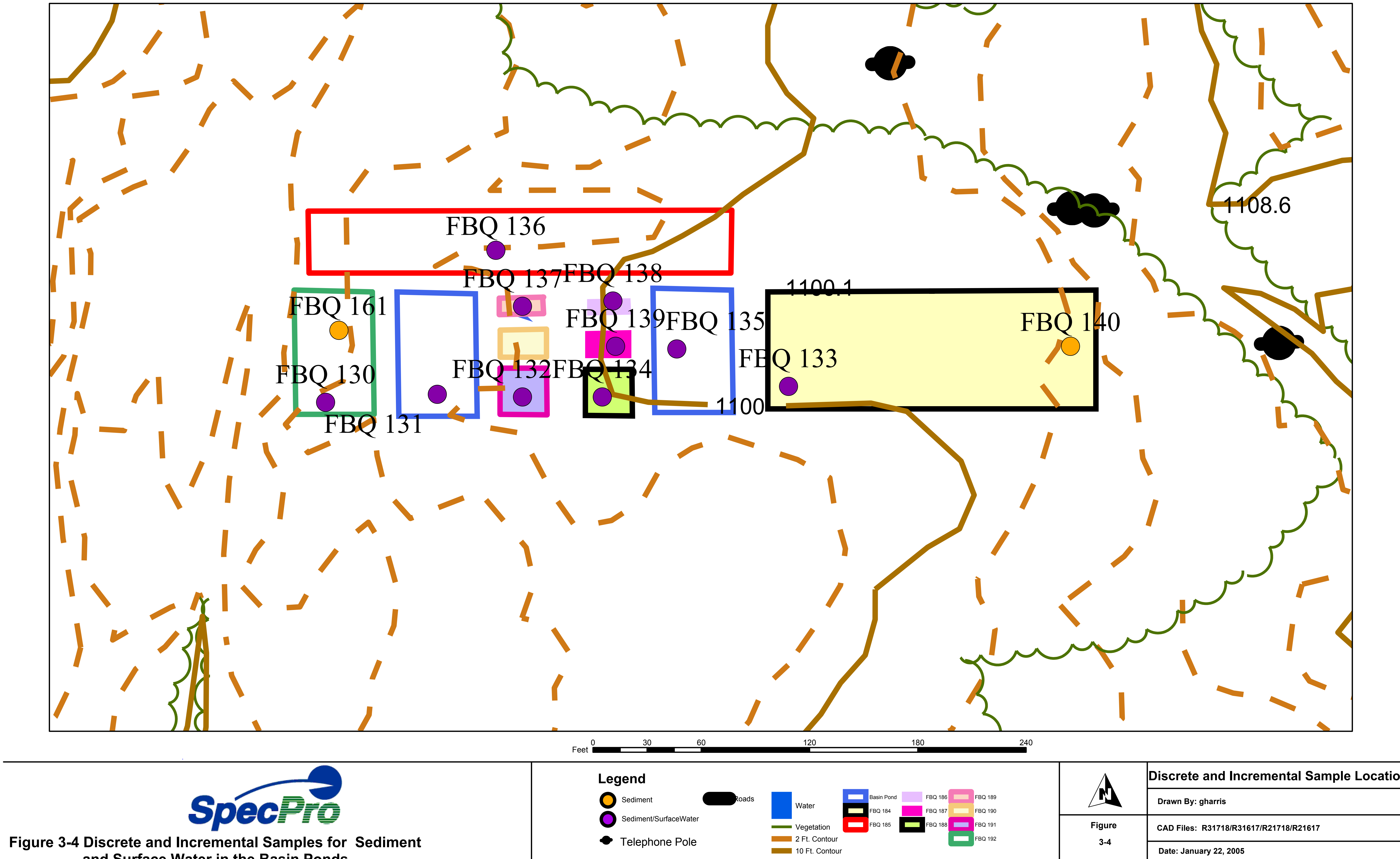

Figure 3-4 Discrete and Incremental Samples for Sediment and Surface Water in the Basin Ponds.

Discrete and Incremental Sample Locations

Drawn By: gharris

Figure 3-4

CAD Files: R31718/R31617/R21718/R21617

Date: January 22, 2005

3.2.2 Sediment Field Sampling Methods

Sediment samples in locations where water depth did not exceed 15.2 cm (0.5 ft) were collected with a stainless steel trowel or scoop following Section 4.5.2.2.1 of the Facility-wide SAP. The scoop was used to manually obtain sediment to a depth of 15.2 cm (0.5 ft) below the sediment surface.

A remote stainless steel clamshell sediment sampler was used to collect sediment from the ponds where the depth of the surface water exceeds 15.2 cm (0.5 ft) and the sediment could not be accessed directly with scoops. The remote sampler is a device that is lowered to the sample point using a retrieval line or extension rods. The sampler is activated using a second line that closes the clamshell.

A sediment core sampler was used to collect sediment at locations where the depth of the surface water exceeded 15.2 cm (0.5 ft) and the sediment could not be accessed directly with scoops or the clamshell device. All samples collected with the sludge sampler were obtained following the protocol in Section 4.5.2.2.2 of the Facility-wide SAP. The sediment core sampler consists of a stainless steel, 8.26-cm (3.25-in.) OD, 30.5-cm (12-in.)-long capped tube, which can be fitted with either an auger- or core-type sampler end. Each sampler end is equipped with a butterfly valve to prevent loss of sample upon retrieval. The sampler was extended to the sampling depth by connecting stainless steel extension rods to the sampler. The extension rods were attached to a cross handle and was pushed or augered by hand.

Sediment was placed into a stainless steel bowl as it is collected. At sample locations where VOC fractions were collected, the VOC containers were filled immediately with the first sediment obtained. Sample containers for the remaining nonvolatile analytes were filled as described in Section 4.5.2.5 of the Facility-wide SAP.

Field description of the sediment samples was 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 Phase I/II RI Work Plan and SAP Addenda. Headspace gases were not screened in the field for organic vapors. Sediment sampling logs are presented in Appendix F.

3.3 SURFACE WATER CHARACTERIZATION

3.3.1 Rationale

A total of 15 surface water samples were collected from the three ponds and each of the other settling basins at FBQ. Surface water samples were collected in order to (1) assess the potential for contaminant migration in surface water; (2) evaluate potential contaminant accumulation areas, such as runoff collection points, to evaluate if residual contamination is partitioning to water and are acting as secondary sources for contamination to groundwater; and (3) evaluate potential contaminant exit pathways from FBQ.

The surface water sample locations were co-located with sediment sample locations within the larger quarry ponds and smaller settling basins (Table 3-2; Figures 3-3 and 3-4).

3.3.2 Surface Water Field Sampling Methods

All surface water samples were collected directly into sample containers as referenced in the Phase I/II RI Work Plan and SAP Addenda (USACE 2002). Filtered samples were not collected. The sample container was submerged, with the cap in place, into the surface water. Then the container was slowly and continuously filled using the cap to regulate the rate of sample entry into the container. Surface water samples were collected prior to sediment samples at co-located sites also in an attempt to minimize the effects of sediment turbidity on surface water quality. All surface water samples were collected from ponds, and care was taken to minimize the effects of sediment turbidity on water sample quality.

Field measurements were taken during sampling including pH, conductivity, dissolved oxygen content, and temperature. These measurements were performed in accordance with procedures in Section 4.3.3 of the Facility-wide SAP as referenced by the Phase I/II RI Work Plan and SAP Addenda. All field measurements were recorded in the sampling logbooks. Surface water sampling logs are contained in Appendix F.

3.4 GROUNDWATER CHARACTERIZATION

3.4.1 Rationale

Twelve new monitoring wells were installed as a part of the Phase I/Phase II RI to monitor shallow groundwater at FBQ (Figure 3-2). Table 3-3 describes the rationale for the placement of the monitoring wells. The proposed locations were selected on the basis of DQOs, and the CSM developed for FBQ (Chapter 3.0). Monitoring wells were installed to assess impacts to shallow groundwater and to evaluate potential migration pathways. The groundwater characterization effort included installation of monitoring wells in a configuration that provided data on general hydrogeologic characteristics and groundwater flow patterns. Monitoring wells were also specifically installed in the vicinity of known and suspected source areas to evaluate whether contaminants are leaching to groundwater. Monitoring wells were also placed topographically down gradient of the quarry ponds to determine whether groundwater and potential contaminant transport is occurring off of FBQ. Monitoring wells FBQmw-172, 173, 174, and 175 were installed to characterize groundwater quality upgradient from FBQ.

3.4.2 Monitoring Well Installation Methods

All monitoring well installation activities were conducted according to the Facility-wide SAP and the FBQ Phase I/II RI Work Plan and SAP Addenda. Monitoring wells borings were drilled through unconsolidated soil and rock, and the monitoring wells installed under the direct supervision of a qualified geologist. An 11-cm (4.25-in.) inside-diameter, hollow-stem auger was used to advance the borehole through unconsolidated and weathered bedrock materials. Soil samples were collected continuously from the surface to refusal or the planned borehole termination depth using a split-spoon sampler. Soil sampling was conducted during well drilling for description of soil stratigraphy and geotechnical analyses.

Bedrock was encountered at seven of the monitoring well borings. Borings through bedrock were advanced using air-rotary drilling and coring techniques as described in Section 4.3.2.1 of the Facility-wide SAP.

Organic vapors were monitored from soil and rock cuttings at each borehole using an organic vapor analyzer (OVA); however, samples for headspace readings were not collected. In addition, the breathing zone was continuously monitored for evidence of organic chemicals. All readings were recorded in the project logbooks.

Table 3-3. Groundwater Sample List and Rationale, Fuze and Booster Quarry Landfill/Ponds Phase I/II RI

Area Description	Station	Sample Location Rationale	Sample ID	Sample Collected (Yes/No)	Comments
FBQ	FBQ-166	Downgradient quarry ponds	FBQmw-166-0306-GW	Yes	
FBQ	FBQ-166	“	FBQmw-166-0307-GF	Yes	
FBQ	FBQ-167	“	FBQmw-167-0308-GW	Yes	
FBQ	FBQ-167	“	FBQmw-167-0309-GF	Yes	
FBQ	FBQ-168	Potential source area	FBQmw-168-0310GW	Yes	
FBQ	FBQ-168	“	FBQmw-168-0311-GF	Yes	
FBQ	FBQ-169	Downgradient quarry ponds	FBQmw-169-0312-GW	Yes	
FBQ	FBQ-169	“	FBQmw-169-0313-GF	Yes	
FBQ	FBQ-170	Potential source area	FBQmw-170-0314-GW	Yes	
FBQ	FBQ-170	“	FBQmw-170-0315-GF	Yes	
FBQ	FBQ-171	“	FBQmw-171-0316-GW	Yes	
FBQ	FBQ-171	“	FBQmw-171-0317-GF	Yes	
FBQ	FBQ-172	Upgradient quarry ponds	FBQmw-172-0318-GW	Yes	
FBQ	FBQ-172	“	FBQmw-173-0319-GF	Yes	
FBQ	FBQ-173	“	FBQmw-173-0320-GW	Yes	
FBQ	FBQ-173	“	FBQmw-173-0321-GF	Yes	
FBQ	FBQ-174	“	FBQmw-174-0322-GW	Yes	
FBQ	FBQ-174	“	FBQmw-174-0323-GF	Yes	
FBQ	FBQ-175	“	FBQmw-175-0324-GW	Yes	
FBQ	FBQ-175	“	FBQmw-175-0325-GF	Yes	
FBQ	FBQ-176	Potential source area	FBQmw-176-0326-GW	Yes	
FBQ	FBQ-176	“	FBQmw-176-0327-GF	Yes	
FBQ	FBQ-177	Downgradient quarry ponds	FBQmw-177-0328-GW	Yes	
FBQ	FBQ-177	“	FBQmw-177-0329-GF	Yes	

RI = Remedial investigation.

Following drilling of the boreholes to the appropriate depths, monitoring wells were constructed from pre-cleaned 5-cm (2-in.) schedule 40 polyvinyl chloride (PVC) pipes. Well screens were commercially fabricated with slot widths of 0.025 cm (0.01 in.). All monitoring wells were constructed using a 3-m (10-ft) screen, except for FBQ-173, which was constructed with a 6-m (20-ft) screen. The well casing and screens were assembled and lowered into the open borehole. Following placement of the well casing and screen, a pre-washed filter pack, consisting of Global Supply No. 5 sand, was placed from the bottom of the borehole to approximately 0.6 m (2 ft) above the top of the well screen in each well. A 0.6-m (2-ft) or 0.9-m (3-ft) bentonite pellet annular seal was then poured into the borehole on top of the filter pack.

For monitoring well completion, a grout mixture consisting of Type I Portland cement and 5% bentonite was placed from the top of the annular seal to the ground surface, followed by the placement of a protective steel surface casing with locking cover and construction of a mortar collar and cement pad. Four steel posts were installed around each well and painted. Monitoring well installation procedures are provided in Section 4.3.2 of the Facility-wide SAP (USACE 2001a). In concurrence with Ohio EPA officials, exceptions to the installation procedures provided in the Facility-wide SAP were as follows:

- Monitoring wells FBQmw-166, -167, and -169 were installed with only 2 ft of sand over the top of screen (instead of 3 ft), and only 1 ft of bentonite seal on top of the sand pack (instead of 2 ft). This change was due to the shallow depth to groundwater in these monitoring wells.

- FBQmw-173 was installed with 20 ft of well screen instead of 10 ft to maximize the yield in this well.

Well diagrams provided in Appendix C summarize the construction details for the monitoring wells installed during the Phase I/II RI at the FBQ AOC, including depths, screened intervals, and groundwater elevations. This information is summarized in Table 3-4.

Table 3-4. Groundwater Monitoring Well Summary

Monitoring Well ID No.	Screened Interval (ft)	Total Depth (ft)	Lithology in Screened Interval	Ground Elevation (ft AMSL)	Top of Casing Elevation (ft AMSL)
FBQmw-166	5.5 to 15.5	16	Unconsolidated Materials (clayey silt, silty clay)	1,104.87	1,108.86
FBQmw-167	5 to 15	18	Unconsolidated Materials (clay, sand, sand with gravel)	1,112.05	1,115.90
FBQmw-168	9 to 19	19.5	Unconsolidated Materials (sand, silt)	1,131.27	1,133.91
FBQmw-169	5 to 15	16	Unconsolidated Materials (sand, gravel, silt, clay)	1,117.36	1,120.58
FBQmw-170	20 to 30	30.5	Sandstone	1,139.67	1,142.26
FBQmw-171	18 to 28	30	Sandstone	1,140.49	1,143.55
FBQmw-172	20 to 30	33	Sandstone	1,145.71	1,150.09
FBQmw-173	29.5 to 49.5	50	Sandstone	1,162.43	1,165.94
FBQmw-174	12 to 22	22.5	Sandstone	1,135.78	1,139.97
FBQmw-175	12 to 22	22.5	Sandstone	1,137.16	1,140.73
FBQmw-176	11 to 21	21.5	Unconsolidated Materials/Shale	1,129.57	1,131.91
FBQmw-177	12 to 22	22.5	Unconsolidated Materials (sand, silt)	1,125.73	1,128.57

AMSL = Above mean sea level.

Once the wells were completely installed, the well's location and elevation were surveyed by a licensed surveyor. The monitoring well's location and elevations are provided in the well logs in Appendix C. A report of the survey is provided in Appendix G.

3.4.3 Well Development Methods

At least 48 hr after completion, each monitoring well was developed so that representative groundwater samples could be collected. Well development was accomplished by purging at least five well volumes of groundwater, using a submersible pump or a bailer, until the development water was visually clear (where possible) and sediment thickness in the well was less than 3.0 cm (0.1 ft). Well development records were included in the project logbooks and are provided in Appendix C.

3.4.4 Groundwater Field Sampling Methods

Following development of the wells, groundwater samples were collected. The procedure used for sampling groundwater is described in Sections 4.3.4 and 4.3.5 of the Facility-wide SAP. Before sampling, the monitoring wells were purged until readings of pH, conductivity, dissolved oxygen, and water temperature reached equilibrium. Groundwater samples were collected using a bailer. General groundwater quality indicator parameters (pH, specific conductance, dissolved oxygen, temperature, and turbidity) were monitored during the sampling procedure and are presented in Appendix C. All monitoring wells were purged until temperature, pH, dissolved oxygen, and specific conductivity readings had stabilized. At FBQmw-166, -167, -168, -169, -170, -171, -172, -173, -174, -175, -176, and -177 turbidity readings were greater than 5 NTUs despite efforts to obtain the lowest turbidity readings possible. Accordingly, only filtered metals samples were obtained. All groundwater samples were analyzed for explosives, propellants, Inorganics (filtered only), hexavalent chromium, VOCs, SVOCs, and pesticides/polychlorinated biphenyls (PCBs). Groundwater samples analyzed for dissolved metals were filtered using a disposable filter with 0.45-µm pores. The results of groundwater sampling at FBQ are discussed in detail in Section 4.6. The groundwater sampling logs are contained in Appendix C. The laboratory analytical data are presented in Appendix H.

3.4.5 In Situ Permeability Testing

Slug tests were performed at all monitoring wells to determine the hydraulic conductivity of the geologic materials surrounding each well screen. Slug tests followed the provisions of the Phase I/II RI Work Plan and SAP Addenda. These analyses calculate horizontal hydraulic conductivities in the screened interval of each well. Both falling-head and rising-head tests were conducted to obtain comparative results and validate the test results. Falling-head tests were performed by inserting a PVC cylinder into the well and monitoring the return (drop) of the potentiometric surface to the pretest static water level over time. Rising-head tests were performed by reversing the process (e.g., the slug was removed, and the rise in water level was monitored). The tests were performed after each well had fully recovered from groundwater sampling, using pressure transducers for water level measurements and automated data collection. The slug was designed to displace approximately 0.3 m (1 ft) of water.

Water level measurements were recorded using a pre-programmed logarithmic time interval. Water levels were monitored for a period of 6 hr or until the well re-equilibrated to 90% of the pretest water level. The data were evaluated using the updated Bouwer and Rice method (Bouwer 1989). Compensation for water levels within the screened interval is included in this evaluation method. The results of the slug tests performed in December 2003 are presented in Appendix K and are discussed in Chapter 2.

3.5 ANALYTICAL PROGRAM OVERVIEW

3.5.1 Geotechnical Analyses

Soil samples collected using the bucket hand-auger method are classified as disturbed samples. Disturbed sediment samples (e.g., collected using manual methods) were visually classified in the field and submitted for Unified Soil Classification System (USCS) classification, and grain size distribution by chemical analysis. The results of the geotechnical evaluation for sediment samples are discussed in Chapter 4 and included in Appendix B.

In addition to disturbed samples, Shelby tubes were collected from test pit excavations and monitoring well borings. Two Shelby tube samples were collected from each test pit. It was originally planned to collect two Shelby tube samples from each monitoring well boring, one from the unconsolidated materials and one from the screened interval. Due to the hardness of the unconsolidated materials and the screened interval of six of the monitoring wells being totally within bedrock, only seven of the planned Shelby tubes from the monitoring well boring were able to be collected. The Shelby tube samples were analyzed for a comprehensive suite of parameters to evaluate site hydrogeologic characteristics and to obtain data for potential future evaluation of natural attenuation. Geotechnical analytical parameters for undisturbed samples included moisture content, grain size distribution, USCS, Atterberg limits, hydraulic conductivity, hydrometer analysis, specific gravity, bulk density, porosity, and pH.

3.5.2 Laboratory Analyses

All analytical procedures were completed in accordance with applicable professional standards, EPA requirements, government regulations and guidelines, USACE Louisville District analytical QA guidelines, and specific project goals and requirements. The sampling and analysis program conducted during the Phase I/II RI for FBQ involved the collection and analysis of surface soil, subsurface soil, sediment, surface water, and groundwater. Field screening for organic vapors was conducted at each sample location using an OVA. Specified samples were analyzed by an independent quality control (QC) split analytical laboratory under contract with the USACE Louisville District.

Samples collected during the investigation were analyzed by GPL Laboratories, Gaithersburg, MD, a USACE Center of Excellence certified laboratory. The specified QC split samples collected for soil, sediment, surface water, and groundwater 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.

Samples were collected and analyzed according to the Facility-wide SAP and the FBQ Phase I/II RI Work Plan and SAP Addendum. Prepared in accordance with USACE and EPA guidance, the Facility-wide SAP and associated addenda outline the organization, objectives, intended data uses, and QA/QC activities to achieve the desired DQOs and maintain the defensibility of the data. Project DQOs were established in accordance with EPA Region 5 guidance. Requirements for sample collection, handling, analysis criteria, target analytes, laboratory criteria, and data validation criteria for the Phase I/II RI are consistent with EPA requirements for National Priorities List sites. DQOs for this project included analytical precision, accuracy, representativeness, completeness, comparability, and sensitivity for the measurement data. Appendix J presents an assessment of those objectives as they apply to the analytical program.

Strict adherence to the requirements set forth in the Facility-wide SAP and project addenda was required of the analytical laboratory so that conditions adverse to quality would not arise. The laboratory was required to perform all analyses in compliance with EPA SW-846 (EPA 1990a), *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, Analytical Protocols*. SW-846 chemical analytical procedures were followed for the analyses of inorganics, VOCs, SVOCs, pesticides, PCBs, explosives, propellants, and cyanide. Laboratories were required to comply with all methods as written; recommendations were considered requirements.

QA/QC samples for this project included field blanks, trip 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). As contingency samples were added to the original Scope of Work, additional QA/QC samples were collected in accordance with Facility-Wide guidelines. Field blanks, consisting of potable water used in the decontamination process, equipment rinsate blanks, and trip 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. Field blank samples were analyzed to determine procedural contamination at the site that may contribute to sample contamination. Equipment rinsate blanks were used to assess the adequacy of the equipment decontamination processes for soil sample collection. Trip blanks were used to assess the potential for contamination of samples caused by contaminant migration during sample shipment and storage. Field duplicate samples were analyzed to determine sample heterogeneity and sampling methodology reproducibility. Laboratory method blanks and laboratory control samples were employed to determine the accuracy and precision of the analytical method as implemented by the laboratory. MSs provided information about the effect of the sample matrix on the measurement methodology. Laboratory sample duplicates and MS/MSDs assisted in determining the analytical reproducibility and precision of the analysis for the samples of interest. 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 Appendix J, Data Quality Summary Report (DQSR).

SpecPro, Inc. 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 SpecPro, Inc. 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 will retain all original raw data information (both hardcopy and electronic) in a secure area under the custody of the laboratory project manager.

3.5.3 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 Department of Transportation regulations for environmental samples.

Data were produced, reviewed, and reported by the laboratory in accordance with specifications outlined in the FBQ Phase I/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 SpecPro 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 SpecPro 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 SpecPro 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 SpecPro 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 Appendix H. Following data verification, all data packages were forwarded to the USACE independent data validation contractor.

This review constituted 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.

3.6 ORDNANCE AND EXPLOSIVE AVOIDANCE AND FIELD RECONNAISSANCE

Ordnance and explosives (OE) avoidance subcontractor support staff were present during all field operations. The OE Team Leader led an initial safety briefing on OE to train all field personnel to recognize and stay away from propellants and OE. Daily tailgate safety briefings included reminders regarding OE avoidance. Site visitors were briefed on OE 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 OE using visual surveys and hand-held magnetometers. The OE Team Leader, USACE technical representative, and SpecPro project manager located proposed sample locations and monitoring wells within the AOC using pin flags or wooden stakes marked with the sample location identification number. The pin flag or stake was placed at a point approved by the OE technician.

An OE technician remained with the sampling crews as work progressed. At stations where subsurface soil samples were to be collected from 0.3 to 0.9 m (1 to 3 ft) BGS, a magnetometer was lowered into the borehole to screen for subsurface magnetic anomalies at the top of the subsurface interval. For monitoring well borings, OE technicians screened the locations by hand augering to a minimum depth of at least 0.6 m (2 ft) or original undisturbed native soil or bedrock encounter, whichever was greater. The OE technician remained on-site as drilling was performed to visually examine drill cuttings for any unusual materials indicative of potential OE.

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4.0 NATURE AND EXTENT OF CONTAMINATION

This chapter presents results of the Phase I/II RI data screening to identify contaminants indicative of AOC operations. 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 environmental media at FBQ and the nearby 40-mm Firing Range. Section 4.1 of this chapter 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. Sections 4.2 through 4.5 present the nature and extent of identified SRCs by environmental media (surface and subsurface soil, sediment, surface water, and groundwater). A summary of the results of the O&E avoidance activities is presented in Section 4.6. Section 4.7 provides a summary of the results of the contaminant nature and extent evaluation.

4.1 DATA EVALUATION METHODS

The evaluation of FBQ and 40-mm Firing Range Phase I/II RI analytical data for each environmental medium involved four general steps: (1) defining background concentrations, (2) defining data aggregates, (3) performing data reduction and screening, and (4) presenting data.

4.1.1 Site Background

Site background are discussed in Section 1.3 of this report. RVAAP facility-wide background criteria for each medium are listed in Table 1-1.

4.1.2 Definition of Aggregates

The FBQ and 40-mm Firing Range Phase I/II RI data were grouped (aggregated) by environmental media (soil, sediment, surface water, and groundwater) to facilitate evaluation of contaminant nature and extent and site risks. Data for the soil medium was 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 0.3 m (1 ft).

For each of the media aggregates, an evaluation was conducted to determine if further aggregation was warranted on the basis of site characteristics, historical operations, ecological habitat, and potential future land use (spatial aggregates). For surface and subsurface soil, the geographic area of the AOC was separated into two aggregates:

- FBQ (sample locations FBQ-1 through -60), and
- 40-mm Firing Range (sample locations FBQ-61 through -100).

For this Phase I/II RI, the surface water and sediment mediums were not subdivided into spatial aggregates. Six of the monitoring wells installed during the RI were screened within the sandstone bedrock (FBQ-170 through -175), and six were screened within the unconsolidated materials (FBQ-166 through -169, -176, and -177). Thus, the groundwater sampling results were separated into two aggregates: the Unconsolidated Materials and Bedrock.

4.1.3 Data Reduction and Screening

4.1.3.1 Data reduction

More than 268 environmental soil, sediment, surface water, groundwater, and field QC samples were collected with approximately 24,226 discrete laboratory analyses (i.e., analytes) being obtained, reviewed, and integrated into this RI. These totals do not include field measurements and field descriptions.

Analytical results were reported by the laboratory in electronic format and loaded into a database. As discussed in Section 3.5, verification of data was performed to ensure that all requested data were received and complete. A complete discussion of the results of the verification process is contained in the data quality assessment (Appendix J). Independent validation of 10% of the Phase I/II RI data and 100% of the USACE QA laboratory data was performed by a third-party subcontractor to the USACE Louisville District.

The data reduction process employed to identify SRCs involved first calculating data summary statistics. Site data were extracted from the database such that QC splits and field duplicates were excluded from the screening data sets. Rejected results were excluded from the screening process. All analytes having at least one detected value were included in the data reduction process. Summary statistics calculated for each data aggregate (Tables 4-2, 4-3, 4-6, 4-7, 4-10, 4-12, 4-14, and 4-15) included the minimum, maximum, and average (mean) values and the proportion of detected results to the total number of samples collected. Nondetected results meeting contract-required detection limits were set to one-half of the reported detection limit during calculation of the mean result for each compound. Nondetected results with elevated detection limits (more than 5 times the contract-required detection limit) were excluded from the summary statistics in order not to skew the calculation of mean values.

Following data reduction, the data were screened to identify SRCs using the processes outlined in the following sections.

4.1.3.2 Frequency of detection screen

For sample aggregates containing more than 20 samples, a frequency of detection criterion was applied to identify SRCs. Inorganic constituents, VOCs, SVOCs, pesticides, and PCBs with a frequency of detection greater than or equal to 5% (e.g., 1 in 20 samples) were identified as SRCs. If the frequency of detection for one of these classes of analytes was less than 5%, a weight of evidence (WOE) approach was used to determine if the chemical was a SRC. The WOE approach involved examining the magnitude and locations of the detected results. If no clustering within a particular area was noted and concentrations were not substantially elevated relative to the detection limits, the detected results were considered spurious, and the compound was eliminated as an SRC. If an aggregate had a sample population of less than 20 samples, all detected constituents were carried forward to the facility-wide background and essential human nutrient screening steps.

All detected explosives and propellants were considered to be SRCs regardless of the frequency of detection. However, appropriate qualification is made in the assessment of occurrence and distribution for explosives and propellants having a frequency of detection less than 5%.

4.1.3.3 Facility-wide background screen

For each inorganic constituent passing the frequency of detection screen, concentrations were compared against facility-wide background developed as part of the Phase II RI for the Winklepeck Burning Grounds (USACE 2001b). For inorganic constituents, if the maximum detected concentration of an analyte exceeded its respective background criterion, it was considered to be an SRC. In the event a constituent was not detected in the background data set, the background was set to zero, and any detected result for that constituent was considered above background. This conservative process ensured that detected constituents were not eliminated as SRCs simply because they were not detected in the background data set. All detected organic compounds were considered to be above background because these classes of compounds do not occur naturally.

4.1.3.4 Essential nutrients screen

Chemicals that are considered to be essential nutrients (calcium, chloride, iodine, iron, magnesium, potassium, phosphorus, and sodium) are an integral part of the food supply and are often added to foods as supplements. Thus, these constituents are not generally addressed as SRCs in the contaminant nature and extent evaluation (EPA 1989a, 1989b, 1996) unless they are grossly elevated relative to background.

4.1.4 Data Presentation

Data summary statistics and screening results for SRCs in each data aggregate are presented in Tables 4-2 through 4-17 presented at the end of this section. In the sections addressing the nature and extent of contamination for each medium, analytical results for selected SRCs are presented on maps to depict spatial distribution. Groupings depicted in these figures were selected based on a tally of SRCs at each sample location. This distribution of grouping resulted in a bell shaped curve and represented no, low, medium, and high number of SRCs within each aggregate. This approach was taken to show which sample locations had a greater number of SRCs and to show the lateral distribution of SRCs in the clearest manner. Analytical results for classes of SRCs (e.g., explosive compounds, inorganics, or VOCs) are presented in data summary tables for each medium and spatial aggregate whenever a sufficient number of detected values occurred to merit such tables. Where few detected values for a class of SRCs occurred, the values are addressed in the text of the section. Complete analytical results, including all nondetected results, are contained in Appendix H. Each table in Appendix H presents the results for each sample location for a specific medium aggregate (e.g., surface soil, subsurface soil, and sediment) and class of analytes.

4.2 GEOTECHNICAL RESULTS

Twenty-five soil samples for geotechnical analyses were collected from 12 stations (6 monitoring well boring locations and 6 test pit locations). Shelby tube samples were collected from depths ranging from 0 to 2.5 m (8.3 ft) at the test pit locations. Shelby tube samples were also collected from depths ranging from 0 to 2.4 m at the monitoring well locations. One Shelby tube was collected from the screened interval (1.83 to 2.4 m) at monitoring well boring FBQmw-166. Shelby tube samples were planned for each of the 12 monitoring well boring locations; however field conditions prevented the collection of the samples at six of the locations.

The soil samples were analyzed for moisture, Atterberg limits, USCS classification, bulk density, hydraulic conductivity, porosity, pH, specific gravity, and grain-size distribution analyses. Table 4-1 provides a summary of the geotechnical data for subsurface soil at the FBQ AOC.

Sieve analyses and USCS classification identified the samples as ranging from lean clay (CL) to silty clayey sand with gravel (SC-SM). Moisture content of the samples varied depending on the location, with results ranging from 9.7% [0 to 0.6 m (0 to 2 ft) BGS at FBQ-174] to 31.2% [0 to 0.6 m (0 to 2 ft) BGS at FBQ-176].

Hydraulic conductivity values ranged from 1.1×10^{-8} cm/sec [0 to 0.3 m (0 to 1 ft) BGS at FBQ-180] to 4.5×10^{-5} cm/sec [0 to 0.6 m (0 to 2 ft) BGS at FBQ-167].

Porosity values ranged from 0.24 for the silty sand with gravel at a depth of 1.8 to 2.4 m (6 to 8 ft) BGS at station FBQ-167 to 0.468 for the sandy lean clay present at the 0 to 0.6 m (0 to 2 ft) BGS depth at station FBQ-168.

Dry bulk density ranged from 89 lb/ft^3 [0 to 0.6 m (0 to 2 ft) BGS at FBQ-168] to 128 lb/ft^3 [1.8 to 2.4 m (6 to 8 ft) BGS at FBQ-167.

Table 4-1. Fuze and Booster Quarry Ponds Phase I and II RI Geotechnical Summary

Monitoring Well/ Test Pit ID No.	Depth (ft)	Moisture Content (%)	Specific Gravity	Density (pcf)		Porosity	Permeability (cm/sec)	pH	USCS Class	Description
				Wet	Dry					
FBQmw-166	0 to 2	14.9	2.731	123.9	107.8	0.368	3.62×10^{-7}	5.3	SC	Clayey sand with gravel
	2 to 4	15.5	2.759	134.5	116.4	0.324	1.96×10^{-8}	6.9	CL	Sandy lean clay
	6 to 8	17.8	2.748	130	110.4	0.357	5.67×10^{-8}	7.2	CL	Sandy lean clay
FBQmw-167	0 to 2	19	2.745	131.2	110.8	0.353	4.52×10^{-6}	6	CL	Sandy lean clay
	6 to 8	13	2.715	144.1	128	0.245	4.15×10^{-7}	6.3	SC-SM	Silty sand with gravel
FBQmw-168	0 to 2	17.6	2.68	104.8	89	0.468	2.51×10^{-6}	5.7	CL	Sandy lean clay
	2 to 4	14.1	2.713	129.6	113.6	0.329	1.03×10^{-6}	4.9	SC	Clayey sand
FBQmw-169	0 to 2	18	2.756	126.9	107.1	0.377	8.36×10^{-8}	5.9	CL	Lean clay with sand
FBQmw-172	0 to 2	11.5	2.722	131.3	117.7	0.307	2.58×10^{-6}	4.7	SC-SM	Silty clayey sand with gravel
FBQmw-173	0 to 2	13	2.606	129	113.7	0.301	2.52×10^{-6}	4	CL	Sandy lean clay
FBQmw-174	0 to 2	9.7	2.697	128.6	117.2	0.304	2.61×10^{-6}	4.8	SC-SM	Silty clayey sand with gravel
FBQmw-176	0 to 2	31.2	2.537	124.2	94.7	0.402	1.41×10^{-6}	4.6	ML	Silt with sand
FBQmw-177	0 to 2	17.2	2.741	Large rock in sample				7	CL	Lean clay with sand
FBQtr-178	0 to 1	17.7	2.742	131.3	111.6	0.348	2.39×10^{-8}	6.7	CL	Lean clay with sand
	3 to 5	12.8	2.743	135	119.7	0.301	3.51×10^{-8}	7.9	CL	Sandy lean clay
FBQtr-179	1.5 to 4	16.6	2.74	134.4	115.3	0.326	1.34×10^{-8}	7	CL	Lean clay with sand
	4 to 7	17.5	2.762	132.2	112.5	0.348	5.87×10^{-8}	7.5	CL	Lean clay
FBQtr-180	0 to 1	20.8	2.75	129.5	107.2	0.376	1.11×10^{-8}	6.3	CL	Lean clay
	5 to 8	12	2.724	116	103.6	0.391	6.11×10^{-7}	8	CL	Lean clay
FBQtr-181	1.5 to 4	21.6	2.685	127.9	105.2	0.372	2.05×10^{-7}	6.1	CL	Lean clay with sand
	4 to 6.5	12.3	2.688	134.7	119.9	0.285	1.03×10^{-6}	7.1	SC-SM	Silty clayey sand with gravel
FBQtr-182	1 to 3.75	21.4	2.726	127.4	104.9	0.383	2.96×10^{-8}	4.7	CL	Lean clay with sand
	3.75 to 4.5	13.5	2.671	123.8	109.1	0.346	9.14×10^{-7}	5	SC-SM	Silty clayey sand
FBQtr-183	0 to 1	19	2.69	132.3	111.1	0.338	2.83×10^{-7}	4.8	CL	Lean clay with sand
	spoils at 4	17.1	2.655	126.4	107.9	0.349	6.47×10^{-7}	4.6	CL	Sandy lean clay

RI = Remedial investigation.
USCS = Unified Soil Classification System.

1 **Table 4-2. Summary Statistics and Determination of SRCs in Surface Soil Samples at Fuze and Booster Quarry Landfill/Ponds**

Analyte	Units	Results >Detection Limit	Average Result	Minimum Detect	Maximum Detect	Background Criteria	Site Related?	Justification
Miscellaneous								
Chromium, hexavalent	mg/kg	7/ 8	3.72	1.3	6.8		Yes	No Background Data Available
Metals								
Aluminum	mg/kg	60/ 60	10,900	723	17,200	17,700	No	Below Background
Antimony	mg/kg	15/ 60	2.04	0.91	74.4	0.96	Yes	Above Background
Arsenic	mg/kg	60/ 60	11.2	1.1	27.1	15.4	Yes	Above Background
Barium	mg/kg	60/ 60	86.9	10.7	1,070	88.4	Yes	Above Background
Beryllium	mg/kg	60/ 60	0.709	0.21	1.5	0.88	Yes	Above Background
Cadmium	mg/kg	31/ 60	0.221	0.1	4	0	Yes	Above Background
Calcium	mg/kg	60/ 60	2,620	108	39,800	15,800	No	Essential Element
Chromium	mg/kg	60/ 60	17.7	2.7	88.9	17.4	Yes	Above Background
Cobalt	mg/kg	60/ 60	10.5	1.1	36.8	10.4	Yes	Above Background
Copper	mg/kg	60/ 60	26.1	2.1	559	17.7	Yes	Above Background
Iron	mg/kg	60/ 60	25,900	42,50	110,000	23,100	No	Essential Element
Lead	mg/kg	60/ 60	56.6	5.8	887	26.1	Yes	Above Background
Magnesium	mg/kg	60/ 60	2,390	143	9,850	3,030	No	Essential Element
Manganese	mg/kg	60/ 60	657	218	2,310	1,450	Yes	Above Background
Mercury	mg/kg	12/ 60	0.0625	0.054	1.2	0.036	Yes	Above Background
Nickel	mg/kg	60/ 60	18.3	2.9	85.4	21.1	Yes	Above Background
Potassium	mg/kg	60/ 60	1,070	122	2,660	927	No	Essential Element
Selenium	mg/kg	34/ 60	1.19	1.1	7.9	1.4	Yes	Above Background
Silver	mg/kg	1/ 60	0.0634	0.26	0.26	0	?	<= 5% Detects
Sodium	mg/kg	55/ 60	103	60.6	687	123	No	Essential Element
Vanadium	mg/kg	60/ 60	20.7	3	36	31.1	Yes	Above Background
Zinc	mg/kg	60/ 60	99.3	15.3	1,330	61.8	Yes	Above Background
Organics-Explosives								
1,3,5-Trinitrobenzene	mg/kg	6/ 60	0.09	0.062	1.7		Yes	No Background Data Available
2,4,6-Trinitrotoluene	mg/kg	11/ 60	1.85	0.027	99		Yes	No Background Data Available
2,4-Dinitrotoluene	mg/kg	4/ 60	0.0583	0.038	0.4		Yes	No Background Data Available
2,6-Dinitrotoluene	mg/kg	2/ 60	0.0712	0.07	1.3		Yes	No Background Data Available
2-Amino-4,6-dinitrotoluene	mg/kg	9/ 60	0.303	0.14	12		Yes	No Background Data Available
4-Amino-2,6-dinitrotoluene	mg/kg	9/ 60	0.255	0.11	9.7		Yes	No Background Data Available

Table 4-2. Summary Statistics and Determination of SRCs in Surface Soil Samples at Fuze and Booster Quarry Landfill/Ponds (continued)

Analyte	Units	Results >Detection Limit	Average Result	Minimum Detect	Maximum Detect	Background Criteria	Site Related?	Justification
Nitrobenzene	mg/kg	4/ 60	0.0501	0.04	0.083		Yes	No Background Data Available
Nitrocellulose	mg/kg	6/ 8	56.3	25	150		Yes	No Background Data Available
RDX	mg/kg	1/ 60	0.104	0.33	0.33		Yes	No Background Data Available
Organics-Pesticide/PCB								
4,4'-DDE	mg/kg	2/ 8	0.00085	0.00018	0.00037		Yes	No Background Data Available
Organics-Semivolatile								
Benz(*a*)anthracene	mg/kg	1/ 8	0.206	0.19	0.19		Yes	No Background Data Available
Benzo(*a*)pyrene	mg/kg	1/ 8	0.193	0.084	0.084		Yes	No Background Data Available
Benzo(*b*)fluoranthene	mg/kg	1/ 8	0.215	0.26	0.26		Yes	No Background Data Available
Benzo(*k*)fluoranthene	mg/kg	1/ 8	0.193	0.085	0.085		Yes	No Background Data Available
Chrysene	mg/kg	1/ 8	0.229	0.37	0.37		Yes	No Background Data Available
Di-n-butyl phthalate	mg/kg	1/ 5	0.217	0.24	0.24		Yes	No Background Data Available
Fluoranthene	mg/kg	2/ 8	0.271	0.05	0.87		Yes	No Background Data Available
Pyrene	mg/kg	1/ 8	0.263	0.64	0.64		Yes	No Background Data Available
Organics-Volatile								
Acetone	mg/kg	1/ 4	0.00496	0.0051	0.0051		Yes	No Background Data Available
Carbon Disulfide	mg/kg	1/ 8	0.0114	0.069	0.069		Yes	No Background Data Available
Methylene Chloride	mg/kg	1/ 4	0.00983	0.027	0.027		Yes	No Background Data Available
Trichloroethene	mg/kg	2/ 8	0.00335	0.0032	0.0049		Yes	No Background Data Available

PCB = Polychlorinated biphenyl.
SRC = Site-related contaminant.

Table 4-3. Summary Statistics and Determination of SRCs in Surface Soil Samples at the 40-mm Range

Analyte	Units	Results >Detection Limit	Average Result	Minimum Detect	Maximum Detect	Background Criteria	Site Related?	Justification
Metals								
Aluminum	mg/kg	40/ 40	11,100	3,470	21,000	17,700	Yes	Above Background
Arsenic	mg/kg	40/ 40	11.4	5.7	20.5	15.4	Yes	Above Background
Barium	mg/kg	40/ 40	65.8	21.9	144	88.4	Yes	Above Background
Beryllium	mg/kg	36/ 36	0.66	0.42	1	0.88	Yes	Above Background
Cadmium	mg/kg	20/ 40	0.129	0.057	0.87	0	Yes	Above Background
Calcium	mg/kg	40/ 40	1,150	153	9,250	15,800	No	Essential Element
Chromium	mg/kg	40/ 40	26.5	7.5	429	17.4	Yes	Above Background
Cobalt	mg/kg	40/ 40	8.83	4.4	13	10.4	Yes	Above Background
Copper	mg/kg	40/ 40	17.3	6	68.6	17.7	Yes	Above Background
Iron	mg/kg	40/ 40	23,400	15,200	34,700	23,100	No	Essential Element
Lead	mg/kg	40/ 40	16.9	11.6	49.5	26.1	Yes	Above Background
Magnesium	mg/kg	40/ 40	2,160	575	4,290	3,030	No	Essential Element
Manganese	mg/kg	40/ 40	546	204	1,300	1,450	No	Below Background
Nickel	mg/kg	40/ 40	16.5	9.2	28.2	21.1	Yes	Above Background
Potassium	mg/kg	40/ 40	1,080	578	2,010	927	No	Essential Element
Sodium	mg/kg	36/ 40	66	30.4	118	123	No	Essential Element
Thallium	mg/kg	6/ 40	0.611	2	2.6	0	Yes	Above Background
Vanadium	mg/kg	40/ 40	20.7	9.2	34.1	31.1	Yes	Above Background
Zinc	mg/kg	40/ 40	60.6	44.2	114	61.8	Yes	Above Background
Organics-Explosives								
2,4,6-Trinitrotoluene	mg/kg	1/ 40	0.0515	0.11	0.11		Yes	No Background Data Available
2,4-Dinitrotoluene	mg/kg	1/ 40	0.0512	0.096	0.096		Yes	No Background Data Available
3-Nitrotoluene	mg/kg	1/ 40	0.1	0.1	0.1		Yes	No Background Data Available
HMX	mg/kg	1/ 40	0.105	0.28	0.28		Yes	No Background Data Available
Nitrobenzene	mg/kg	4/ 40	0.0483	0.033	0.066		Yes	No Background Data Available
Nitrocellulose	mg/kg	4/ 4	43	20	64		Yes	No Background Data Available
Tetryl	mg/kg	1/ 30	0.102	0.17	0.17		Yes	No Background Data Available
Organics-Pesticide/PCB								
4,4'-DDE	mg/kg	1/ 4	0.000883	0.00033	0.00033		Yes	No Background Data Available
Aldrin	mg/kg	1/ 4	0.0011	0.0012	0.0012		Yes	No Background Data Available
Endrin aldehyde	mg/kg	1/ 4	0.00101	0.00085	0.00085		Yes	No Background Data Available
Endrin ketone	mg/kg	1/ 4	0.000885	0.00034	0.00034		Yes	No Background Data Available

Table 4-3. Summary Statistics and Determination of SRCs in Surface Soil Samples at the 40-mm Range (continued)

Analyte	Units	Results >Detection Limit	Average Result	Minimum Detect	Maximum Detect	Background Criteria	Site Related?	Justification
Heptachlor	mg/kg	1/ 4	0.000998	0.00079	0.00079		Yes	No Background Data Available
Lindane	mg/kg	1/ 4	0.00103	0.00093	0.00093		Yes	No Background Data Available
Organics-Semivolatile								
Bis(2-ethylhexyl)phthalate	mg/kg	1/ 4	0.196	0.15	0.15		Yes	No Background Data Available
Diethyl phthalate	mg/kg	1/ 4	1.56	5.6	5.6		Yes	No Background Data Available
Organics-Volatile								
1,1,1-Trichloroethane	mg/kg	1/ 4	0.00561	0.013	0.013		Yes	No Background Data Available
1,1-Dichloroethene	mg/kg	1/ 3	0.00463	0.0074	0.0074		Yes	No Background Data Available
Toluene	mg/kg	1/ 4	0.00286	0.002	0.002		Yes	No Background Data Available

PCB = Polychlorinated biphenyl.
SRC = Site-related contaminant.

Table 4-4. SRCs in Surface Soil at the Fuze and Booster Quarry Ponds/Landfill

Station Sample ID Customer ID Date Depth (ft) Field Type Analyte (mg/kg)	Units	Facility-wide Background	FBQso-001 FBQSS-001-0001-SO FBQss-001-0001-SO 10/14/2003 0.0 - 1.0 Regular samples	FBQso-002 FBQSS-002-0003-SO FBQss-002-0003-SO 10/14/2003 0.0 - 1.0 Regular samples	FBQso-003 FBQSS-003-0005-SO FBQss-003-0005-SO 10/20/2003 0.0 - 1.0 Regular samples	FBQso-004 FBQSS-004-0007-SO FBQss-004-0007-SO 10/20/2003 0.0 - 1.0 Regular samples
Explosives						
1,3,5-Trinitrobenzene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
2,4,6-Trinitrotoluene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
2,4-Dinitrotoluene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
2,6-Dinitrotoluene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
2-Amino-4,6-dinitrotoluene	mg/kg		0.1 U	0.1 U	NA	NA
4-Amino-2,6-dinitrotoluene	mg/kg		0.1 U	0.1 U	NA	NA
Nitrobenzene	mg/kg		0.1 U	0.1 U	0.1 U	0.04 J
Nitrocellulose	mg/kg		NA	NA	NA	NA
RDX	mg/kg		0.2 U	0.2 U	0.2 U	0.2 U
Inorganics						
Aluminum	mg/kg	17,700	11,700	16,400	15,200	14,600
Antimony	mg/kg	0.96	1.3 N#	1 BN#	0.29 U	0.33 U
Arsenic	mg/kg	15.4	17.6 #	13.9	14.1	13.3
Barium	mg/kg	88.4	80.9	123 #	81	77.1
Beryllium	mg/kg	0.88	0.64	1.1 #	0.86	0.84
Cadmium	mg/kg	0	0.017 U	0.02 U	0.019 U	0.021 U
Calcium	mg/kg	15,800	1,870	2,680	39,800 #	33,900 #
Chromium	mg/kg	17.4	16	20.3 #	22.3 *E#	21.3 *E#
Chromium, hexavalent	mg/kg		NA	NA	NA	NA
Cobalt	mg/kg	10.4	9.2	13.9 #	13.3 #	13.2 #
Copper	mg/kg	17.7	13.2	11.1	26.1 #	22.8 #
Iron	mg/kg	23,100	22,800	27,100 #	30,500 #	29,300 #
Lead	mg/kg	26.1	21.6	26.6 #	12.7	12.8
Magnesium	mg/kg	3,030	2,460 N	2,890 N	8,520 #	9,850 *#
Manganese	mg/kg	1450	720	2,310 #	426	397
Mercury	mg/kg	0.036	0.17 #	0.055 B#	0.017 U	0.017 U
Nickel	mg/kg	21.1	15.6	17.9	31 #	29 #
Potassium	mg/kg	927	998 N#	1,250 N#	2,650 #	2,640 #
Selenium	mg/kg	1.4	1.2	2.9 B#	1.3	1.3
Silver	mg/kg	0	0.058 U	0.44 B#	0.089 B#	0.074 U

Table 4-4. SRCs in Surface Soil at the Fuze and Booster Quarry Ponds/Landfill (continued)

Station Sample ID Customer ID Date Depth (ft) Field Type Analyte (mg/kg)	Units	Facility-wide Background	FBQso-001 FBQSS-001-0001-SO FBQss-001-0001-SO 10/14/2003 0.0 - 1.0 Regular samples	FBQso-002 FBQSS-002-0003-SO FBQss-002-0003-SO 10/14/2003 0.0 - 1.0 Regular samples	FBQso-003 FBQSS-003-0005-SO FBQss-003-0005-SO 10/20/2003 0.0 - 1.0 Regular samples	FBQso-004 FBQSS-004-0007-SO FBQss-004-0007-SO 10/20/2003 0.0 - 1.0 Regular samples
Sodium	mg/kg	123	84.4	113	160 #	178 #
Thallium	mg/kg	0	0.43 U	2.6 U	0.49 U	0.55 U
Vanadium	mg/kg	31.1	23.3 N	30.9 N	24.9	24.3
Zinc	mg/kg	61.8	69.7 #	64.4 #	64.2 #	64.6 #
Organic-Semivolatiles						
Benz(*a*)anthracene	mg/kg		NA	NA	NA	NA
Benzo(*a*)pyrene	mg/kg		NA	NA	NA	NA
Benzo(*b*)fluoranthene	mg/kg		NA	NA	NA	NA
Benzo(*k*)fluoranthene	mg/kg		NA	NA	NA	NA
Chrysene	mg/kg		NA	NA	NA	NA
Di-n-butyl phthalate	mg/kg		NA	NA	NA	NA
Fluoranthene	mg/kg		NA	NA	NA	NA
Pyrene	mg/kg		NA	NA	NA	NA
Organic-Volatiles						
Acetone	mg/kg		NA	NA	NA	NA
Carbon Disulfide	mg/kg		NA	NA	NA	NA
Methylene Chloride	mg/kg		NA	NA	NA	NA
Trichloroethene	mg/kg		NA	NA	NA	NA
Organics-Pesticide/PCB						
4,4'-DDE	mg/kg		NA	NA	NA	NA

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Table 4-4. SRCs in Surface Soil at the Fuze and Booster Quarry Ponds/Landfill (continued)

Station Sample ID Customer ID Date Depth (ft) Field Type Analyte (mg/kg)	Units	Facility-wide Background	FBQso-005 FBQSS-005-0009-SO FBQss-005-0009-SO 10/20/2003 0.0 - 1.0 Regular samples	FBQso-006 FBQSS-006-0011-SO FBQss-006-0011-SO 10/20/2003 0.0 - 1.0 Regular samples	FBQso-007 FBQSS-007-0013-SO FBQss-007-0013-SO 10/15/2003 0.0 - 1.0 Regular samples	FBQso-008 FBQSS-008-0015-SO FBQss-008-0015-SO 10/14/2003 0.0 - 1.0 Regular samples
Explosives						
1,3,5-Trinitrobenzene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
2,4,6-Trinitrotoluene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
2,4-Dinitrotoluene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
2,6-Dinitrotoluene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
2-Amino-4,6-dinitrotoluene	mg/kg		NA	NA	0.1 U	0.1 U
4-Amino-2,6-dinitrotoluene	mg/kg		NA	NA	0.1 U	0.1 U
Nitrobenzene	mg/kg		0.041 J	0.083 J	0.1 U	0.1 U
Nitrocellulose	mg/kg		NA	NA	NA	NA
RDX	mg/kg		0.2 U	0.2 U	0.2 U	0.2 U
Inorganics						
Aluminum	mg/kg	17,700	16,600	16,700	9,330	9,440
Antimony	mg/kg	0.96	0.48 B	0.42 B	0.66 B	0.29 BN
Arsenic	mg/kg	15.4	13.6	18.1 #	11.9	7.8
Barium	mg/kg	88.4	122 #	81	56	57.7
Beryllium	mg/kg	0.88	0.94 #	0.9 #	0.53	0.55
Cadmium	mg/kg	0	0.02 U	0.019 U	0.018 U	0.018 U
Calcium	mg/kg	15,800	13,200	4,280	1,240	853
Chromium	mg/kg	17.4	23.5 *E#	21.9 *E#	13.7	11.6
Chromium, hexavalent	mg/kg		NA	NA	NA	NA
Cobalt	mg/kg	10.4	14.3 #	11.3 #	7.6	7.3
Copper	mg/kg	17.7	23.9 #	24.5 #	13.8	5.9
Iron	mg/kg	23,100	31,400 #	32,500 #	19,400	15,000
Lead	mg/kg	26.1	16.3	17	19.2	12.8
Magnesium	mg/kg	3,030	6,430 #	3,910 #	1,790	1,410 N
Manganese	mg/kg	1,450	480	356	478	586
Mercury	mg/kg	0.036	0.018 B	0.029 B	0.071 #	0.037 B#
Nickel	mg/kg	21.1	32.9 #	27.4 #	15.1	9.8
Potassium	mg/kg	927	2,230 #	1,830 #	856	509 N
Selenium	mg/kg	1.4	1.5 #	1.9 #	1.1	1.1 B
Silver	mg/kg	0	0.072 U	0.067 U	0.063 U	0.071 B#

Table 4-4. SRCs in Surface Soil at the Fuze and Booster Quarry Ponds/Landfill (continued)

Station Sample ID Customer ID Date Depth (ft) Field Type Analyte (mg/kg)	Units	Facility-wide Background	FBQso-005 FBQSS-005-0009-SO FBQss-005-0009-SO 10/20/2003 0.0 - 1.0 Regular samples	FBQso-006 FBQSS-006-0011-SO FBQss-006-0011-SO 10/20/2003 0.0 - 1.0 Regular samples	FBQso-007 FBQSS-007-0013-SO FBQss-007-0013-SO 10/15/2003 0.0 - 1.0 Regular samples	FBQso-008 FBQSS-008-0015-SO FBQss-008-0015-SO 10/14/2003 0.0 - 1.0 Regular samples
Sodium	mg/kg	123	128 #	101	77.2	96.3
Thallium	mg/kg	0	0.53 U	0.5 U	0.47 U	0.46 U
Vanadium	mg/kg	31.1	26.8	28.3	17.6	19 N
Zinc	mg/kg	61.8	68.6 #	70.6 #	57.9	38.6
Organic-Semivolatiles						
Benz(*a*)anthracene	mg/kg		NA	NA	NA	NA
Benzo(*a*)pyrene	mg/kg		NA	NA	NA	NA
Benzo(*b*)fluoranthene	mg/kg		NA	NA	NA	NA
Benzo(*k*)fluoranthene	mg/kg		NA	NA	NA	NA
Chrysene	mg/kg		NA	NA	NA	NA
Di-n-butyl phthalate	mg/kg		NA	NA	NA	NA
Fluoranthene	mg/kg		NA	NA	NA	NA
Pyrene	mg/kg		NA	NA	NA	NA
Organic-Volatiles						
Acetone	mg/kg		NA	NA	NA	NA
Carbon Disulfide	mg/kg		NA	NA	NA	NA
Methylene Chloride	mg/kg		NA	NA	NA	NA
Trichloroethene	mg/kg		NA	NA	NA	NA
Organics-Pesticide/PCB						
4,4'-DDE	mg/kg		NA	NA	NA	NA

Table 4-4. SRCs in Surface Soil at the Fuze and Booster Quarry Ponds/Landfill (continued)

Station Sample ID Customer ID Date Depth (ft) Field Type Analyte (mg/kg)	Units	Facility-wide Background	FBQso-009 FBQSS-009-0017-SO FBQss-009-0017-SO 10/20/2003 0.0 - 1.0 Regular samples	FBQso-010 FBQSS-010-0019-SO FBQss-010-0019-SO 10/14/2003 0.0 - 1.0 Regular samples	FBQso-011 FBQSS-011-0021-SO FBQss-011-0021-SO 10/15/2003 0.0 - 1.0 Regular samples	FBQso-012 FBQSS-012-0023-SO FBQss-012-0023-SO 10/20/2003 0.0 - 1.0 Regular samples
Explosives						
1,3,5-Trinitrobenzene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
2,4,6-Trinitrotoluene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
2,4-Dinitrotoluene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
2,6-Dinitrotoluene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
2-Amino-4,6-dinitrotoluene	mg/kg		NA	0.1 U	0.1 U	NA
4-Amino-2,6-dinitrotoluene	mg/kg		NA	0.1 U	0.1 U	NA
Nitrobenzene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
Nitrocellulose	mg/kg		32	NA	NA	NA
RDX	mg/kg		0.2 U	0.2 U	0.2 U	0.2 U
Inorganics						
Aluminum	mg/kg	17,700	12,800	14,100	12,400	10,400
Antimony	mg/kg	0.96	0.43 B	0.31 BN	0.48 BN	0.3 UN
Arsenic	mg/kg	15.4	11	9.2	16.8 #	10.5 NE*
Barium	mg/kg	88.4	83.7	54.8	81.2	47.3 N
Beryllium	mg/kg	0.88	0.77	0.54	0.74	0.6
Cadmium	mg/kg	0	0.028 B#	0.019 U	0.019 U	0.02 U
Calcium	mg/kg	15,800	1,030	245	1,220	447 *
Chromium	mg/kg	17.4	17.2 *E	17.3	15.4	15 *E
Chromium, hexavalent	mg/kg		6.7 #	NA	NA	NA
Cobalt	mg/kg	10.4	10.4	7.2	10.7 #	9.8 *
Copper	mg/kg	17.7	10.9	8.7	14.4	14.3
Iron	mg/kg	23,100	21,600	23,300 #	22,200	22,100
Lead	mg/kg	26.1	17.4	15.2	24.1	17.5 E
Magnesium	mg/kg	3,030	2,160	2,200 N	2,220 N	1,980 N*
Manganese	mg/kg	1,450	357	218	625	668 *
Mercury	mg/kg	0.036	0.029 B	0.035 B	0.056 B#	0.028 B
Nickel	mg/kg	21.1	16.5	12.5	19	16.4
Potassium	mg/kg	927	1,150 #	857 N	1,020 N#	1,010 N#
Selenium	mg/kg	1.4	1.2	1.8 #	1.3	1.7 #
Silver	mg/kg	0	0.067 U	0.066 U	0.1 B#	0.069 U

Table 4-4. SRCs in Surface Soil at the Fuze and Booster Quarry Ponds/Landfill (continued)

Station Sample ID Customer ID Date Depth (ft) Field Type Analyte (mg/kg)	Units	Facility-wide Background	FBQso-009 FBQSS-009-0017-SO FBQss-009-0017-SO 10/20/2003 0.0 - 1.0 Regular samples	FBQso-010 FBQSS-010-0019-SO FBQss-010-0019-SO 10/14/2003 0.0 - 1.0 Regular samples	FBQso-011 FBQSS-011-0021-SO FBQss-011-0021-SO 10/15/2003 0.0 - 1.0 Regular samples	FBQso-012 FBQSS-012-0023-SO FBQss-012-0023-SO 10/20/2003 0.0 - 1.0 Regular samples
Sodium	mg/kg	123	101	70.1	92.7	73.9
Thallium	mg/kg	0	0.5 U	0.49 U	0.5 U	0.51 U
Vanadium	mg/kg	31.1	25.7	27.2 N	21.6	19.8 N
Zinc	mg/kg	61.8	53.9	47	64.8 #	59 E
Organic-Semivolatiles						
Benz(*a*)anthracene	mg/kg		0.43 U	NA	NA	NA
Benzo(*a*)pyrene	mg/kg		0.43 U	NA	NA	NA
Benzo(*b*)fluoranthene	mg/kg		0.43 U	NA	NA	NA
Benzo(*k*)fluoranthene	mg/kg		0.43 U	NA	NA	NA
Chrysene	mg/kg		0.43 U	NA	NA	NA
Di-n-butyl phthalate	mg/kg		0.43 U	NA	NA	NA
Fluoranthene	mg/kg		0.43 U	NA	NA	NA
Pyrene	mg/kg		0.43 U	NA	NA	NA
Organic-Volatiles						
Acetone	mg/kg		0.0092 JB	NA	NA	NA
Carbon Disulfide	mg/kg		0.0064 U	NA	NA	NA
Methylene Chloride	mg/kg		0.027	NA	NA	NA
Trichloroethene	mg/kg		0.0064 U	NA	NA	NA
Organics-Pesticide/PCB						
4,4'-DDE	mg/kg		0.00018 J	NA	NA	NA

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Table 4-4. SRCs in Surface Soil at the Fuze and Booster Quarry Ponds/Landfill (continued)

Station Sample ID Customer ID Date Depth (ft) Field Type Analyte (mg/kg)	Units	Facility-wide Background	FBQso-013 FBQSS-013-0025-SO FBQss-013-0025-SO 10/15/2003 0.0 - 1.0 Regular samples	FBQso-014 FBQSS-014-0027-SO FBQss-014-0027-SO 10/14/2003 0.0 - 1.0 Regular samples	FBQso-015 FBQSS-015-0029-SO FBQss-015-0029-SO 10/15/2003 0.0 - 1.0 Regular samples	FBQss-016 FBQSS-016-0031-SO FBQss-016-0031-SO 10/13/2003 0.0 - 1.0 Regular samples
Explosives						
1,3,5-Trinitrobenzene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
2,4,6-Trinitrotoluene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
2,4-Dinitrotoluene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
2,6-Dinitrotoluene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
2-Amino-4,6-dinitrotoluene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
4-Amino-2,6-dinitrotoluene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
Nitrobenzene	mg/kg		0.043 J	0.1 U	0.1 U	0.1 U
Nitrocellulose	mg/kg		NA	NA	NA	NA
RDX	mg/kg		0.2 U	0.2 U	0.2 U	0.2 U
Inorganics						
Aluminum	mg/kg	17,700	15,500	12,700	7,430	8,500
Antimony	mg/kg	0.96	0.45 BN	0.64 B	0.75 BN	0.91 N
Arsenic	mg/kg	15.4	12.2	9	13.5	13.4
Barium	mg/kg	88.4	70.7	60.4	35.2	46.2
Beryllium	mg/kg	0.88	0.69	0.6	0.46	0.56
Cadmium	mg/kg	0	0.018 U	0.019 U	0.018 U	0.12 #
Calcium	mg/kg	15,800	972	257	372	986
Chromium	mg/kg	17.4	20.7 #	15.8	11.2	13.7 E
Chromium, hexavalent	mg/kg		NA	NA	NA	NA
Cobalt	mg/kg	10.4	11 #	11.3 #	7.1	8.7
Copper	mg/kg	17.7	14.9	8.9	16.1	16.4
Iron	mg/kg	23,100	26,500 #	21,000	19,900	22,000
Lead	mg/kg	26.1	18.8	20.4	16.2	15.6
Magnesium	mg/kg	3,030	3,070 N#	2,000	1,440 N	2,020 N
Manganese	mg/kg	1,450	527	667	373	413
Mercury	mg/kg	0.036	0.032 B	0.033 B	0.038 B#	0.046 B#
Nickel	mg/kg	21.1	21.1	12.1	14.3	17.8 E
Potassium	mg/kg	927	1,410 N#	869	736 N	912 N
Selenium	mg/kg	1.4	1.4 #	1.4 #	1 B	0.26 U
Silver	mg/kg	0	0.062 U	0.13 B#	0.064 U	0.14 B#

Table 4-4. SRCs in Surface Soil at the Fuze and Booster Quarry Ponds/Landfill (continued)

Station Sample ID Customer ID Date Depth (ft) Field Type Analyte (mg/kg)	Units	Facility-wide Background	FBQso-013 FBQSS-013-0025-SO FBQss-013-0025-SO 10/15/2003 0.0 - 1.0 Regular samples	FBQso-014 FBQSS-014-0027-SO FBQss-014-0027-SO 10/14/2003 0.0 - 1.0 Regular samples	FBQso-015 FBQSS-015-0029-SO FBQss-015-0029-SO 10/15/2003 0.0 - 1.0 Regular samples	FBQss-016 FBQSS-016-0031-SO FBQss-016-0031-SO 10/13/2003 0.0 - 1.0 Regular samples
Sodium	mg/kg	123	103	86.4	79.6	129 #
Thallium	mg/kg	0	0.46 U	0.51 U	0.48 U	0.41 U
Vanadium	mg/kg	31.1	26.8 N	24.3	14	15.4 N
Zinc	mg/kg	61.8	59.1	46.6	56.7	60.9
Organic-Semivolatiles						
Benz(*a*)anthracene	mg/kg		NA	NA	NA	NA
Benzo(*a*)pyrene	mg/kg		NA	NA	NA	NA
Benzo(*b*)fluoranthene	mg/kg		NA	NA	NA	NA
Benzo(*k*)fluoranthene	mg/kg		NA	NA	NA	NA
Chrysene	mg/kg		NA	NA	NA	NA
Di-n-butyl phthalate	mg/kg		NA	NA	NA	NA
Fluoranthene	mg/kg		NA	NA	NA	NA
Pyrene	mg/kg		NA	NA	NA	NA
Organic-Volatiles						
Acetone	mg/kg		NA	NA	NA	NA
Carbon Disulfide	mg/kg		NA	NA	NA	NA
Methylene Chloride	mg/kg		NA	NA	NA	NA
Trichloroethene	mg/kg		NA	NA	NA	NA
Organics-Pesticide/PCB						
4,4'-DDE	mg/kg		NA	NA	NA	NA

Table 4-4. SRCs in Surface Soil at the Fuze and Booster Quarry Ponds/Landfill (continued)

Station Sample ID Customer ID Date Depth (ft) Field Type Analyte (mg/kg)	Units	Facility-wide Background	FBQso-017 FBQSS-017-0033-SO FBQss-017-0033-SO 10/03/2003 0.0 - 1.0 Regular samples	FBQss-018 FBQSS-018-0035-SO FBQss-018-0035-SO 10/20/2003 0.0 - 1.0 Regular samples	FBQso-019 FBQSS-019-0037-SO FBQss-019-0037-SO 10/13/2003 0.0 - 1.0 Regular samples	FBQso-020 FBQSS-020-0039-SO FBQss-020-0039-SO 10/09/2003 0.0 - 1.0 Regular samples
Explosives						
1,3,5-Trinitrobenzene	mg/kg		0.1 U/U	0.1 U	0.1 U	0.1 U
2,4,6-Trinitrotoluene	mg/kg		0.1 U/U	0.1 U	0.1 U	0.1 U
2,4-Dinitrotoluene	mg/kg		0.1 U/U	0.1 U	0.1 U	0.1 U
2,6-Dinitrotoluene	mg/kg		0.1 U/U	0.1 U	0.1 U	0.1 U
2-Amino-4,6-dinitrotoluene	mg/kg		0.1 U/U	NA	0.1 U	0.1 U
4-Amino-2,6-dinitrotoluene	mg/kg		0.1 U/U	NA	0.1 U	0.1 U
Nitrobenzene	mg/kg		0.1 U/U	0.1 U	0.1 U	0.1 U
Nitrocellulose	mg/kg		86 /=	20 U	110	NA
RDX	mg/kg		0.2 U/U	0.2 U	0.2 U	0.2 U
Inorganics						
Aluminum	mg/kg	17,700	13,300 /=	12,600	12,700	12,900
Antimony	mg/kg	0.96	0.29 UN/UJ	0.4 B	0.36 BN	0.31 UN
Arsenic	mg/kg	15.4	9.7 /J	10.7 *	17.8 #	10.2
Barium	mg/kg	88.4	81.7 N/J	87.9	57.6	48 N
Beryllium	mg/kg	0.88	0.79 /=	0.62	0.61	0.6
Cadmium	mg/kg	0	0.018 U/U	0.02 U	0.14 #	0.14 #
Calcium	mg/kg	15,800	296 /=	511 *	496	189
Chromium	mg/kg	17.4	15.3 /J	15.9 *E	16.1 E	16.2
Chromium, hexavalent	mg/kg		1.3 /=#	6.8 #	3.7 #	NA
Cobalt	mg/kg	10.4	11.7 /=#	11.5 *#	12.9 #	7.7
Copper	mg/kg	17.7	11.6 /J	13.1	10.6	9.9
Iron	mg/kg	23,100	21,800 /J	18,600	23,300 #	21,300
Lead	mg/kg	26.1	18.7 /=	18.8	25.1	23.3
Magnesium	mg/kg	3,030	2,130 /J	1,970	2,110 N	1,860 N
Manganese	mg/kg	1,450	999 /=	845 *	697	523
Mercury	mg/kg	0.036	0.043 B/UJ	0.037 B#	0.043 B#	0.03 B
Nickel	mg/kg	21.1	15.3 /J	17.4	14.2 E	12.5
Potassium	mg/kg	927	819 N/J	840	807 N	779 N
Selenium	mg/kg	1.4	1.8 B/UJ	1.3	0.64 B	0.58 B
Silver	mg/kg	0	0.13 U/U	0.071 U	0.11 B#	0.069 U

Table 4-4. SRCs in Surface Soil at the Fuze and Booster Quarry Ponds/Landfill (continued)

Station Sample ID Customer ID Date Depth (ft) Field Type Analyte (mg/kg)	Units	Facility-wide Background	FBQso-017 FBQSS-017-0033-SO FBQss-017-0033-SO 10/03/2003 0.0 - 1.0 Regular samples	FBQss-018 FBQSS-018-0035-SO FBQss-018-0035-SO 10/20/2003 0.0 - 1.0 Regular samples	FBQso-019 FBQSS-019-0037-SO FBQss-019-0037-SO 10/13/2003 0.0 - 1.0 Regular samples	FBQso-020 FBQSS-020-0039-SO FBQss-020-0039-SO 10/09/2003 0.0 - 1.0 Regular samples
Sodium	mg/kg	123	112 /=	79.3	91.8	96.5 E
Thallium	mg/kg	0	0.96 UN/UJ	0.53 U	0.46 U	0.51 U
Vanadium	mg/kg	31.1	24 N/J	23.2	25.8 N	25.8 N
Zinc	mg/kg	61.8	62 /=#	62.2 #	49.7	47.4
Organic-Semivolatiles						
Benz(*a*)anthracene	mg/kg		0.43 U/U	0.41 U	0.42 U	NA
Benzo(*a*)pyrene	mg/kg		0.43 U/U	0.41 U	0.42 U	NA
Benzo(*b*)fluoranthene	mg/kg		0.43 U/U	0.41 U	0.42 U	NA
Benzo(*k*)fluoranthene	mg/kg		0.43 U/U	0.41 U	0.42 U	NA
Chrysene	mg/kg		0.43 U/U	0.41 U	0.42 U	NA
Di-n-butyl phthalate	mg/kg		0.43 U/R	0.41 U	0.42 U	NA
Fluoranthene	mg/kg		0.05 J/J	0.41 U	0.42 U	NA
Pyrene	mg/kg		0.43 U/U	0.41 U	0.42 U	NA
Organic-Volatiles						
Acetone	mg/kg		0.011 JB/R	0.0051 J	0.0093 JB/R	NA
Carbon Disulfide	mg/kg		0.0064 U/UJ	0.0062 U	0.0062 U/UJ	NA
Methylene Chloride	mg/kg		0.019 B/R	0.01 JB	0.0082 JB/R	NA
Trichloroethene	mg/kg		0.0064 U/UJ	0.0062 U	0.0062 U/UJ	NA
Organics-Pesticide/PCB						
4,4'-DDE	mg/kg		0.0021 U/U	0.0021 U	0.0021 U	NA

Table 4-4. SRCs in Surface Soil at the Fuze and Booster Quarry Ponds/Landfill (continued)

Station Sample ID Customer ID Date Depth (ft) Field Type Analyte (mg/kg)	Units	Facility-wide Background	FBQso-020 FBQSS-020-0371-SO FBQss-020-0371-SO 10/09/2003 0.0 - 1.0 Field Duplicate	FBQso-021 FBQSS-021-0041-SO FBQss-021-0041-SO 10/09/2003 0.0 - 1.0 Regular samples	FBQso-021 FBQSS-021-0373-SO FBQss-021-0373-SO 10/09/2003 0.0 - 1.0 Field Duplicate	FBQso-022 FBQSS-022-0043-SO FBQss-022-0043-SO 10/09/2003 0.0 - 1.0 Regular samples
Explosives						
1,3,5-Trinitrobenzene	mg/kg		0.1 U	0.1 U/U	0.1 U/U	0.1 U/U
2,4,6-Trinitrotoluene	mg/kg		0.1 U	0.1 U/U	0.1 U/U	0.1 U/U
2,4-Dinitrotoluene	mg/kg		0.1 U	0.1 U/U	0.1 U/U	0.1 U/U
2,6-Dinitrotoluene	mg/kg		0.1 U	0.1 U/U	0.1 U/U	0.1 U/U
2-Amino-4,6-dinitrotoluene	mg/kg		0.1 U	0.1 U/U	0.1 U/U	0.1 U/U
4-Amino-2,6-dinitrotoluene	mg/kg		0.1 U	0.1 U/U	0.1 U/U	0.1 U/U
Nitrobenzene	mg/kg		0.1 U	0.1 U/U	0.1 U/U	0.1 U/U
Nitrocellulose	mg/kg		NA	NA	NA	NA
RDX	mg/kg		0.2 U	0.2 U/U	0.2 U/U	0.2 U/U
Inorganics						
Aluminum	mg/kg	17,700	13,000	15,400 /=	16,900 /=	13,200 /=
Antimony	mg/kg	0.96	0.33 BN	0.39 BN/UJ	0.54 BN/UJ	0.31 UN/UJ
Arsenic	mg/kg	15.4	9.5	11.1 /J	11.2 /J	10.8 /J
Barium	mg/kg	88.4	49 N	71.2 N/J	74.5 N/J	46.4 N/J
Beryllium	mg/kg	0.88	0.58	0.68 /=	0.68 /=	0.59 /=
Cadmium	mg/kg	0	0.12 #	0.02 U/U	0.02 U/U	0.02 U/U
Calcium	mg/kg	15,800	187	414 /=	513 /=	205 /=
Chromium	mg/kg	17.4	15.4	20.1 /J#	21.4 /J#	17.1 /J
Chromium, hexavalent	mg/kg		NA	NA	NA	NA
Cobalt	mg/kg	10.4	8.3	11.4 /=#	9.3 /=	9.2 /=
Copper	mg/kg	17.7	9.5	13.8 /J	15.3 /J	9 /J
Iron	mg/kg	23,100	20,200	26,400 /J#	27,200 /J#	23,200 /J#
Lead	mg/kg	26.1	24.7	22.3 /=	17.4 /=	21.4 /=
Magnesium	mg/kg	3,030	1,840 N	2,790 /J	3,190 /J#	1,990 /J
Manganese	mg/kg	1,450	608	773 /=	533 /=	621 /=
Mercury	mg/kg	0.036	0.03 B	0.041 B/UJ	0.045 B/UJ	0.021 B/UJ
Nickel	mg/kg	21.1	10.9	17.6 /J	19.6 /J	11.7 /J
Potassium	mg/kg	927	780 N	1,290 N/J#	1,470 N/J#	829 N/J
Selenium	mg/kg	1.4	0.66 B	2.2 /J#	2.1 /J#	2.2 /J#
Silver	mg/kg	0	0.089 B#	0.26 /=#	0.07 U/U	0.069 U/U

Table 4-4. SRCs in Surface Soil at the Fuze and Booster Quarry Ponds/Landfill (continued)

Station Sample ID Customer ID Date Depth (ft) Field Type Analyte (mg/kg)	Units	Facility-wide Background	FBQso-020 FBQSS-020-0371-SO FBQss-020-0371-SO 10/09/2003 0.0 - 1.0 Field Duplicate	FBQso-021 FBQSS-021-0041-SO FBQss-021-0041-SO 10/09/2003 0.0 - 1.0 Regular samples	FBQso-021 FBQSS-021-0373-SO FBQss-021-0373-SO 10/09/2003 0.0 - 1.0 Field Duplicate	FBQso-022 FBQSS-022-0043-SO FBQss-022-0043-SO 10/09/2003 0.0 - 1.0 Regular samples
Sodium	mg/kg	123	91.5 E	131 /=#	132 /=#	118 /=
Thallium	mg/kg	0	0.51 U	0.53 UN/UJ	0.52 UN/UJ	0.52 UN/UJ
Vanadium	mg/kg	31.1	25.3 N	28.3 N/J	28.8 N/J	27.5 N/J
Zinc	mg/kg	61.8	47.2	59.8 /=	60.1 /=	52 /=
Organic-Semivolatiles						
Benz(*a*)anthracene	mg/kg		NA	NA	NA	NA
Benzo(*a*)pyrene	mg/kg		NA	NA	NA	NA
Benzo(*b*)fluoranthene	mg/kg		NA	NA	NA	NA
Benzo(*k*)fluoranthene	mg/kg		NA	NA	NA	NA
Chrysene	mg/kg		NA	NA	NA	NA
Di-n-butyl phthalate	mg/kg		NA	NA	NA	NA
Fluoranthene	mg/kg		NA	NA	NA	NA
Pyrene	mg/kg		NA	NA	NA	NA
Organic-Volatiles						
Acetone	mg/kg		NA	NA	NA	NA
Carbon Disulfide	mg/kg		NA	NA	NA	NA
Methylene Chloride	mg/kg		NA	NA	NA	NA
Trichloroethene	mg/kg		NA	NA	NA	NA
Organics-Pesticide/PCB						
4,4'-DDE	mg/kg		NA	NA	NA	NA

Table 4-4. SRCs in Surface Soil at the Fuze and Booster Quarry Ponds/Landfill (continued)

Station Sample ID Customer ID Date Depth (ft) Field Type Analyte (mg/kg)	Units	Facility-wide Background	FBQso-023 FBQSS-023-0045-SO FBQss-023-0045-SO 10/10/2003 0.0 - 1.0 Regular samples	FBQso-023 FBQSS-023-0376-SO FBQss-023-0376-SO 10/10/2003 0.0 - 1.0 Field Duplicate	FBQss-024 FBQSS-024-0047-SO FBQss-024-0047-SO 10/10/2003 0.0 - 1.0 Regular samples	FBQss-024 FBQSS-024-0375-SO FBQss-024-0375-SO 10/10/2003 0.0 - 1.0 Field Duplicate
Explosives						
1,3,5-Trinitrobenzene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
2,4,6-Trinitrotoluene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
2,4-Dinitrotoluene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
2,6-Dinitrotoluene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
2-Amino-4,6-dinitrotoluene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
4-Amino-2,6-dinitrotoluene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
Nitrobenzene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
Nitrocellulose	mg/kg		NA	NA	NA	NA
RDX	mg/kg		0.2 U	0.2 U	0.2 U	0.2 U
Inorganics						
Aluminum	mg/kg	17,700	17,200	13,500	9,750	8,670
Antimony	mg/kg	0.96	0.33 BN	0.39 BN	0.25 UN	0.24 UN
Arsenic	mg/kg	15.4	11.7	10.8	15.1	11.7
Barium	mg/kg	88.4	64.8	58	44	37.2
Beryllium	mg/kg	0.88	0.75	0.6	0.53	0.48
Cadmium	mg/kg	0	0.11 #	0.087 #	0.1 #	0.035 B#
Calcium	mg/kg	15,800	536	554	207	184
Chromium	mg/kg	17.4	21.8 E#	18.3 E#	14.1 E	13.2 E
Chromium, hexavalent	mg/kg		NA	NA	NA	NA
Cobalt	mg/kg	10.4	9.2	10.2	7.6	7
Copper	mg/kg	17.7	18.6 #	13.9	16.5	14.6
Iron	mg/kg	23,100	30,600 #	24,400 #	24,300 #	22,800
Lead	mg/kg	26.1	13.9	16.1	12	11.2
Magnesium	mg/kg	3,030	3,600 N#	2,770 N	1,820 N	1,640 N
Manganese	mg/kg	1,450	267	374	241	218
Mercury	mg/kg	0.036	0.028 B	0.029 B	0.016 U	0.016 U
Nickel	mg/kg	21.1	23.3 E#	18.8 E	15.1 E	14.1 E
Potassium	mg/kg	927	1,420 N#	1,060 N#	912 N	782 N
Selenium	mg/kg	1.4	0.45 B	0.7 B	0.44 B	0.42 B
Silver	mg/kg	0	0.096 B#	0.062 U	0.056 U	0.062 B#

Table 4-4. SRCs in Surface Soil at the Fuze and Booster Quarry Ponds/Landfill (continued)

Station Sample ID Customer ID Date Depth (ft) Field Type Analyte (mg/kg)	Units	Facility-wide Background	FBQso-023 FBQSS-023-0045-SO FBQss-023-0045-SO 10/10/2003 0.0 - 1.0 Regular samples	FBQso-023 FBQSS-023-0376-SO FBQss-023-0376-SO 10/10/2003 0.0 - 1.0 Field Duplicate	FBQss-024 FBQSS-024-0047-SO FBQss-024-0047-SO 10/10/2003 0.0 - 1.0 Regular samples	FBQss-024 FBQSS-024-0375-SO FBQss-024-0375-SO 10/10/2003 0.0 - 1.0 Field Duplicate
Sodium	mg/kg	123	105	92	86.2	82.8
Thallium	mg/kg	0	0.44 U	0.46 U	0.42 U	0.41 U
Vanadium	mg/kg	31.1	27.9 N	23.3 N	16.5 N	15.1 N
Zinc	mg/kg	61.8	56.7	53.9	55.2	53.1
Organic-Semivolatiles						
Benz(*a*)anthracene	mg/kg		NA	NA	NA	NA
Benzo(*a*)pyrene	mg/kg		NA	NA	NA	NA
Benzo(*b*)fluoranthene	mg/kg		NA	NA	NA	NA
Benzo(*k*)fluoranthene	mg/kg		NA	NA	NA	NA
Chrysene	mg/kg		NA	NA	NA	NA
Di-n-butyl phthalate	mg/kg		NA	NA	NA	NA
Fluoranthene	mg/kg		NA	NA	NA	NA
Pyrene	mg/kg		NA	NA	NA	NA
Organic-Volatiles						
Acetone	mg/kg		NA	NA	NA	NA
Carbon Disulfide	mg/kg		NA	NA	NA	NA
Methylene Chloride	mg/kg		NA	NA	NA	NA
Trichloroethene	mg/kg		NA	NA	NA	NA
Organics-Pesticide/PCB						
4,4'-DDE	mg/kg		NA	NA	NA	NA

Table 4-4. SRCs in Surface Soil at the Fuze and Booster Quarry Ponds/Landfill (continued)

Station Sample ID Customer ID Date Depth (ft) Field Type Analyte (mg/kg)	Units	Facility-wide Background	FBQss-025 FBQSS-025-0049-SO FBQss-025-0049-SO 10/09/2003 0.0 - 1.0 Regular samples	FBQso-026 FBQSS-026-0051-SO FBQss-026-0051-SO 10/09/2003 0.0 - 1.0 Regular samples	FBQss-027 FBQSS-027-0053-SO FBQss-027-0053-SO 10/10/2003 0.0 - 1.0 Regular samples	FBQso-028 FBQSS-028-0055-SO FBQss-028-0055-SO 10/07/2003 0.0 - 1.0 Regular samples
Explosives						
1,3,5-Trinitrobenzene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
2,4,6-Trinitrotoluene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
2,4-Dinitrotoluene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
2,6-Dinitrotoluene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
2-Amino-4,6-dinitrotoluene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
4-Amino-2,6-dinitrotoluene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
Nitrobenzene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
Nitrocellulose	mg/kg		NA	NA	NA	NA
RDX	mg/kg		0.2 U	0.2 U	0.2 U	0.2 U
Inorganics						
Aluminum	mg/kg	17,700	6,720	16,100	7,910	17,000
Antimony	mg/kg	0.96	0.27 UN	0.3 UN	0.3 BN	0.47 BN
Arsenic	mg/kg	15.4	9.1	10.7	15	10.6 N
Barium	mg/kg	88.4	42.1 N	64.9 N	45.2	89 #
Beryllium	mg/kg	0.88	0.7	0.6	0.61	0.8
Cadmium	mg/kg	0	0.24 #	0.12 #	0.12 #	0.11 #
Calcium	mg/kg	15,800	135	287	527	438
Chromium	mg/kg	17.4	12.7	19.8 #	12.9 E	21.5 #
Chromium, hexavalent	mg/kg		NA	NA	NA	NA
Cobalt	mg/kg	10.4	12.1 #	11.7 #	7.8	10.5 #
Copper	mg/kg	17.7	13.6	10.8	21.7 #	12.9 E
Iron	mg/kg	23,100	31,900 #	23,600 #	24,300 #	24,300 #
Lead	mg/kg	26.1	21.4	17.8	15.9	21.1
Magnesium	mg/kg	3,030	1,120 N	2,510 N	1,800 N	3,080 N#
Manganese	mg/kg	1,450	817	690	227	762
Mercury	mg/kg	0.036	0.028 B	0.03 B	0.027 B	0.032 B
Nickel	mg/kg	21.1	16.7	15.2	17.5 E	21.1
Potassium	mg/kg	927	934 N#	1,150 N#	755 N	1,380 N#
Selenium	mg/kg	1.4	0.72 B	0.5 B	0.26 U	1.1 B
Silver	mg/kg	0	0.15 B#	0.083 B#	0.056 U	0.073 U

Table 4-4. SRCs in Surface Soil at the Fuze and Booster Quarry Ponds/Landfill (continued)

Station Sample ID Customer ID Date Depth (ft) Field Type Analyte (mg/kg)	Units	Facility-wide Background	FBQss-025 FBQSS-025-0049-SO FBQss-025-0049-SO 10/09/2003 0.0 - 1.0 Regular samples	FBQso-026 FBQSS-026-0051-SO FBQss-026-0051-SO 10/09/2003 0.0 - 1.0 Regular samples	FBQss-027 FBQSS-027-0053-SO FBQss-027-0053-SO 10/10/2003 0.0 - 1.0 Regular samples	FBQso-028 FBQSS-028-0055-SO FBQss-028-0055-SO 10/07/2003 0.0 - 1.0 Regular samples
Sodium	mg/kg	123	84.7 E	89.7 E	88.7	113
Thallium	mg/kg	0	0.45 U	0.5 U	0.42 U	0.54 U
Vanadium	mg/kg	31.1	15.3 N	31 N	14.2 N	29.2
Zinc	mg/kg	61.8	92.3 #	56.5	78 #	63.9 #
Organic-Semivolatiles						
Benz(*a*)anthracene	mg/kg		NA	NA	NA	NA
Benzo(*a*)pyrene	mg/kg		NA	NA	NA	NA
Benzo(*b*)fluoranthene	mg/kg		NA	NA	NA	NA
Benzo(*k*)fluoranthene	mg/kg		NA	NA	NA	NA
Chrysene	mg/kg		NA	NA	NA	NA
Di-n-butyl phthalate	mg/kg		NA	NA	NA	NA
Fluoranthene	mg/kg		NA	NA	NA	NA
Pyrene	mg/kg		NA	NA	NA	NA
Organic-Volatiles						
Acetone	mg/kg		NA	NA	NA	NA
Carbon Disulfide	mg/kg		NA	NA	NA	NA
Methylene Chloride	mg/kg		NA	NA	NA	NA
Trichloroethene	mg/kg		NA	NA	NA	NA
Organics-Pesticide/PCB						
4,4'-DDE	mg/kg		NA	NA	NA	NA

1 **Table 4-4. SRCs in Surface Soil at the Fuze and Booster Quarry Ponds/Landfill (continued)**

Station Sample ID Customer ID Date Depth (ft) Field Type Analyte (mg/kg)	Units	Facility-wide Background	FBQso-029 FBQSS-029-0057-SO FBQss-029-0057-SO 10/08/2003 0.0 - 1.0 Regular samples	FBQso-030 FBQSS-030-0059-SO FBQss-030-0059-SO 10/08/2003 0.0 - 1.0 Regular samples	FBQso-030 FBQSS-030-0368-SO FBQss-030-0368-SO 10/08/2003 0.0 - 1.0 Field Duplicate	FBQss-031 FBQSS-031-0061-SO FBQss-031-0061-SO 10/09/2003 0.0 - 1.0 Regular samples
Explosives						
1,3,5-Trinitrobenzene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
2,4,6-Trinitrotoluene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
2,4-Dinitrotoluene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
2,6-Dinitrotoluene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
2-Amino-4,6-dinitrotoluene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
4-Amino-2,6-dinitrotoluene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
Nitrobenzene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
Nitrocellulose	mg/kg		19 U	NA	NA	NA
RDX	mg/kg		0.2 U	0.2 U	0.2 U	0.2 U
Inorganics						
Aluminum	mg/kg	17,700	3,190	6,620	7,090	7,480
Antimony	mg/kg	0.96	0.41 BN	0.76 BN	0.44 BN	0.29 UN
Arsenic	mg/kg	15.4	2.1 N	8.7 N	7.6 N	5.9
Barium	mg/kg	88.4	24.5	39.7	38.9	33.7 N
Beryllium	mg/kg	0.88	0.21	0.71	0.81	0.89 #
Cadmium	mg/kg	0	0.041 B#	0.12 #	0.098 #	0.22 #
Calcium	mg/kg	15,800	108	456	375	342
Chromium	mg/kg	17.4	3.8	12.8	13.8	14.8
Chromium, hexavalent	mg/kg		3.3 #	NA	NA	NA
Cobalt	mg/kg	10.4	2.8	10.8 #	10.9 #	12.6 #
Copper	mg/kg	17.7	2.1 E	16.8 E	18.4 E#	19.8 #
Iron	mg/kg	23,100	4,250	25,000 #	28,700 #	30,400 #
Lead	mg/kg	26.1	5.8	23.2	21.3	21.1
Magnesium	mg/kg	3,030	536 N	1,710 N	1,830 N	1,940 N
Manganese	mg/kg	1,450	327	654	725	603
Mercury	mg/kg	0.036	0.05 B#	0.057 B#	0.031 B	0.02 B
Nickel	mg/kg	21.1	4.5	17.2	17.6	17.6
Potassium	mg/kg	927	225 N	1,070 N#	1,100 N#	1,240 N#
Selenium	mg/kg	1.4	0.29 U	0.87 B	1.2	0.72 B
Silver	mg/kg	0	0.079 B#	0.066 U	0.067 U	0.065 U

Table 4-4. SRCs in Surface Soil at the Fuze and Booster Quarry Ponds/Landfill (continued)

Station **Sample ID** **Customer ID** **Date** **Depth (ft)** **Field Type** **Analyte (mg/kg)**	**Units**	**Facility-wide Background**	**FBQso-029** **FBQSS-029-0057-SO** **FBQss-029-0057-SO** **10/08/2003** **0.0 - 1.0** **Regular samples**	**FBQso-030** **FBQSS-030-0059-SO** **FBQss-030-0059-SO** **10/08/2003** **0.0 - 1.0** **Regular samples**	**FBQso-030** **FBQSS-030-0368-SO** **FBQss-030-0368-SO** **10/08/2003** **0.0 - 1.0** **Field Duplicate**	**FBQss-031** **FBQSS-031-0061-SO** **FBQss-031-0061-SO** **10/09/2003** **0.0 - 1.0** **Regular samples**
Sodium	mg/kg	123	24 B	77.9	83.5	86.5 E
Thallium	mg/kg	0	0.46 U	0.49 U	0.5 U	0.49 U
Vanadium	mg/kg	31.1	5.3	14	15	16.2 N
Zinc	mg/kg	61.8	15.3	108 #	104 #	103 #
Organic-Semivolatiles						
Benz(*a*)anthracene	mg/kg		0.43 U	NA	NA	NA
Benzo(*a*)pyrene	mg/kg		0.43 U	NA	NA	NA
Benzo(*b*)fluoranthene	mg/kg		0.43 U	NA	NA	NA
Benzo(*k*)fluoranthene	mg/kg		0.43 U	NA	NA	NA
Chrysene	mg/kg		0.43 U	NA	NA	NA
Di-n-butyl phthalate	mg/kg		0.43 U	NA	NA	NA
Fluoranthene	mg/kg		0.43 U	NA	NA	NA
Pyrene	mg/kg		0.43 U	NA	NA	NA
Organic-Volatiles						
Acetone	mg/kg		0.013 U	NA	NA	NA
Carbon Disulfide	mg/kg		0.0065 U	NA	NA	NA
Methylene Chloride	mg/kg		0.0077 JB	NA	NA	NA
Trichloroethene	mg/kg		0.0049 J	NA	NA	NA
Organics-Pesticide/PCB						
4,4'-DDE	mg/kg		0.00037 J	NA	NA	NA

1 **Table 4-4. SRCs in Surface Soil at the Fuze and Booster Quarry Ponds/Landfill (continued)**

Station Sample ID Customer ID Date Depth (ft) Field Type Analyte (mg/kg)	Units	Facility-wide Background	FBQss-031 FBQSS-031-0370-SO FBQss-031-0370-SO 10/09/2003 0.0 - 1.0 Field Duplicate	FBQso-032 FBQSS-032-0063-SO FBQss-032-0063-SO 10/08/2003 0.0 - 1.0 Regular samples	FBQso-033 FBQSS-033-0065-SO FBQss-033-0065-SO 10/07/2003 0.0 - 1.0 Regular samples	FBQss-034 FBQSS-034-0067-SO FBQss-034-0067-SO 10/07/2003 0.0 - 1.0 Regular samples
Explosives						
1,3,5-Trinitrobenzene	mg/kg		0.1 U	0.1 U	0.1 U/U	0.1 U/U
2,4,6-Trinitrotoluene	mg/kg		0.1 U	0.1 U	0.1 U/U	0.1 U/U
2,4-Dinitrotoluene	mg/kg		0.1 U	0.1 U	0.1 U/U	0.1 U/U
2,6-Dinitrotoluene	mg/kg		0.1 U	0.1 U	0.1 U/U	0.1 U/U
2-Amino-4,6-dinitrotoluene	mg/kg		0.1 U	0.1 U	0.1 U/U	0.1 U/U
4-Amino-2,6-dinitrotoluene	mg/kg		0.1 U	0.1 U	0.1 U/U	0.1 U/U
Nitrobenzene	mg/kg		0.1 U	0.1 U	0.1 U/U	0.1 U/U
Nitrocellulose	mg/kg		NA	25	NA	NA
RDX	mg/kg		0.2 U	0.2 U	0.2 U/U	0.2 U/U
Inorganics						
Aluminum	mg/kg	17,700	7,870	14,700	10,200 /=	9,020 /=
Antimony	mg/kg	0.96	0.29 UN	0.74 B	0.53 BN/UJ	74.4 N/J#
Arsenic	mg/kg	15.4	6.6	10.3	17.4 /J#	10.3 /J
Barium	mg/kg	88.4	36.1 N	105 #	37.5 N/J	46.5 N/J
Beryllium	mg/kg	0.88	0.92 #	0.83	0.63 /=	0.51 /=
Cadmium	mg/kg	0	0.23 #	0.02 U	0.017 U/U	0.019 U/U
Calcium	mg/kg	15,800	357	156	272 /=	355 /=
Chromium	mg/kg	17.4	15.5	18 #	14.3 /J	11.6 /J
Chromium, hexavalent	mg/kg		NA	6.1 U	NA	NA
Cobalt	mg/kg	10.4	12.7 #	14.8 #	8.9 /=	8.5 /=
Copper	mg/kg	17.7	20.9 #	11.2	20.3 /J#	10.4 /J
Iron	mg/kg	23,100	30,700 #	21,400	24,700 /J#	18,900 /J
Lead	mg/kg	26.1	22.7	23.5	22.3 /=	262 /=#
Magnesium	mg/kg	3,030	2,050 N	2,760	1,920 /J	1,420 /J
Manganese	mg/kg	1,450	656	963	362 /=	539 /=
Mercury	mg/kg	0.036	0.023 B	0.034 B	0.016 U/U	0.017 B/UJ
Nickel	mg/kg	21.1	18.2	19.6	18.7 /J	12.7 /J
Potassium	mg/kg	927	1,290 N#	1,070 #	1,070 N/J#	676 N/J
Selenium	mg/kg	1.4	0.41 B	0.96 B	1.9 /J#	1.6 /J#
Silver	mg/kg	0	0.067 U	0.072 U	0.1 B/UJ	0.087 B/UJ

Table 4-4. SRCs in Surface Soil at the Fuze and Booster Quarry Ponds/Landfill (continued)

Station **Sample ID** **Customer ID** **Date** **Depth (ft)** **Field Type** **Analyte (mg/kg)**	**Units**	**Facility-wide Background**	**FBQss-031** **FBQSS-031-0370-SO** **FBQss-031-0370-SO** **10/09/2003** **0.0 - 1.0** **Field Duplicate**	**FBQso-032** **FBQSS-032-0063-SO** **FBQss-032-0063-SO** **10/08/2003** **0.0 - 1.0** **Regular samples**	**FBQso-033** **FBQSS-033-0065-SO** **FBQss-033-0065-SO** **10/07/2003** **0.0 - 1.0** **Regular samples**	**FBQss-034** **FBQSS-034-0067-SO** **FBQss-034-0067-SO** **10/07/2003** **0.0 - 1.0** **Regular samples**
Sodium	mg/kg	123	91.5 E	111	111 /=	104 /=
Thallium	mg/kg	0	0.49 U	0.62 B#	0.45 UN/UJ	0.48 UN/UJ
Vanadium	mg/kg	31.1	16.7 N	24.7	18.6 N/J	18.8 N/J
Zinc	mg/kg	61.8	103 #	62.6 #	69.8 /=#	59.9 /=
Organic-Semivolatiles						
Benz(*a*)anthracene	mg/kg		NA	0.42 U	NA	NA
Benzo(*a*)pyrene	mg/kg		NA	0.42 U	NA	NA
Benzo(*b*)fluoranthene	mg/kg		NA	0.42 U	NA	NA
Benzo(*k*)fluoranthene	mg/kg		NA	0.42 U	NA	NA
Chrysene	mg/kg		NA	0.42 U	NA	NA
Di-n-butyl phthalate	mg/kg		NA	0.24 J	NA	NA
Fluoranthene	mg/kg		NA	0.42 U	NA	NA
Pyrene	mg/kg		NA	0.42 U	NA	NA
Organic-Volatiles						
Acetone	mg/kg		NA	0.0073 JB	NA	NA
Carbon Disulfide	mg/kg		NA	0.0065 U	NA	NA
Methylene Chloride	mg/kg		NA	0.0069 JB	NA	NA
Trichloroethene	mg/kg		NA	0.0032 J	NA	NA
Organics-Pesticide/PCB						
4,4'-DDE	mg/kg		NA	0.0021 U	NA	NA

Table 4-4. SRCs in Surface Soil at the Fuze and Booster Quarry Ponds/Landfill (continued)

Station Sample ID Customer ID Date Depth (ft) Field Type Analyte (mg/kg)	Units	Facility-wide Background	FBQss-035 FBQSS-035-0069-SO FBQss-035-0069-SO 10/07/2003 0.0 - 1.0 Regular samples	FBQso-036 FBQSS-036-0071-SO FBQss-036-0071-SO 10/07/2003 0.0 - 1.0 Regular samples	FBQss-037 FBQSS-037-0073-SO FBQss-037-0073-SO 10/03/2003 0.0 - 1.0 Regular samples	FBQso-038 FBQSS-038-0075-SO FBQss-038-0075-SO 10/03/2003 0.0 - 1.0 Regular samples
Explosives						
1,3,5-Trinitrobenzene	mg/kg		0.1 U	0.1 U/U	0.1 U	0.1 U
2,4,6-Trinitrotoluene	mg/kg		0.1 U	0.1 U/U	0.1 U	0.037 J
2,4-Dinitrotoluene	mg/kg		0.1 U	0.1 U/U	0.1 U	0.1 U
2,6-Dinitrotoluene	mg/kg		0.1 U	0.1 U/U	0.1 U	0.1 U
2-Amino-4,6-dinitrotoluene	mg/kg		0.1 U	0.1 U/U	0.1 U	0.1 U
4-Amino-2,6-dinitrotoluene	mg/kg		0.1 U	0.1 U/U	0.1 U	0.1 U
Nitrobenzene	mg/kg		0.1 U	0.1 U/U	0.1 U	0.1 U
Nitrocellulose	mg/kg		NA	NA	NA	NA
RDX	mg/kg		0.2 U	0.2 U/U	0.2 U	0.2 U
Inorganics						
Aluminum	mg/kg	17,700	12,000	15,000 /=	6,430	723
Antimony	mg/kg	0.96	0.89 BN	0.94 BN/UJ	0.67 BN	0.62 BN
Arsenic	mg/kg	15.4	8.6 N	10.4 /J	6.5	1.1 N
Barium	mg/kg	88.4	82.9	105 N/J#	48.7 N	10.7
Beryllium	mg/kg	0.88	0.73	0.86 /=	0.83	0.22
Cadmium	mg/kg	0	0.12 #	0.021 U/U	0.42 #	0.066 B#
Calcium	mg/kg	15,800	261	639 /=	2,160	293
Chromium	mg/kg	17.4	13.8	19.3 /J#	14.3 E	2.7
Chromium, hexavalent	mg/kg		NA	NA	NA	NA
Cobalt	mg/kg	10.4	9.7	15.7 /=#	9.8	1.1
Copper	mg/kg	17.7	8.7 E	11.5 /J	18.8 #	2.2 E
Iron	mg/kg	23,100	16,600	24,900 /J#	24,700 #	15,700
Lead	mg/kg	26.1	28.2 #	73.5 /=#	24.7	7.3
Magnesium	mg/kg	3,030	1,760 N	2,890 /J	2,070 N	143 N
Manganese	mg/kg	1,450	826	1,370 /=	615	298
Mercury	mg/kg	0.036	0.055 B#	0.048 B/UJ	0.032 B	0.026 B
Nickel	mg/kg	21.1	15.5	18.5 /J	18.2	2.9
Potassium	mg/kg	927	639 N	1,260 N/J#	1,110 N#	122 N
Selenium	mg/kg	1.4	1.1	2.4 B/UJ	1.1 B	0.53 B
Silver	mg/kg	0	0.062 U	0.15 U/U	0.069 U	0.08 B#

Table 4-4. SRCs in Surface Soil at the Fuze and Booster Quarry Ponds/Landfill (continued)

Station **Sample ID** **Customer ID** **Date** **Depth (ft)** **Field Type** **Analyte (mg/kg)**	**Units**	**Facility-wide Background**	**FBQss-035** **FBQSS-035-0069-SO** **FBQss-035-0069-SO** **10/07/2003** **0.0 - 1.0** **Regular samples**	**FBQso-036** **FBQSS-036-0071-SO** **FBQss-036-0071-SO** **10/07/2003** **0.0 - 1.0** **Regular samples**	**FBQss-037** **FBQSS-037-0073-SO** **FBQss-037-0073-SO** **10/03/2003** **0.0 - 1.0** **Regular samples**	**FBQso-038** **FBQSS-038-0075-SO** **FBQss-038-0075-SO** **10/03/2003** **0.0 - 1.0** **Regular samples**
Sodium	mg/kg	123	88.1	136 /=#	93.8	24 B
Thallium	mg/kg	0	0.46 U	1.1 UN/UJ	0.51 U	0.48 U
Vanadium	mg/kg	31.1	21.2	28.7 N/J	14.3 N	3
Zinc	mg/kg	61.8	64.6 #	66.5 /=#	113 #	19.2
Organic-Semivolatiles						
Benz(*a*)anthracene	mg/kg		NA	NA	NA	NA
Benzo(*a*)pyrene	mg/kg		NA	NA	NA	NA
Benzo(*b*)fluoranthene	mg/kg		NA	NA	NA	NA
Benzo(*k*)fluoranthene	mg/kg		NA	NA	NA	NA
Chrysene	mg/kg		NA	NA	NA	NA
Di-n-butyl phthalate	mg/kg		NA	NA	NA	NA
Fluoranthene	mg/kg		NA	NA	NA	NA
Pyrene	mg/kg		NA	NA	NA	NA
Organic-Volatiles						
Acetone	mg/kg		NA	NA	NA	NA
Carbon disulfide	mg/kg		NA	NA	NA	NA
Methylene chloride	mg/kg		NA	NA	NA	NA
Trichloroethene	mg/kg		NA	NA	NA	NA
Organics-Pesticide/PCB						
4,4'-DDE	mg/kg		NA	NA	NA	NA

1 **Table 4-4. SRCs in Surface Soil at the Fuze and Booster Quarry Ponds/Landfill (continued)**

Station Sample ID Customer ID Date Depth (ft) Field Type Analyte (mg/kg)	Units	Facility-wide Background	FBQss-039 FBQSS-039-0077-SO FBQss-039-0077-SO 10/03/2003 0.0 - 1.0 Regular samples	FBQso-040 FBQSS-040-0079-SO FBQss-040-0079-SO 10/06/2003 0.0 - 1.0 Regular samples	FBQss-041 FBQSS-041-0081-SO FBQss-041-0081-SO 10/03/2003 0.0 - 1.0 Regular samples	FBQss-042 FBQSS-042-0083-SO FBQss-042-0083-SO 10/03/2003 0.0 - 1.0 Regular samples
Explosives						
1,3,5-Trinitrobenzene	mg/kg		0.25	0.1 U	0.1 U	1.7
2,4,6-Trinitrotoluene	mg/kg		0.49	0.1 U	1.6	99
2,4-Dinitrotoluene	mg/kg		0.1 U	0.1 U	0.1 U	0.4
2,6-Dinitrotoluene	mg/kg		0.07 J	0.1 U	0.1 U	1.3
2-Amino-4,6-dinitrotoluene	mg/kg		0.33	0.1 U	0.55	12
4-Amino-2,6-dinitrotoluene	mg/kg		0.43	0.1 U	0.62	9.7
Nitrobenzene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
Nitrocellulose	mg/kg		NA	NA	NA	NA
RDX	mg/kg		0.2 U	0.2 U	0.2 U	0.2 U
Inorganics						
Aluminum	mg/kg	17,700	6,530	16,000	6,990	6,310
Antimony	mg/kg	0.96	2.6 N#	0.53 BN	2.4 N#	1.8 N#
Arsenic	mg/kg	15.4	6.3 N	10.2	8.1 N	6.5 N
Barium	mg/kg	88.4	58.1	89.5 N#	73.5	86.8
Beryllium	mg/kg	0.88	0.76	0.84	0.78	0.83
Cadmium	mg/kg	0	0.72 #	0.18 #	0.45 #	0.52 #
Calcium	mg/kg	15,800	8,020	367	1,220	2,410
Chromium	mg/kg	17.4	13	38 #	15	14.3
Chromium, hexavalent	mg/kg		NA	NA	NA	NA
Cobalt	mg/kg	10.4	5.4	13.8 #	10.1	10.2
Copper	mg/kg	17.7	32.5 E#	12.9	20.2 E#	27.1 E#
Iron	mg/kg	23,100	22,800	25,500 #	25,400 #	24,500 #
Lead	mg/kg	26.1	86.9 #	43.3 #	114 #	70.8 #
Magnesium	mg/kg	3,030	1,720 N	3,000 N	1,860 N	1,900 N
Manganese	mg/kg	1,450	406	1,060	851	490
Mercury	mg/kg	0.036	0.07 #	0.026 B	0.11 #	0.044 B#
Nickel	mg/kg	21.1	12.4	18.1	18.9	19.3
Potassium	mg/kg	927	806 N	1,290 N#	1,050 N#	1,260 N#
Selenium	mg/kg	1.4	0.85 B	4.6 B#	1.1	1.3
Silver	mg/kg	0	0.06 U	0.64 U	0.1 B#	0.067 U

Table 4-4. SRCs in Surface Soil at the Fuze and Booster Quarry Ponds/Landfill (continued)

Station Sample ID Customer ID Date Depth (ft) Field Type Analyte (mg/kg)	Units	Facility-wide Background	FBQss-039 FBQSS-039-0077-SO FBQss-039-0077-SO 10/03/2003 0.0 - 1.0 Regular samples	FBQso-040 FBQSS-040-0079-SO FBQss-040-0079-SO 10/06/2003 0.0 - 1.0 Regular samples	FBQss-041 FBQSS-041-0081-SO FBQss-041-0081-SO 10/03/2003 0.0 - 1.0 Regular samples	FBQss-042 FBQSS-042-0083-SO FBQss-042-0083-SO 10/03/2003 0.0 - 1.0 Regular samples
Sodium	mg/kg	123	105	102 E	84.6	90.3
Thallium	mg/kg	0	0.69 B#	4.8 U	0.44 U	0.5 U
Vanadium	mg/kg	31.1	12.9	29 N	15.1	13.7
Zinc	mg/kg	61.8	107 #	60.1	121 #	142 #
Organic-Semivolatiles						
Benz(*a*)anthracene	mg/kg		NA	NA	NA	NA
Benzo(*a*)pyrene	mg/kg		NA	NA	NA	NA
Benzo(*b*)fluoranthene	mg/kg		NA	NA	NA	NA
Benzo(*k*)fluoranthene	mg/kg		NA	NA	NA	NA
Chrysene	mg/kg		NA	NA	NA	NA
Di-n-butyl phthalate	mg/kg		NA	NA	NA	NA
Fluoranthene	mg/kg		NA	NA	NA	NA
Pyrene	mg/kg		NA	NA	NA	NA
Organic-Volatiles						
Acetone	mg/kg		NA	NA	NA	NA
Carbon Disulfide	mg/kg		NA	NA	NA	NA
Methylene Chloride	mg/kg		NA	NA	NA	NA
Trichloroethene	mg/kg		NA	NA	NA	NA
Organics-Pesticide/PCB						
4,4'-DDE	mg/kg		NA	NA	NA	NA

Table 4-4. SRCs in Surface Soil at the Fuze and Booster Quarry Ponds/Landfill (continued)

Station Sample ID Customer ID Date Depth (ft) Field Type Analyte (mg/kg)	Units	Facility-wide Background	FBQss-043 FBQSS-043-0085-SO FBQss-043-0085-SO 10/02/2003 0.0 - 1.0 Regular samples	FBQss-044 FBQSS-044-0087-SO FBQss-044-0087-SO 10/07/2003 0.0 - 1.0 Regular samples	FBQss-045 FBQSS-045-0089-SO FBQss-045-0089-SO 10/13/2003 0.0 - 1.0 Regular samples	FBQss-046 FBQSS-046-0091-SO FBQss-046-0091-SO 10/03/2003 0.0 - 1.0 Regular samples
Explosives						
1,3,5-Trinitrobenzene	mg/kg		0.1 U	0.1 U/U	0.062 J/J	0.23
2,4,6-Trinitrotoluene	mg/kg		0.32	0.1 U/U	0.1 U/U	4.4
2,4-Dinitrotoluene	mg/kg		0.1 U	0.1 U/U	0.1 U/U	0.038 J
2,6-Dinitrotoluene	mg/kg		0.1 U	0.1 U/U	0.1 U/U	0.1 U
2-Amino-4,6-dinitrotoluene	mg/kg		0.15	0.1 U/U	0.1 U/U	0.63
4-Amino-2,6-dinitrotoluene	mg/kg		0.22	0.1 U/U	0.1 U/U	0.54
Nitrobenzene	mg/kg		0.1 U	0.1 U/U	0.1 U/U	0.1 U
Nitrocellulose	mg/kg		NA	NA	28 /=	NA
RDX	mg/kg		0.2 U	0.2 U/U	0.2 U/U	0.2 U
Inorganics						
Aluminum	mg/kg	17,700	6,330	17,000 /=	3,470 /=	7,620
Antimony	mg/kg	0.96	2.7 N#	4.4 BN/UJ	6.4 N/J#	1.7 N#
Arsenic	mg/kg	15.4	11.5	27.1 /J#	9.2 /J	4.8 N
Barium	mg/kg	88.4	78.6 N	1,070 N/J#	35.8 N/J	86.2
Beryllium	mg/kg	0.88	0.77	1 /=#	1.5 /=#	1 #
Cadmium	mg/kg	0	0.94 #	4 /=#	0.036 U/U	0.23 #
Calcium	mg/kg	15,800	3,170	14,700 /=	829 /=	841
Chromium	mg/kg	17.4	32.6 E#	88.9 /J#	19.5 /J#	16.1
Chromium, hexavalent	mg/kg		NA	NA	1.5 /=#	NA
Cobalt	mg/kg	10.4	9.9	36.8 /=#	13.7 /=#	11.7 #
Copper	mg/kg	17.7	30.4 #	559 /J#	37.1 /J#	23.3 E#
Iron	mg/kg	23,100	31,500 #	110,000 /J#	63,100 /J#	29,300 #
Lead	mg/kg	26.1	256 #	887 /=#	66.8 /=#	82.8 #
Magnesium	mg/kg	3,030	1,300 N	6,150 /J#	396 /J	2,270 N
Manganese	mg/kg	1,450	680	1,000 /=	842 /=	515
Mercury	mg/kg	0.036	0.085 #	0.068 /=#	0.25 /=#	0.043 B#
Nickel	mg/kg	21.1	17	85.4 /J#	31.7 /J#	21.8 #
Potassium	mg/kg	927	875 N	2,660 N/J#	509 N/J	1,300 N#
Selenium	mg/kg	1.4	1.7 #	7.9 /J#	3.2 /J#	1.1
Silver	mg/kg	0	0.22 B#	0.34 U/U	0.31 B/UJ	0.058 U

Table 4-4. SRCs in Surface Soil at the Fuze and Booster Quarry Ponds/Landfill (continued)

Station Sample ID Customer ID Date Depth (ft) Field Type Analyte (mg/kg)	Units	Facility-wide Background	FBQss-043 FBQSS-043-0085-SO FBQss-043-0085-SO 10/02/2003 0.0 - 1.0 Regular samples	FBQss-044 FBQSS-044-0087-SO FBQss-044-0087-SO 10/07/2003 0.0 - 1.0 Regular samples	FBQss-045 FBQSS-045-0089-SO FBQss-045-0089-SO 10/13/2003 0.0 - 1.0 Regular samples	FBQss-046 FBQSS-046-0091-SO FBQss-046-0091-SO 10/03/2003 0.0 - 1.0 Regular samples
Sodium	mg/kg	123	117	687 /=#	82.2 B/UJ	82.9
Thallium	mg/kg	0	0.48 U	2.5 UN/UJ	0.94 UN/UJ	0.43 U
Vanadium	mg/kg	31.1	15.7 N	36 N/J#	17.3 N/J	15.6
Zinc	mg/kg	61.8	182 #	1,330 /=#	309 /=#	107 #
Organic-Semivolatiles						
Benz(*a*)anthracene	mg/kg		NA	NA	0.38 U/U	NA
Benzo(*a*)pyrene	mg/kg		NA	NA	0.38 U/U	NA
Benzo(*b*)fluoranthene	mg/kg		NA	NA	0.38 U/U	NA
Benzo(*k*)fluoranthene	mg/kg		NA	NA	0.38 U/U	NA
Chrysene	mg/kg		NA	NA	0.38 U/U	NA
Di-n-butyl phthalate	mg/kg		NA	NA	0.38 U/R	NA
Fluoranthene	mg/kg		NA	NA	0.38 U/U	NA
Pyrene	mg/kg		NA	NA	0.38 U/U	NA
Organic-Volatiles						
Acetone	mg/kg		NA	NA	0.0057 JB/R	NA
Carbon Disulfide	mg/kg		NA	NA	0.0057 U/UJ	NA
Methylene Chloride	mg/kg		NA	NA	0.02 B/R	NA
Trichloroethene	mg/kg		NA	NA	0.0057 U/UJ	NA
Organics-Pesticide/PCB						
4,4'-DDE	mg/kg		NA	NA	0.0019 U/U	NA

Table 4-4. SRCs in Surface Soil at the Fuze and Booster Quarry Ponds/Landfill (continued)

Station **Sample ID** **Customer ID** **Date** **Depth (ft)** **Field Type** **Analyte (mg/kg)**	**Units**	**Facility-wide Background**	**FBQss-047** **FBQSS-047-0093-SO** **FBQss-047-0093-SO** **10/02/2003** **0.0 - 1.0** **Regular samples**	**FBQso-048** **FBQSS-048-0095-SO** **FBQss-048-0095-SO** **10/02/2003** **0.0 - 1.0** **Regular samples**	**FBQss-049** **FBQSS-049-0097-SO** **FBQss-049-0097-SO** **10/10/2003** **0.0 - 1.0** **Regular samples**	**FBQss-049** **FBQSS-049-0378-SO** **FBQss-049-0378-SO** **10/10/2003** **0.0 - 1.0** **Field Duplicate**
Explosives						
1,3,5-Trinitrobenzene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
2,4,6-Trinitrotoluene	mg/kg		0.1 U	0.32	0.082 J	0.12
2,4-Dinitrotoluene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
2,6-Dinitrotoluene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
2-Amino-4,6-dinitrotoluene	mg/kg		0.1 U	0.17	0.14	0.19
4-Amino-2,6-dinitrotoluene	mg/kg		0.1 U	0.34	0.11	0.14
Nitrobenzene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
Nitrocellulose	mg/kg		NA	NA	NA	NA
RDX	mg/kg		0.2 U	0.2 U	0.2 U	0.2 U
Inorganics						
Aluminum	mg/kg	17,700	3,720	15,500	8,630	9,480
Antimony	mg/kg	0.96	1.7 N#	0.43 BN	1.3 N#	0.94 BN
Arsenic	mg/kg	15.4	6.7 N	18 #	10.8	9.4
Barium	mg/kg	88.4	30.9	76.7 N	67.3	75.2
Beryllium	mg/kg	0.88	0.52	0.74	0.55	0.63
Cadmium	mg/kg	0	0.15 #	0.22 #	0.4 #	0.48 #
Calcium	mg/kg	15,800	163	2,180	1,940	3,240
Chromium	mg/kg	17.4	15.5	21.1 E#	13.3 E	13.6 E
Chromium, hexavalent	mg/kg		NA	NA	NA	NA
Cobalt	mg/kg	10.4	7.7	9	6.8	7.5
Copper	mg/kg	17.7	27.7 E#	20.7 #	45.8 #	39.7 #
Iron	mg/kg	23,100	36,300 #	29,700 #	18,500	19,600
Lead	mg/kg	26.1	38.9 #	18.2	49.6 #	51.3 #
Magnesium	mg/kg	3,030	720 N	3,200 N#	1,740 N	2,020 N
Manganese	mg/kg	1,450	639	340	424	507
Mercury	mg/kg	0.036	0.029 B	0.019 B	0.7 #	0.59 #
Nickel	mg/kg	21.1	15.4	20.4	13 E	12.7 E
Potassium	mg/kg	927	695 N	1,240 N#	874 N	860 N
Selenium	mg/kg	1.4	1.3	1.4 #	0.47 B	0.32 B
Silver	mg/kg	0	0.1 B#	0.069 B#	0.18 B#	0.11 B#

Table 4-4. SRCs in Surface Soil at the Fuze and Booster Quarry Ponds/Landfill (continued)

Station **Sample ID** **Customer ID** **Date** **Depth (ft)** **Field Type** **Analyte (mg/kg)**	**Units**	**Facility-wide Background**	**FBQss-047** **FBQSS-047-0093-SO** **FBQss-047-0093-SO** **10/02/2003** **0.0 - 1.0** **Regular samples**	**FBQso-048** **FBQSS-048-0095-SO** **FBQss-048-0095-SO** **10/02/2003** **0.0 - 1.0** **Regular samples**	**FBQss-049** **FBQSS-049-0097-SO** **FBQss-049-0097-SO** **10/10/2003** **0.0 - 1.0** **Regular samples**	**FBQss-049** **FBQSS-049-0378-SO** **FBQss-049-0378-SO** **10/10/2003** **0.0 - 1.0** **Field Duplicate**
Sodium	mg/kg	123	73.9	108	103	103
Thallium	mg/kg	0	0.51 B#	0.48 U	0.46 U	0.5 U
Vanadium	mg/kg	31.1	10.4	28.2 N	17 N	18 N
Zinc	mg/kg	61.8	84.7 #	64.9 #	102 #	96.6 #
Organic-Semivolatiles						
Benz(*a*)anthracene	mg/kg		NA	NA	NA	NA
Benzo(*a*)pyrene	mg/kg		NA	NA	NA	NA
Benzo(*b*)fluoranthene	mg/kg		NA	NA	NA	NA
Benzo(*k*)fluoranthene	mg/kg		NA	NA	NA	NA
Chrysene	mg/kg		NA	NA	NA	NA
Di-n-butyl phthalate	mg/kg		NA	NA	NA	NA
Fluoranthene	mg/kg		NA	NA	NA	NA
Pyrene	mg/kg		NA	NA	NA	NA
Organic-Volatiles						
Acetone	mg/kg		NA	NA	NA	NA
Carbon Disulfide	mg/kg		NA	NA	NA	NA
Methylene Chloride	mg/kg		NA	NA	NA	NA
Trichloroethene	mg/kg		NA	NA	NA	NA
Organics-Pesticide/PCB						
4,4'-DDE	mg/kg		NA	NA	NA	NA

Table 4-4. SRCs in Surface Soil at the Fuze and Booster Quarry Ponds/Landfill (continued)

Station Sample ID Customer ID Date Depth (ft) Field Type Analyte (mg/kg)	Units	Facility-wide Background	FBQss-050 FBQSS-050-0099-SO FBQss-050-0099-SO 10/02/2003 0.0 - 1.0 Regular samples	FBQso-051 FBQSS-051-0101-SO FBQss-051-0101-SO 10/06/2003 0.0 - 1.0 Regular samples	FBQss-052 FBQSS-052-0103-SO FBQss-052-0103-SO 10/02/2003 0.0 - 1.0 Regular samples	FBQss-053 FBQSS-053-0105-SO FBQss-053-0105-SO 10/02/2003 0.0 - 1.0 Regular samples
Explosives						
1,3,5-Trinitrobenzene	mg/kg		0.1 U	0.1 U	0.36	0.1 U
2,4,6-Trinitrotoluene	mg/kg		0.047 J	0.1 U	2.4	0.1 U
2,4-Dinitrotoluene	mg/kg		0.1	0.1 U	0.16	0.1 U
2,6-Dinitrotoluene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
2-Amino-4,6-dinitrotoluene	mg/kg		0.73	0.1 U	0.95	0.1 U
4-Amino-2,6-dinitrotoluene	mg/kg		0.4	0.1 U	0.39	0.1 U
Nitrobenzene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
Nitrocellulose	mg/kg		NA	NA	NA	NA
RDX	mg/kg		0.33	0.2 U	0.2 U	0.2 U
Inorganics						
Aluminum	mg/kg	17,700	4,850	14,900	5,100	4,770
Antimony	mg/kg	0.96	3 N#	1.5 U	3.9 N#	1.6 N#
Arsenic	mg/kg	15.4	10.1	14.1	6.4	10.1
Barium	mg/kg	88.4	32.2 N	114 #	51.9 N	58.6 N
Beryllium	mg/kg	0.88	0.4	0.91 #	0.78	0.7
Cadmium	mg/kg	0	0.19 #	0.099 U	0.64 #	0.39 #
Calcium	mg/kg	15,800	223	572	731	475
Chromium	mg/kg	17.4	9.2 E	18.8 #	12.4 E	12.3 E
Chromium, hexavalent	mg/kg		NA	NA	NA	NA
Cobalt	mg/kg	10.4	8	16.6 #	7.9	10.4
Copper	mg/kg	17.7	13	10.5	23.7 #	20.6 #
Iron	mg/kg	23,100	17,300	25,900 #	25,700 #	27,400 #
Lead	mg/kg	26.1	166 #	26.7 #	164 #	84.5 #
Magnesium	mg/kg	3,030	974 N	2,640	1,380 N	1,180 N
Manganese	mg/kg	1,450	677	1,760 #	422	822
Mercury	mg/kg	0.036	0.039 B#	0.042 B#	0.054 #	0.07 #
Nickel	mg/kg	21.1	10.7	19.3	16.4	15.2
Potassium	mg/kg	927	620 N	1,150 #	916 N	832 N
Selenium	mg/kg	1.4	0.84 B	1.9 B#	1.2	1.6 #
Silver	mg/kg	0	0.11 B#	0.35 U	0.074 B#	0.12 B#

1 **Table 4-4. SRCs in Surface Soil at the Fuze and Booster Quarry Ponds/Landfill (continued)**

Station Sample ID Customer ID Date Depth (ft) Field Type Analyte (mg/kg)	Units	Facility-wide Background	FBQss-050 FBQSS-050-0099-SO FBQss-050-0099-SO 10/02/2003 0.0 - 1.0 Regular samples	FBQso-051 FBQSS-051-0101-SO FBQss-051-0101-SO 10/06/2003 0.0 - 1.0 Regular samples	FBQss-052 FBQSS-052-0103-SO FBQss-052-0103-SO 10/02/2003 0.0 - 1.0 Regular samples	FBQss-053 FBQSS-053-0105-SO FBQss-053-0105-SO 10/02/2003 0.0 - 1.0 Regular samples
Sodium	mg/kg	123	60.6	78.3 U	80.5	77.4
Thallium	mg/kg	0	0.45 U	2.6 U	0.43 U	0.45 U
Vanadium	mg/kg	31.1	10.6 N	28.3	11.3 N	12.7 N
Zinc	mg/kg	61.8	61.9 #	57.9	164 #	98.3 #
Organic-Semivolatiles						
Benz(*a*)anthracene	mg/kg		NA	NA	NA	NA
Benzo(*a*)pyrene	mg/kg		NA	NA	NA	NA
Benzo(*b*)fluoranthene	mg/kg		NA	NA	NA	NA
Benzo(*k*)fluoranthene	mg/kg		NA	NA	NA	NA
Chrysene	mg/kg		NA	NA	NA	NA
Di-n-butyl phthalate	mg/kg		NA	NA	NA	NA
Fluoranthene	mg/kg		NA	NA	NA	NA
Pyrene	mg/kg		NA	NA	NA	NA
Organic-Volatiles						
Acetone	mg/kg		NA	NA	NA	NA
Carbon Disulfide	mg/kg		NA	NA	NA	NA
Methylene Chloride	mg/kg		NA	NA	NA	NA
Trichloroethene	mg/kg		NA	NA	NA	NA
Organics-Pesticide/PCB						
4,4'-DDE	mg/kg		NA	NA	NA	NA

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Table 4-4. SRCs in Surface Soil at the Fuze and Booster Quarry Ponds/Landfill (continued)

Station Sample ID Customer ID Date Depth (ft) Field Type Analyte (mg/kg)	Units	Facility-wide Background	FBQso-054 FBQSS-054-0107-SO FBQss-054-0107-SO 10/02/2003 0.0 - 1.0 Regular samples	FBQss-055 FBQSS-055-0109-SO FBQss-055-0109-SO 10/02/2003 0.0 - 1.0 Regular samples	FBQso-056 FBQSS-056-0111-SO FBQss-056-0111-SO 10/02/2003 0.0 - 1.0 Regular samples	FBQso-057 FBQSS-057-0113-SO FBQss-057-0113-SO 10/01/2003 0.0 - 1.0 Regular samples
Explosives						
1,3,5-Trinitrobenzene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
2,4,6-Trinitrotoluene	mg/kg		0.1 U	0.027 J	0.1 U	0.1 U
2,4-Dinitrotoluene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
2,6-Dinitrotoluene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
2-Amino-4,6-dinitrotoluene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
4-Amino-2,6-dinitrotoluene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
Nitrobenzene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
Nitrocellulose	mg/kg		NA	NA	NA	NA
RDX	mg/kg		0.2 U	0.2 U	0.2 U	0.2 U
Inorganics						
Aluminum	mg/kg	17,700	13,400	10,700	11,900	11,900
Antimony	mg/kg	0.96	1.5 UN	0.93 BN	0.52 BN	0.72 BN
Arsenic	mg/kg	15.4	11.8	9.7	16.4 #	16.2 #
Barium	mg/kg	88.4	104 N#	353 N#	42.9 N	64 N
Beryllium	mg/kg	0.88	0.8	0.7	0.62	0.65
Cadmium	mg/kg	0	0.1 U	0.34 #	0.14 #	0.17 #
Calcium	mg/kg	15,800	311	1,240	128	2,440
Chromium	mg/kg	17.4	16 E	17.1 E	16.2 E	16.7 E
Chromium, hexavalent	mg/kg		NA	NA	NA	NA
Cobalt	mg/kg	10.4	10.4	10.5 #	9	7.5
Copper	mg/kg	17.7	11.1	20.8 #	20.2 #	18 #
Iron	mg/kg	23,100	21,900	22,300	25,300 #	22,800
Lead	mg/kg	26.1	21	59.7 #	18.4	16.7
Magnesium	mg/kg	3,030	2,220 N	2,220 N	2,410 N	2,260 N
Manganese	mg/kg	1,450	1170	593	275	517
Mercury	mg/kg	0.036	0.04 B#	0.098 #	0.017 B	0.047 B#
Nickel	mg/kg	21.1	16	16.9	18.8	16.5
Potassium	mg/kg	927	964 N#	1,060 N#	1,130 N#	1,030 N#
Selenium	mg/kg	1.4	1.6 U	1.2	1.3	1.1
Silver	mg/kg	0	0.35 U	0.065 U	0.061 U	0.075 B#

Table 4-4. SRCs in Surface Soil at the Fuze and Booster Quarry Ponds/Landfill (continued)

Station Sample ID Customer ID Date Depth (ft) Field Type Analyte (mg/kg)	Units	Facility-wide Background	FBQso-054 FBQSS-054-0107-SO FBQss-054-0107-SO 10/02/2003 0.0 - 1.0 Regular samples	FBQss-055 FBQSS-055-0109-SO FBQss-055-0109-SO 10/02/2003 0.0 - 1.0 Regular samples	FBQso-056 FBQSS-056-0111-SO FBQss-056-0111-SO 10/02/2003 0.0 - 1.0 Regular samples	FBQso-057 FBQSS-057-0113-SO FBQss-057-0113-SO 10/01/2003 0.0 - 1.0 Regular samples
Sodium	mg/kg	123	130 B#	90.1	97.5	92.3
Thallium	mg/kg	0	2.6 U	0.49 U	0.45 U	0.48 U
Vanadium	mg/kg	31.1	23.5 N	21 N	20.3 N	21.1 N
Zinc	mg/kg	61.8	57.2	89 #	64.9 #	61.2
Organic-Semivolatiles						
Benz(*a*)anthracene	mg/kg		NA	NA	NA	NA
Benzo(*a*)pyrene	mg/kg		NA	NA	NA	NA
Benzo(*b*)fluoranthene	mg/kg		NA	NA	NA	NA
Benzo(*k*)fluoranthene	mg/kg		NA	NA	NA	NA
Chrysene	mg/kg		NA	NA	NA	NA
Di-n-butyl phthalate	mg/kg		NA	NA	NA	NA
Fluoranthene	mg/kg		NA	NA	NA	NA
Pyrene	mg/kg		NA	NA	NA	NA
Organic-Volatiles						
Acetone	mg/kg		NA	NA	NA	NA
Carbon Disulfide	mg/kg		NA	NA	NA	NA
Methylene Chloride	mg/kg		NA	NA	NA	NA
Trichloroethene	mg/kg		NA	NA	NA	NA
Organics-Pesticide/PCB						
4,4'-DDE	mg/kg		NA	NA	NA	NA

Table 4-4. SRCs in Surface Soil at the Fuze and Booster Quarry Ponds/Landfill (continued)

Station Sample ID Customer ID Date Depth (ft) Field Type Analyte (mg/kg)	Units	Facility-wide Background	FBQss-058 FBQSS-058-0115-SO FBQss-058-0115-SO 10/01/2003 0.0 - 1.0 Regular samples	FBQso-059 FBQSS-059-0117-SO FBQss-059-0117-SO 10/06/2003 0.0 - 1.0 Regular samples	FBQso-060 FBQSS-060-0119-SO FBQss-060-0119-SO 10/13/2003 0.0 - 1.0 Regular samples
Explosives					
1,3,5-Trinitrobenzene	mg/kg		0.1 U	0.1 U	0.1 /=
2,4,6-Trinitrotoluene	mg/kg		0.1 U	0.1 U	0.1 U/U
2,4-Dinitrotoluene	mg/kg		0.1 U	0.1 U	0.1 U/U
2,6-Dinitrotoluene	mg/kg		0.1 U	0.1 U	0.1 U/U
2-Amino-4,6-dinitrotoluene	mg/kg		0.1 U	0.1 U	0.1 U/U
4-Amino-2,6-dinitrotoluene	mg/kg		0.1 U	0.1 U	0.1 U/U
Nitrobenzene	mg/kg		0.1 U	0.1 U	0.1 U/U
Nitrocellulose	mg/kg		NA	NA	150 /=
RDX	mg/kg		0.2 U	0.2 U	0.2 U/U
Inorganics					
Aluminum	mg/kg	17,700	6,290	12,300	13,200 /=
Antimony	mg/kg	0.96	0.61 BN	2.6 N#	0.61 BN/UJ
Arsenic	mg/kg	15.4	10	11.4	9.1 /J
Barium	mg/kg	88.4	25.3 N	86.8 N	92.6 N/J#
Beryllium	mg/kg	0.88	0.49	0.7	0.88 /=
Cadmium	mg/kg	0	0.15 #	0.97 #	0.021 U/U
Calcium	mg/kg	15,800	237	2,300	206 /=
Chromium	mg/kg	17.4	14.2 E	19.4 E#	15.6 /J
Chromium, hexavalent	mg/kg		NA	NA	3.4 /=#
Cobalt	mg/kg	10.4	7.6	11.2 #	11.7 /=#
Copper	mg/kg	17.7	12.1	41.4 #	9.7 /J
Iron	mg/kg	23,100	19,800	24,200 #	18,400 /J
Lead	mg/kg	26.1	18.9	77.2 #	22.1 /=
Magnesium	mg/kg	3,030	1,220 N	2,430 N	1,660 /J
Manganese	mg/kg	1,450	389	842	1,060 /=
Mercury	mg/kg	0.036	0.021 B	1.2 #	0.036 B/UJ
Nickel	mg/kg	21.1	12.9	15.4	15.4 /J
Potassium	mg/kg	927	812 N	1,090 N#	676 N/J
Selenium	mg/kg	1.4	1.1	1.7 #	1.6 /J#
Silver	mg/kg	0	0.06 U	0.18 B#	0.074 U/U

Table 4-4. SRCs in Surface Soil at the Fuze and Booster Quarry Ponds/Landfill (continued)

Station **Sample ID** **Customer ID** **Date** **Depth (ft)** **Field Type** **Analyte (mg/kg)**	**Units**	**Facility-wide Background**	**FBQss-058** **FBQSS-058-0115-SO** **FBQss-058-0115-SO** **10/01/2003** **0.0 - 1.0** **Regular samples**	**FBQso-059** **FBQSS-059-0117-SO** **FBQss-059-0117-SO** **10/06/2003** **0.0 - 1.0** **Regular samples**	**FBQso-060** **FBQSS-060-0119-SO** **FBQss-060-0119-SO** **10/13/2003** **0.0 - 1.0** **Regular samples**
Sodium	mg/kg	123	79.2	116	115 /=
Thallium	mg/kg	0	0.45 U	0.52 U	0.55 UN/UJ
Vanadium	mg/kg	31.1	12.6 N	24.5 N	24.4 N/J
Zinc	mg/kg	61.8	55.7	213 #	60.1 /=
Organic-Semivolatiles					
Benz(*a*)anthracene	mg/kg		NA	NA	0.19 J/J
Benzo(*a*)pyrene	mg/kg		NA	NA	0.084 J/J
Benzo(*b*)fluoranthene	mg/kg		NA	NA	0.26 J/J
Benzo(*k*)fluoranthene	mg/kg		NA	NA	0.085 J/J
Chrysene	mg/kg		NA	NA	0.37 J/J
Di-n-butyl phthalate	mg/kg		NA	NA	0.43 U/R
Fluoranthene	mg/kg		NA	NA	0.87 /=
Pyrene	mg/kg		NA	NA	0.64 /=
Organic-Volatiles					
Acetone	mg/kg		NA	NA	0.0096 JB/R
Carbon Disulfide	mg/kg		NA	NA	0.069 /=
Methylene Chloride	mg/kg		NA	NA	0.01 JB/R
Trichloroethene	mg/kg		NA	NA	0.0065 U/U
Organics-Pesticide/PCB					
4,4'-DDE	mg/kg		NA	NA	0.0022 U/U

Note: Data qualifiers are presented as laboratory qualifiers/validation qualifiers.
B for inorganics = Result is less than the contract-required detection limit but greater than the instrument detection limit.
B for organics = Compound is detected in the blank as well as the sample.
E = Result estimated because of the presence of interference.
J = Estimated value is less than the reporting limits.
N = Matrix spike recovery is outside the control limits.
P = Greater than 25% difference between the two GC columns.
R = Data are rejected.
U = Not detected.
# = Value is above the facility-wide background.
* = Duplicate analysis is outside the control limits.
"=" = Analyte present and concentration accurate.
Facility-wide background is determined for the Winklepeck Burning Ground Phase II Remedial Investigation (USACE 2001b).
NA = Not applicable.
PCB = Polychlorinated biphenyl.
SRC = Site-related contaminant.

Table 4-5. SRCs in Surface Soil at the 40-mm Firing Range

Media Location Station Sample ID Customer ID Date Depth (ft) Filtered Field Type Analyte (mg/kg)	Units	Facility-wide Background	Soil 061 FBQso-061 FBQSS-061-0121-SO FBQss-061-0121-SO 11/14/2003 0.0 - 1.0 Total Regular samples	Soil 062 FBQso-062 FBQSS-062-0123-SO FBQss-062-0123-SO 11/17/2003 0.0 - 1.0 Total Regular samples	Soil 063 FBQso-063 FBQSS-063-0125-SO FBQss-063-0125-SO 11/14/2003 0.0 - 1.0 Total Regular samples	Soil 064 FBQso-064 FBQSS-064-0127-SO FBQss-064-0127-SO 11/14/2003 0.0 - 1.0 Total Regular samples
Explosives						
2,4,6-Trinitrotoluene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
2,4-Dinitrotoluene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
3-Nitrotoluene	mg/kg		0.1 J	0.2 U	0.2 U	0.2 U
HMX	mg/kg		0.2 U	0.2 U	0.28	0.2 U
Nitrobenzene	mg/kg		0.1 U	0.033 J	0.1 U	0.1 U
Nitrocellulose	mg/kg		NA	NA	NA	NA
Tetryl	mg/kg		0.2 U	0.2 U	0.2 U	0.2 U
Inorganics						
Aluminum	mg/kg	17,700	16,400	16,600	16,200	11,500
Antimony	mg/kg	0.96	0.5 BN	0.27 U	0.48 BN	0.24 BN
Arsenic	mg/kg	15.4	12.7	10.8	9.8	7.5
Barium	mg/kg	88.4	78.8 N	93.6 #	96.8 N#	66.5 N
Beryllium	mg/kg	0.88	0.62 E	0.76	0.73 E	0.57 E
Cadmium	mg/kg	0	0.031 U*	0.089 #	0.032 U*	0.03 U*
Calcium	mg/kg	15,800	385	579	471	211
Chromium	mg/kg	17.4	22.8 N#	22.4 #	21.4 N#	14.6 N
Cobalt	mg/kg	10.4	9.3	10.9 #	10.9 #	10.4
Copper	mg/kg	17.7	21.6 #	14.8	14.8	10.1
Iron	mg/kg	23,100	27,600 #	24,600 #	24,700 #	16,500
Lead	mg/kg	26.1	21.3	17.5	18.5	17
Magnesium	mg/kg	3,030	2,760 N	3,200 #	2,900 N	1,850 N
Manganese	mg/kg	1,450	672	769	764	716
Mercury	mg/kg	0.04	0.035 B	0.02 U	0.031 B	0.037 B#
Nickel	mg/kg	21.1	17.8	21.1	18.8	15
Potassium	mg/kg	927	1,480 N#	1,460 #	1,350 N#	755 N
Selenium	mg/kg	1.4	0.68 B	0.29 U	0.67 B	0.51 B
Silver	mg/kg	0	0.051 U	0.061 U	0.053 U	0.051 U

Table 4-5. SRCs in Surface Soil at the 40-mm Firing Range (continued)

Media Location Station Sample ID Customer ID Date Depth (ft) Filtered Field Type Analyte (mg/kg)	Units	Facility-wide Background	Soil 061 FBQso-061 FBQSS-061-0121-SO FBQss-061-0121-SO 11/14/2003 0.0 - 1.0 Total Regular samples	Soil 062 FBQso-062 FBQSS-062-0123-SO FBQss-062-0123-SO 11/17/2003 0.0 - 1.0 Total Regular samples	Soil 063 FBQso-063 FBQSS-063-0125-SO FBQss-063-0125-SO 11/14/2003 0.0 - 1.0 Total Regular samples	Soil 064 FBQso-064 FBQSS-064-0127-SO FBQss-064-0127-SO 11/14/2003 0.0 - 1.0 Total Regular samples
Sodium	mg/kg	123	74.4	56.9	83.3	69.3
Thallium	mg/kg	0	0.42 U	2.2 #	0.44 U	0.41 U
Vanadium	mg/kg	31.1	30	28.1	28.2	22.5
Zinc	mg/kg	61.8	59	55.6	66.9 #	55
Organic-Semivolatiles						
Bis(2-ethylhexyl)phthalate	mg/kg		NA	NA	NA	NA
Diethyl phthalate	mg/kg		NA	NA	NA	NA
Organic-Volatiles						
1,1,1-Trichloroethane	mg/kg		NA	NA	NA	NA
1,1-Dichloroethene	mg/kg		NA	NA	NA	NA
Acetone	mg/kg		NA	NA	NA	NA
Methylene Chloride	mg/kg		NA	NA	NA	NA
Toluene	mg/kg		NA	NA	NA	NA
Organics-Pesticide/PCB						
4,4'-DDE	mg/kg		NA	NA	NA	NA
Aldrin	mg/kg		NA	NA	NA	NA
Endrin aldehyde	mg/kg		NA	NA	NA	NA
Endrin ketone	mg/kg		NA	NA	NA	NA
Heptachlor	mg/kg		NA	NA	NA	NA
Lindane	mg/kg		NA	NA	NA	NA

Table 4-5. SRCs in Surface Soil at the 40-mm Firing Range (continued)

Media Location Station Sample ID Customer ID Date Depth (ft) Filtered Field Type Analyte (mg/kg)	Units	Facility-wide Background	Soil 065 FBQso-065 FBQSS-065-0129-SO FBQss-065-0129-SO 11/17/2003 0.0 - 1.0 Total Regular samples	Soil 066 FBQso-066 FBQSS-066-0131-SO FBQss-066-0131-SO 11/17/2003 0.0 - 1.0 Total Regular samples	Soil 067 FBQso-067 FBQSS-067-0133-SO FBQss-067-0133-SO 11/14/2003 0.0 - 1.0 Total Regular samples	Soil 068 FBQso-068 FBQSS-068-0135-SO FBQss-068-0135-SO 11/14/2003 0.0 - 1.0 Total Regular samples
Explosives						
2,4,6-Trinitrotoluene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
2,4-Dinitrotoluene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
3-Nitrotoluene	mg/kg		0.2 U	0.2 U	0.2 U	0.2 U
HMX	mg/kg		0.2 U	0.2 U	0.2 U	0.2 U
Nitrobenzene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
Nitrocellulose	mg/kg		NA	NA	NA	NA
Tetryl	mg/kg		0.2 U	0.2 U	0.2 U	0.2 U
Inorganics						
Aluminum	mg/kg	17,700	11,200	16,100	12,400	11,700
Antimony	mg/kg	0.96	0.3 UN	0.3 UN	0.22 BN	0.42 BN
Arsenic	mg/kg	15.4	12.5 N	11.1 N	17.8 #	9.6
Barium	mg/kg	88.4	55.7	93.3 #	49.6 N	72.3 N
Beryllium	mg/kg	0.88	0.52	0.75	0.58 E	0.58 E
Cadmium	mg/kg	0	0.074 B#	0.25 #	0.027 U*	0.028 U*
Calcium	mg/kg	15,800	246	613	307	1,160
Chromium	mg/kg	17.4	14.3	22 #	18.5 N#	16.8 N
Cobalt	mg/kg	10.4	10.2	10.4	8.4	10.8 #
Copper	mg/kg	17.7	11.1	18.8 #	23.7 #	9.8
Iron	mg/kg	23,100	18,800	24,400 #	27,800 #	20,600
Lead	mg/kg	26.1	13.7	17.1	13.7	14.4
Magnesium	mg/kg	3,030	2,170 N	2,990 N	2,680 N	2,050 N
Manganese	mg/kg	1,450	537	834	265	709
Mercury	mg/kg	0.04	0.019 B	0.018 U	0.022 B	0.033 B
Nickel	mg/kg	21.1	16.2	18.9	20.5	14.8
Potassium	mg/kg	927	967 N#	1,390 N#	1,310 N#	831 N
Selenium	mg/kg	1.4	0.31 U	0.32 U	0.42 B	0.45 B
Silver	mg/kg	0	0.067 U	0.067 U	0.045 U	0.047 U

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Table 4-5. SRCs in Surface Soil at the 40-mm Firing Range (continued)

Media Location Station Sample ID Customer ID Date Depth (ft) Filtered Field Type Analyte (mg/kg)	Units	Facility-wide Background	Soil 065 FBQso-065 FBQSS-065-0129-SO FBQss-065-0129-SO 11/17/2003 0.0 - 1.0 Total Regular samples	Soil 066 FBQso-066 FBQSS-066-0131-SO FBQss-066-0131-SO 11/17/2003 0.0 - 1.0 Total Regular samples	Soil 067 FBQso-067 FBQSS-067-0133-SO FBQss-067-0133-SO 11/14/2003 0.0 - 1.0 Total Regular samples	Soil 068 FBQso-068 FBQSS-068-0135-SO FBQss-068-0135-SO 11/14/2003 0.0 - 1.0 Total Regular samples
Sodium	mg/kg	123	52.3 B	64.6	69.9	68.6
Thallium	mg/kg	0	1.7 B#	2.3 #	0.37 U	0.39 U
Vanadium	mg/kg	31.1	21.3	28.6	21.8	26.1
Zinc	mg/kg	61.8	46.9	70.1 #	58.3	47
Organic-Semivolatiles						
Bis(2-ethylhexyl)phthalate	mg/kg		NA	NA	NA	NA
Diethyl phthalate	mg/kg		NA	NA	NA	NA
Organic-Volatiles						
1,1,1-Trichloroethane	mg/kg		NA	NA	NA	NA
1,1-Dichloroethene	mg/kg		NA	NA	NA	NA
Acetone	mg/kg		NA	NA	NA	NA
Methylene Chloride	mg/kg		NA	NA	NA	NA
Toluene	mg/kg		NA	NA	NA	NA
Organics-Pesticide/PCB						
4,4'-DDE	mg/kg		NA	NA	NA	NA
Aldrin	mg/kg		NA	NA	NA	NA
Endrin aldehyde	mg/kg		NA	NA	NA	NA
Endrin ketone	mg/kg		NA	NA	NA	NA
Heptachlor	mg/kg		NA	NA	NA	NA
Lindane	mg/kg		NA	NA	NA	NA

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Table 4-5. SRCs in Surface Soil at the 40-mm Firing Range (continued)

Media Location Station Sample ID Customer ID Date Depth (ft) Filtered Field Type Analyte (mg/kg)	Units	Facility-wide Background	Soil 069 FBQss-069 FBQSS-069-0137-SO FBQss-069-0137-SO 11/13/2003 0.0 - 1.0 Total Regular samples	Soil 070 FBQss-070 FBQSS-070-0139-SO FBQss-070-0139-SO 11/13/2003 0.0 - 1.0 Total Regular samples	Soil 071 FBQso-071 FBQSS-071-0141-SO FBQss-071-0141-SO 11/17/2003 0.0 - 1.0 Total Regular samples	Soil 072 FBQss-072 FBQSS-072-0143-SO FBQss-072-0143-SO 11/17/2003 0.0 - 1.0 Total Regular samples
Explosives						
2,4,6-Trinitrotoluene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
2,4-Dinitrotoluene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
3-Nitrotoluene	mg/kg		0.2 U	0.2 U	0.2 U	0.2 U
HMX	mg/kg		0.2 U	0.2 U	0.2 U	0.2 U
Nitrobenzene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
Nitrocellulose	mg/kg		NA	NA	NA	NA
Tetryl	mg/kg		0.2 U	0.2 U	0.2 U	0.2 U
Inorganics						
Aluminum	mg/kg	17,700	3,470	5,120	12,100	8,250
Antimony	mg/kg	0.96	0.35 BN	0.25 BN	0.28 UN	0.25 UN
Arsenic	mg/kg	15.4	6.2	8.4	18.8 N#	8.4 N
Barium	mg/kg	88.4	37.7 N	34.4 N	40.6	46.4
Beryllium	mg/kg	0.88	0.47 E	0.45 E	0.7	0.92 #
Cadmium	mg/kg	0	0.028 U*	0.027 U*	0.018 U	0.87 #
Calcium	mg/kg	15,800	924	1,420	413	1650
Chromium	mg/kg	17.4	10 N	10.4 N	16.7	16.4
Cobalt	mg/kg	10.4	5.3	6.1	13 #	10.9 #
Copper	mg/kg	17.7	6.4	9.6	21.6 #	68.6 #
Iron	mg/kg	23,100	25,800 #	21,100	26,800 #	30,100 #
Lead	mg/kg	26.1	11.8	11.6	17.1	20.3
Magnesium	mg/kg	3,030	716 N	1,220 N	2,570 N	2,180 N
Manganese	mg/kg	1,450	489	396	368	609
Mercury	mg/kg	0.04	0.017 U	0.014 U	0.02 B	0.017 U
Nickel	mg/kg	21.1	11.2	13	21.6 #	19.2
Potassium	mg/kg	927	674 N	813 N	1,270 N#	1,040 N#
Selenium	mg/kg	1.4	0.5 B	0.28 B	0.3 U	0.27 U
Silver	mg/kg	0	0.047 U	0.045 U	0.064 U	0.057 U

Table 4-5. SRCs in Surface Soil at the 40-mm Firing Range (continued)

Media			Soil	Soil	Soil	Soil
Location			069	070	071	072
Station			FBQss-069	FBQss-070	FBQso-071	FBQss-072
Sample ID			FBQSS-069-0137-SO	FBQSS-070-0139-SO	FBQSS-071-0141-SO	FBQSS-072-0143-SO
Customer ID			FBQss-069-0137-SO	FBQss-070-0139-SO	FBQss-071-0141-SO	FBQss-072-0143-SO
Date			11/13/2003	11/13/2003	11/17/2003	11/17/2003
Depth (ft)			0.0 - 1.0	0.0 - 1.0	0.0 - 1.0	0.0 - 1.0
Filtered			Total	Total	Total	Total
Field Type			Regular samples	Regular samples	Regular samples	Regular samples
Analyte (mg/kg)	**Units**	**Facility-wide Background**				
Sodium	mg/kg	123	49.2	56.7	63	55.3
Thallium	mg/kg	0	0.41 B#	0.37 U	2 #	2.6 #
Vanadium	mg/kg	31.1	10	11.3	20.4	16.4
Zinc	mg/kg	61.8	55.8	58.4	61.8 #	114 #
Organic-Semivolatiles						
Bis(2-ethylhexyl)phthalate	mg/kg		NA	NA	NA	NA
Diethyl phthalate	mg/kg		NA	NA	NA	NA
Organic-Volatiles						
1,1,1-Trichloroethane	mg/kg		NA	NA	NA	NA
1,1-Dichloroethene	mg/kg		NA	NA	NA	NA
Acetone	mg/kg		NA	NA	NA	NA
Methylene Chloride	mg/kg		NA	NA	NA	NA
Toluene	mg/kg		NA	NA	NA	NA
Organics-Pesticide/PCB						
4,4'-DDE	mg/kg		NA	NA	NA	NA
Aldrin	mg/kg		NA	NA	NA	NA
Endrin aldehyde	mg/kg		NA	NA	NA	NA
Endrin ketone	mg/kg		NA	NA	NA	NA
Heptachlor	mg/kg		NA	NA	NA	NA
Lindane	mg/kg		NA	NA	NA	NA

Table 4-5. SRCs in Surface Soil at the 40-mm Firing Range (continued)

Media Location Station Sample ID Customer ID Date Depth (ft) Filtered Field Type Analyte (mg/kg)	Units	Facility-wide Background	Soil 073 FBQso-073 FBQSS-073-0145-SO FBQss-073-0145-SO 11/17/2003 0.0 - 1.0 Total Regular samples	Soil 074 FBQso-074 FBQSS-074-0147-SO FBQss-074-0147-SO 11/11/2003 0.0 - 1.0 Total Regular samples	Soil 075 FBQso-075 FBQSS-075-0149-SO FBQss-075-0149-SO 11/13/2003 0.0 - 1.0 Total Regular samples	Soil 075 FBQso-075 FBQSS-075-0403-SO FBQss-075-0403-SO 11/13/2003 0.0 - 1.0 Total Field Duplicate
Explosives						
2,4,6-Trinitrotoluene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
2,4-Dinitrotoluene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
3-Nitrotoluene	mg/kg		0.2 U	0.2 U	0.2 U	0.2 U
HMX	mg/kg		0.2 U	0.2 U	0.2 U	0.2 U
Nitrobenzene	mg/kg		0.062 J	0.1 U	0.1 U	0.1 U
Nitrocellulose	mg/kg		NA	NA	NA	NA
Tetryl	mg/kg		0.2 U	0.2 U	0.17 J	0.2 U
Inorganics						
Aluminum	mg/kg	17,700	14,400	13,900	13,000	14,000
Antimony	mg/kg	0.96	0.28 UN	0.29 UN	0.45 B	0.33 BN
Arsenic	mg/kg	15.4	11.4 N	18.7 #	11.1	13.7
Barium	mg/kg	88.4	72.5	53 N	101 #	88.1 N
Beryllium	mg/kg	0.88	0.63	0.77	0.68	0.66 E
Cadmium	mg/kg	0	0.46 #	0.019 U	0.73 *#	0.33 *#
Calcium	mg/kg	15,800	1,510	358	523	556
Chromium	mg/kg	17.4	20.1 #	18.8 N#	18 #	20 N#
Cobalt	mg/kg	10.4	10.7 #	8.9	9.9	9.3
Copper	mg/kg	17.7	49.7 #	24.6 #	28.1 #	23.9 #
Iron	mg/kg	23,100	23,000	30,600 #	23,700 #	26,100 #
Lead	mg/kg	26.1	13.5	17.1	14.3	14
Magnesium	mg/kg	3,030	3,130 N#	2,880 N	2,230	2,470 N
Manganese	mg/kg	1,450	408	312	809	604
Mercury	mg/kg	0.04	0.018 U	0.016 U	0.024 B	0.018 B
Nickel	mg/kg	21.1	18.8	21.4 #	19.4	18.6
Potassium	mg/kg	927	1,300 N#	1,370 N#	1,200 #	1,190 N#
Selenium	mg/kg	1.4	0.3 U	0.31 U	0.56 B	0.59 B
Silver	mg/kg	0	0.063 U	0.066 U	0.046 U	0.045 U

Table 4-5. SRCs in Surface Soil at the 40-mm Firing Range (continued)

Media Location Station Sample ID Customer ID Date Depth (ft) Filtered Field Type Analyte (mg/kg)	Units	Facility-wide Background	Soil 073 FBQso-073 FBQSS-073-0145-SO FBQss-073-0145-SO 11/17/2003 0.0 - 1.0 Total Regular samples	Soil 074 FBQso-074 FBQSS-074-0147-SO FBQss-074-0147-SO 11/11/2003 0.0 - 1.0 Total Regular samples	Soil 075 FBQso-075 FBQSS-075-0149-SO FBQss-075-0149-SO 11/13/2003 0.0 - 1.0 Total Regular samples	Soil 075 FBQso-075 FBQSS-075-0403-SO FBQss-075-0403-SO 11/13/2003 0.0 - 1.0 Total Field Duplicate
Sodium	mg/kg	123	70.9	73.5	82.1	66.1
Thallium	mg/kg	0	1.8 B#	0.49 U	0.8 B#	0.37 U
Vanadium	mg/kg	31.1	24.3	23.5 N	22.5	25.5
Zinc	mg/kg	61.8	53.6	59.7	77.1 #	76.1 #
Organic-Semivolatiles						
Bis(2-ethylhexyl)phthalate	mg/kg		NA	NA	NA	NA
Diethyl phthalate	mg/kg		NA	NA	NA	NA
Organic-Volatiles						
1,1,1-Trichloroethane	mg/kg		NA	NA	NA	NA
1,1-Dichloroethene	mg/kg		NA	NA	NA	NA
Acetone	mg/kg		NA	NA	NA	NA
Methylene Chloride	mg/kg		NA	NA	NA	NA
Toluene	mg/kg		NA	NA	NA	NA
Organics-Pesticide/PCB						
4,4'-DDE	mg/kg		NA	NA	NA	NA
Aldrin	mg/kg		NA	NA	NA	NA
Endrin aldehyde	mg/kg		NA	NA	NA	NA
Endrin ketone	mg/kg		NA	NA	NA	NA
Heptachlor	mg/kg		NA	NA	NA	NA
Lindane	mg/kg		NA	NA	NA	NA

Table 4-5. SRCs in Surface Soil at the 40-mm Firing Range (continued)

Media			Soil	Soil	Soil	Soil
Location			076	077	078	079
Station			FBQss-076	FBQso-077	FBQss-078	FBQso-079
Sample ID			FBQSS-076-0151-SO	FBQSS-077-0153-SO	FBQSS-078-0155-SO	FBQSS-079-0157-SO
Customer ID			FBQss-076-0151-SO	FBQss-077-0153-SO	FBQss-078-0155-SO	FBQss-079-0157-SO
Date			11/13/2003	11/17/2003	11/17/2003	11/12/2003
Depth (ft)			0.0 - 1.0	0.0 - 1.0	0.0 - 1.0	0.0 - 1.0
Filtered			Total	Total	Total	Total
Field Type			Regular samples	Regular samples	Regular samples	Regular samples
Analyte (mg/kg)	**Units**	**Facility-wide Background**				
Explosives						
2,4,6-Trinitrotoluene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U/U
2,4-Dinitrotoluene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U/U
3-Nitrotoluene	mg/kg		0.2 U	0.2 U	0.2 U	0.2 U/U
HMX	mg/kg		0.2 U	0.2 U	0.2 U	0.2 U/U
Nitrobenzene	mg/kg		0.1 U	0.05 J	0.066 J	0.1 U/U
Nitrocellulose	mg/kg		NA	NA	NA	38 /=
Tetryl	mg/kg		0.2 U	0.2 U	0.2 U	0.2 U/U
Inorganics						
Aluminum	mg/kg	17,700	12,700	16,000	8,480	16,500 /J
Antimony	mg/kg	0.96	0.31 UN	0.27 UN	0.28 UN	0.31 B/UJ
Arsenic	mg/kg	15.4	11.4	12.1 N	16.8 N#	13.5 /=
Barium	mg/kg	88.4	80.7 N	72.2	63	81 N/=
Beryllium	mg/kg	0.88	0.62	0.62	0.56	0.78 /R
Cadmium	mg/kg	0	0.19 #	0.052 B#	0.11 #	0.024 U/U
Calcium	mg/kg	15,800	944	970	1,330	814 /J
Chromium	mg/kg	17.4	15.3 N	21.4 #	13.4	23.8 /=#
Cobalt	mg/kg	10.4	9	10	8.7	12.2 /=#
Copper	mg/kg	17.7	13.8	27.1 #	19.5 #	22 N/J#
Iron	mg/kg	23,100	21,100	24,500 #	21,400	30,400 /=#
Lead	mg/kg	26.1	13.6	12.7	11.8	18.5 N/=
Magnesium	mg/kg	3,030	2,200 N	3,100 N#	2,610 N	3,410 /=#
Manganese	mg/kg	1,450	607	347	374	524 /=
Mercury	mg/kg	0.04	0.022 B	0.017 U	0.046 B#	0.023 B/UJ
Nickel	mg/kg	21.1	16.3	17.9	28.2 #	23.5 /=#
Potassium	mg/kg	927	1,010 N#	1,480 N#	1,100 N#	1,700 N/=#
Selenium	mg/kg	1.4	0.5 B	0.29 U	0.3 U	0.68 B/UJ
Silver	mg/kg	0	0.069 U	0.061 U	0.063 U	0.04 U/U

Table 4-5. SRCs in Surface Soil at the 40-mm Firing Range (continued)

Media Location Station Sample ID Customer ID Date Depth (ft) Filtered Field Type Analyte (mg/kg)	Units	Facility-wide Background	Soil 076 FBQss-076 FBQSS-076-0151-SO FBQss-076-0151-SO 11/13/2003 0.0 - 1.0 Total Regular samples	Soil 077 FBQso-077 FBQSS-077-0153-SO FBQss-077-0153-SO 11/17/2003 0.0 - 1.0 Total Regular samples	Soil 078 FBQss-078 FBQSS-078-0155-SO FBQss-078-0155-SO 11/17/2003 0.0 - 1.0 Total Regular samples	Soil 079 FBQso-079 FBQSS-079-0157-SO FBQss-079-0157-SO 11/12/2003 0.0 - 1.0 Total Regular samples
Sodium	mg/kg	123	73.7	66.5	76	43.8 /=
Thallium	mg/kg	0	0.51 U	1.7 B#	2 #	1.1 B/UJ
Vanadium	mg/kg	31.1	22 N	27	15.3	31.6 /=#
Zinc	mg/kg	61.8	57.1	49.7	59.5	59 N/=
Organic-Semivolatiles						
Bis(2-ethylhexyl)phthalate	mg/kg		NA	NA	NA	0.47 U/UJ
Diethyl phthalate	mg/kg		NA	NA	NA	0.47 U/UJ
Organic-Volatiles						
1,1,1-Trichloroethane	mg/kg		NA	NA	NA	0.0061 U/UJ
1,1-Dichloroethene	mg/kg		NA	NA	NA	0.0061 U/UJ
Acetone	mg/kg		NA	NA	NA	0.0066 JB/R
Methylene Chloride	mg/kg		NA	NA	NA	0.012 JB/R
Toluene	mg/kg		NA	NA	NA	0.0061 U/UJ
Organics-Pesticide/PCB						
4,4'-DDE	mg/kg		NA	NA	NA	0.0024 U/U
Aldrin	mg/kg		NA	NA	NA	0.0024 U/U
Endrin aldehyde	mg/kg		NA	NA	NA	0.0024 U/U
Endrin ketone	mg/kg		NA	NA	NA	0.0024 U/U
Heptachlor	mg/kg		NA	NA	NA	0.0024 U/U
Lindane	mg/kg		NA	NA	NA	0.0024 U/U

Table 4-5. SRCs in Surface Soil at the 40-mm Firing Range (continued)

Media			Soil	Soil	Soil	Soil
Location			080	081	082	083
Station			FBQss-080	FBQss-081	FBQso-082	FBQso-083
Sample ID			FBQSS-080-0159-SO	FBQSS-081-0161-SO	FBQSS-082-0163-SO	FBQSS-083-0165-SO
Customer ID			FBQss-080-0159-SO	FBQss-081-0161-SO	FBQss-082-0163-SO	FBQss-083-0165-SO
Date			11/13/2003	11/11/2003	11/11/2003	11/13/2003
Depth (ft)			0.0 - 1.0	0.0 - 1.0	0.0 - 1.0	0.0 - 1.0
Filtered			Total	Total	Total	Total
Field Type			Regular samples	Regular samples	Regular samples	Regular samples
Analyte (mg/kg)	**Units**	**Facility-wide Background**				
Explosives						
2,4,6-Trinitrotoluene	mg/kg		0.1 U	0.1 U/U	0.1 U/U	0.1 U/U
2,4-Dinitrotoluene	mg/kg		0.1 U	0.1 U/U	0.1 U/U	0.1 U/U
3-Nitrotoluene	mg/kg		0.2 U	0.2 U/U	0.2 U/U	0.2 U/U
HMX	mg/kg		0.2 U	0.2 U/U	0.2 U/U	0.2 U/U
Nitrobenzene	mg/kg		0.1 U	0.07 JB/UJ	0.037 JB/UJ	0.1 U/U
Nitrocellulose	mg/kg		NA	NA	NA	50 /=
Tetryl	mg/kg		0.2 U	0.2 U/R	0.2 U/R	0.2 U/U
Inorganics						
Aluminum	mg/kg	17,700	3,740	7,380 /=	6,740 /=	13,500 /J
Antimony	mg/kg	0.96	0.28 UN	0.28 BN/UJ	0.45 BN/UJ	0.25 B/UJ
Arsenic	mg/kg	15.4	5.7	14.1 /=	11.3 /=	13.1 /=
Barium	mg/kg	88.4	29.8 N	144 /=#	49.3 /=	61.5 N/=
Beryllium	mg/kg	0.88	0.6	0.73 /=	0.61 /=	0.43 /R
Cadmium	mg/kg	0	0.17 #	0.2 /=#	0.13 /=#	0.027 U/U
Calcium	mg/kg	15,800	197	6,380 /=	4,420 /=	176 /J
Chromium	mg/kg	17.4	7.5 N	11.3 /=	10.4 /=	18.3 /=#
Cobalt	mg/kg	10.4	5.8	6.7 /=	6.7 /=	8.4 /=
Copper	mg/kg	17.7	6	14 /=	14.1 /=	13.6 N/J
Iron	mg/kg	23,100	24,800 #	21,400 /=	18,300 /=	26,100 /=#
Lead	mg/kg	26.1	24.7	19.1 /=	15.1 /=	12.7 N/=
Magnesium	mg/kg	3,030	575 N	2,180 N/=	1,870 N/=	2,260 /=
Manganese	mg/kg	1,450	625	635 /=	383 /=	437 /=
Mercury	mg/kg	0.04	0.022 B	0.018 B/UJ	0.018 B/UJ	0.017 B/UJ
Nickel	mg/kg	21.1	9.7	14.9 /=	15.2 /=	14.9 /=
Potassium	mg/kg	927	578 N	1,020 N/=#	914 N/=	1,100 N/=#
Selenium	mg/kg	1.4	0.3 U	0.27 U/U	0.45 B/UJ	0.71 B/UJ
Silver	mg/kg	0	0.063 U	0.058 U/U	0.057 U/U	0.045 U/U

Table 4-5. SRCs in Surface Soil at the 40-mm Firing Range (continued)

Media Location Station Sample ID Customer ID Date Depth (ft) Filtered Field Type Analyte (mg/kg)	Units	Facility-wide Background	Soil 080 FBQss-080 FBQSS-080-0159-SO FBQss-080-0159-SO 11/13/2003 0.0 - 1.0 Total Regular samples	Soil 081 FBQss-081 FBQSS-081-0161-SO FBQss-081-0161-SO 11/11/2003 0.0 - 1.0 Total Regular samples	Soil 082 FBQso-082 FBQSS-082-0163-SO FBQss-082-0163-SO 11/11/2003 0.0 - 1.0 Total Regular samples	Soil 083 FBQso-083 FBQSS-083-0165-SO FBQss-083-0165-SO 11/13/2003 0.0 - 1.0 Total Regular samples
Sodium	mg/kg	123	56.5	102 /=	70.2 /=	51.6 /=
Thallium	mg/kg	0	0.47 U	0.43 U/U	0.42 U/U	0.69 B/UJ
Vanadium	mg/kg	31.1	9.7 N	12.4 /=	11.8 /=	25.7 /=
Zinc	mg/kg	61.8	55	78.5 /=#	60.7 /=	48.8 N/=
Organic-Semivolatiles						
Bis(2-ethylhexyl)phthalate	mg/kg		NA	NA	NA	0.41 U/U
Diethyl phthalate	mg/kg		NA	NA	NA	0.41 U/U
Organic-Volatiles						
1,1,1-Trichloroethane	mg/kg		NA	NA	NA	0.013 /=
1,1-Dichloroethene	mg/kg		NA	NA	NA	0.0074 /J
Acetone	mg/kg		NA	NA	NA	0.0097 JB/UJ
Methylene Chloride	mg/kg		NA	NA	NA	0.012 B/UJ
Toluene	mg/kg		NA	NA	NA	0.002 J/J
Organics-Pesticide/PCB						
4,4'-DDE	mg/kg		NA	NA	NA	0.00033 J/J
Aldrin	mg/kg		NA	NA	NA	0.0012 JP/J
Endrin aldehyde	mg/kg		NA	NA	NA	0.00085 J/J
Endrin ketone	mg/kg		NA	NA	NA	0.00034 JP/J
Heptachlor	mg/kg		NA	NA	NA	0.00079 J/J
Lindane	mg/kg		NA	NA	NA	0.00093 J/J

1 **Table 4-5. SRCs in Surface Soil at the 40-mm Firing Range (continued)**

Media Location Station Sample ID Customer ID Date Depth (ft) Filtered Field Type Analyte (mg/kg)	Units	Facility-wide Background	Soil 084 FBQss-084 FBQSS-084-0167-SO FBQss-084-0167-SO 11/13/2003 0.0 - 1.0 Total Regular samples	Soil 084 FBQss-084 FBQSS-084-0404-SO FBQss-084-0404-SO 11/13/2003 0.0 - 1.0 Total Field Duplicate	Soil 085 FBQso-085 FBQSS-085-0169-SO FBQss-085-0169-SO 11/13/2003 0.0 - 1.0 Total Regular samples	Soil 086 FBQso-086 FBQSS-086-0171-SO FBQss-086-0171-SO 11/17/2003 0.0 - 1.0 Total Regular samples
Explosives						
2,4,6-Trinitrotoluene	mg/kg		0.1 U/U	0.1 U/U	0.1 U	0.1 U
2,4-Dinitrotoluene	mg/kg		0.1 U/U	0.1 U/U	0.1 U	0.1 U
3-Nitrotoluene	mg/kg		0.2 U/U	0.2 U/U	0.2 U	0.2 U
HMX	mg/kg		0.2 U/U	0.2 U/U	0.2 U	0.2 U
Nitrobenzene	mg/kg		0.1 U/U	0.1 U/U	0.1 U	0.1 U
Nitrocellulose	mg/kg		20 /=	21 /=	NA	NA
Tetryl	mg/kg		0.2 U/U	0.2 U/U	0.2 U	0.2 U
Inorganics						
Aluminum	mg/kg	17,700	7,320 /J	8,570 /J	13,700	16,200
Antimony	mg/kg	0.96	0.18 U/U	0.3 B/UJ	0.27 BN	0.3 UN
Arsenic	mg/kg	15.4	7.9 /=	8.8 /=	12.3	20.5 N#
Barium	mg/kg	88.4	44.7 N/=	48.3 N/=	71.9 N	55.7
Beryllium	mg/kg	0.88	0.54 /R	0.44 /R	0.57 E	0.73
Cadmium	mg/kg	0	0.023 U/U	0.025 U/U	0.03 U*	0.057 B#
Calcium	mg/kg	15,800	239 /J	189 /J	497	548
Chromium	mg/kg	17.4	11.6 /=	12.5 /=	21.9 N#	21.7 #
Cobalt	mg/kg	10.4	8.6 /=	7.3 /=	9.3	8
Copper	mg/kg	17.7	15.7 N/J	10.5 N/J	15.3	24 #
Iron	mg/kg	23,100	23,000 /=	18,900 /=	25,000 #	30,400 #
Lead	mg/kg	26.1	13.8 N/=	10.8 N/=	15.1	15.5
Magnesium	mg/kg	3,030	1,380 /=	1,490 /=	2,250 N	3,310 N#
Manganese	mg/kg	1,450	519 /=	381 /=	489	217
Mercury	mg/kg	0.04	0.016 U/U	0.017 U/U	0.02 B	0.061 B#
Nickel	mg/kg	21.1	14.2 /=	13.9 /=	14.8	21.8 #
Potassium	mg/kg	927	881 N/=	836 N/=	1,160 N#	1,600 N#
Selenium	mg/kg	1.4	0.47 B/UJ	0.42 B/UJ	0.57 B	0.32 U
Silver	mg/kg	0	0.039 U/U	0.042 U/U	0.05 U	0.068 U

Table 4-5. SRCs in Surface Soil at the 40-mm Firing Range (continued)

Media Location Station Sample ID Customer ID Date Depth (ft) Filtered Field Type Analyte (mg/kg)	Units	Facility-wide Background	Soil 084 FBQss-084 FBQSS-084-0167-SO FBQss-084-0167-SO 11/13/2003 0.0 - 1.0 Total Regular samples	Soil 084 FBQss-084 FBQSS-084-0404-SO FBQss-084-0404-SO 11/13/2003 0.0 - 1.0 Total Field Duplicate	Soil 085 FBQso-085 FBQSS-085-0169-SO FBQss-085-0169-SO 11/13/2003 0.0 - 1.0 Total Regular samples	Soil 086 FBQso-086 FBQSS-086-0171-SO FBQss-086-0171-SO 11/17/2003 0.0 - 1.0 Total Regular samples
Sodium	mg/kg	123	30.4 /=	44.1 /=	76.2	70.2
Thallium	mg/kg	0	0.76 B/UJ	0.64 B/UJ	0.41 U	2.4 #
Vanadium	mg/kg	31.1	14.4 /=	15.9 /=	27.5	27.6
Zinc	mg/kg	61.8	72.4 N/=#	56.8 N/=	44.2	57.1
Organic-Semivolatiles						
Bis(2-ethylhexyl)phthalate	mg/kg		0.39 U/UJ	0.39 U/UJ	NA	NA
Diethyl phthalate	mg/kg		0.39 U/UJ	0.39 U/UJ	NA	NA
Organic-Volatiles						
1,1,1-Trichloroethane	mg/kg		0.0059 U/U	0.0058 U/U	NA	NA
1,1-Dichloroethene	mg/kg		0.0059 U/R	0.0058 U/R	NA	NA
Acetone	mg/kg		0.0081 JB/UJ	0.0073 JB/UJ	NA	NA
Methylene Chloride	mg/kg		0.012 JB/UJ	0.011 JB/UJ	NA	NA
Toluene	mg/kg		0.0059 U/U	0.0058 U/U	NA	NA
Organics-Pesticide/PCB						
4,4'-DDE	mg/kg		0.002 U/U	0.0019 U/U	NA	NA
Aldrin	mg/kg		0.002 U/U	0.0019 U/U	NA	NA
Endrin aldehyde	mg/kg		0.002 U/U	0.0019 U/U	NA	NA
Endrin ketone	mg/kg		0.002 U/U	0.0019 U/U	NA	NA
Heptachlor	mg/kg		0.002 U/U	0.0019 U/U	NA	NA
Lindane	mg/kg		0.002 U/U	0.0019 U/U	NA	NA

1 **Table 4-5. SRCs in Surface Soil at the 40-mm Firing Range (continued)**

Media Location Station Sample ID Customer ID Date Depth (ft) Filtered Field Type Analyte (mg/kg)	Units	Facility-wide Background	Soil 087 FBQso-087 FBQSS-087-0173-SO FBQss-087-0173-SO 11/17/2003 0.0 - 1.0 Total Regular samples	Soil 088 FBQso-088 FBQSS-088-0175-SO FBQss-088-0175-SO 11/11/2003 0.0 - 1.0 Total Regular samples	Soil 088 FBQso-088 FBQSS-088-0399-SO FBQss-088-0399-SO 11/11/2003 0.0 - 1.0 Total Field Duplicate	Soil 089 FBQss-089 FBQSS-089-0177-SO FBQss-089-0177-SO 11/11/2003 0.0 - 1.0 Total Regular samples
Explosives						
2,4,6-Trinitrotoluene	mg/kg		0.1 U/U	0.1 U	0.1 U	0.1 U/U
2,4-Dinitrotoluene	mg/kg		0.1 U/U	0.1 U	0.1 U	0.1 U/U
3-Nitrotoluene	mg/kg		0.2 U/U	0.2 U	0.2 U	0.2 U/U
HMX	mg/kg		0.2 U/U	0.2 U	0.2 U	0.2 U/U
Nitrobenzene	mg/kg		0.1 U/U	0.1 U	0.1 U	0.1 U/U
Nitrocellulose	mg/kg		NA	NA	NA	NA
Tetryl	mg/kg		0.2 U/R	0.2 U	0.2 U	0.2 U/R
Inorganics						
Aluminum	mg/kg	17,700	21,000 /=#	17,600	14,800	3,990 /=
Antimony	mg/kg	0.96	0.34 BN/UJ	0.23 BN	0.24 U	0.3 UN/U
Arsenic	mg/kg	15.4	17.7 /=#	12.1	12.1	8.9 /=
Barium	mg/kg	88.4	79.8 /=	68.5 N	55.2	25.7 /=
Beryllium	mg/kg	0.88	0.9 /=#	0.67	0.6	0.48 /=
Cadmium	mg/kg	0	0.054 B/UJ	0.057 #	0.029 B#	0.09 /=#
Calcium	mg/kg	15,800	575 /=	939	932	425 /=
Chromium	mg/kg	17.4	27.2 /=#	21.6 N#	19.2 #	8.5 /=
Cobalt	mg/kg	10.4	9.7 /=	8.1	6.3	5.4 /=
Copper	mg/kg	17.7	27.2 /=#	23.2 #	18.5 #	8.5 /=
Iron	mg/kg	23,100	34,700 /=#	26,500 #	25,400 #	20,100 /=
Lead	mg/kg	26.1	15.6 /=	13.1	12.7	14.6 /=
Magnesium	mg/kg	3,030	4,290 N/=#	2,920 N	2,610	771 N/=
Manganese	mg/kg	1,450	243 /=	204	170	320 /=
Mercury	mg/kg	0.04	0.021 B/UJ	0.02 B	0.017 B	0.03 B/UJ
Nickel	mg/kg	21.1	26.6 /=#	17.5	16	9.8 /=
Potassium	mg/kg	927	2,010 N/=#	1,270 N#	1,110 #	777 N/=
Selenium	mg/kg	1.4	0.51 B/UJ	0.79 B	0.36 B	0.5 B/UJ
Silver	mg/kg	0	0.06 U/U	0.049 U	0.055 U	0.069 U/U

Table 4-5. SRCs in Surface Soil at the 40-mm Firing Range (continued)

Media Location Station Sample ID Customer ID Date Depth (ft) Filtered Field Type Analyte (mg/kg)	Units	Facility-wide Background	Soil 087 FBQso-087 FBQSS-087-0173-SO FBQss-087-0173-SO 11/17/2003 0.0 - 1.0 Total Regular samples	Soil 088 FBQso-088 FBQSS-088-0175-SO FBQss-088-0175-SO 11/11/2003 0.0 - 1.0 Total Regular samples	Soil 088 FBQso-088 FBQSS-088-0399-SO FBQss-088-0399-SO 11/11/2003 0.0 - 1.0 Total Field Duplicate	Soil 089 FBQss-089 FBQSS-089-0177-SO FBQss-089-0177-SO 11/11/2003 0.0 - 1.0 Total Regular samples
Sodium	mg/kg	123	78.9 /=	68	67.7	52.2 B/UJ
Thallium	mg/kg	0	0.45 U/U	0.36 U	0.41 U	0.51 U/U
Vanadium	mg/kg	31.1	34.1 /=#	33.8 N#	28.9	10.6 /=
Zinc	mg/kg	61.8	65.5 /=#	49.3	44	55.1 /=
Organic-Semivolatiles						
Bis(2-ethylhexyl)phthalate	mg/kg		NA	NA	NA	NA
Diethyl phthalate	mg/kg		NA	NA	NA	NA
Organic-Volatiles						
1,1,1-Trichloroethane	mg/kg		NA	NA	NA	NA
1,1-Dichloroethene	mg/kg		NA	NA	NA	NA
Acetone	mg/kg		NA	NA	NA	NA
Methylene Chloride	mg/kg		NA	NA	NA	NA
Toluene	mg/kg		NA	NA	NA	NA
Organics-Pesticide/PCB						
4,4'-DDE	mg/kg		NA	NA	NA	NA
Aldrin	mg/kg		NA	NA	NA	NA
Endrin aldehyde	mg/kg		NA	NA	NA	NA
Endrin ketone	mg/kg		NA	NA	NA	NA
Heptachlor	mg/kg		NA	NA	NA	NA
Lindane	mg/kg		NA	NA	NA	NA

Table 4-5. SRCs in Surface Soil at the 40-mm Firing Range (continued)

Media Location Station Sample ID Customer ID Date Depth (ft) Filtered Field Type Analyte (mg/kg)	Units	Facility-wide Background	Soil 090 FBQss-090 FBQSS-090-0179-SO FBQss-090-0179-SO 11/11/2003 0.0 - 1.0 Total Regular samples	Soil 091 FBQss-091 FBQSS-091-0181-SO FBQss-091-0181-SO 11/11/2003 0.0 - 1.0 Total Regular samples	Soil 092 FBQss-092 FBQSS-092-0183-SO FBQss-092-0183-SO 11/11/2003 0.0 - 1.0 Total Regular samples	Soil 093 FBQss-093 FBQSS-093-0185-SO FBQss-093-0185-SO 11/11/2003 0.0 - 1.0 Total Regular samples
Explosives						
2,4,6-Trinitrotoluene	mg/kg		0.1 U/U	0.11 /=	0.1 U/U	0.1 U/U
2,4-Dinitrotoluene	mg/kg		0.1 U/U	0.096 J/J	0.1 U/U	0.1 U/U
3-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 U/U	0.1 U/U	0.1 U/U	0.1 U/U
Nitrocellulose	mg/kg		NA	NA	NA	NA
Tetryl	mg/kg		0.2 U/R	0.2 U/R	0.2 U/R	0.2 U/R
Inorganics						
Aluminum	mg/kg	17,700	4,080 /=	10,100 /=	4,510 /=	4,870 /=
Antimony	mg/kg	0.96	0.28 UN/U	0.52 BN/UJ	0.29 UN/U	0.27 UN/U
Arsenic	mg/kg	15.4	7.3 /=	12.3 /=	6.7 /=	10.7 /=
Barium	mg/kg	88.4	21.9 /=	96.3 /=#	30.8 /=	29.3 /=
Beryllium	mg/kg	0.88	0.42 /=	1 /=#	0.61 /=	0.53 /=
Cadmium	mg/kg	0	0.07 B/UJ	0.3 /=#	0.2 /=#	0.19 /=#
Calcium	mg/kg	15,800	252 /=	9,250 /=	2,860 /=	1,510 /=
Chromium	mg/kg	17.4	7.8 /=	19.6 /=#	8.3 /=	9.9 /=
Cobalt	mg/kg	10.4	4.7 /=	7.2 /=	4.4 /=	6.2 /=
Copper	mg/kg	17.7	8.7 /=	18.5 /=#	7.6 /=	10.2 /=
Iron	mg/kg	23,100	15,200 /=	20,900 /=	17,800 /=	23,200 /=#
Lead	mg/kg	26.1	16.9 /=	49.5 /=#	19.1 /=	20.3 /=
Magnesium	mg/kg	3,030	837 N/=	2,670 N/=	1,050 N/=	1,370 N/=
Manganese	mg/kg	1,450	251 /=	737 /=	329 /=	414 /=
Mercury	mg/kg	0.04	0.02 B/UJ	0.037 B/UJ	0.025 B/UJ	0.037 B/UJ
Nickel	mg/kg	21.1	9.2 /=	14.8 /=	9.2 /=	13.2 /=
Potassium	mg/kg	927	614 N/=	1,080 N/=#	692 N/=	858 N/=
Selenium	mg/kg	1.4	0.37 B/UJ	0.93 B/UJ	0.53 B/UJ	0.83 B/UJ
Silver	mg/kg	0	0.063 U/U	0.064 U/U	0.066 U/U	0.06 U/U

Table 4-5. SRCs in Surface Soil at the 40-mm Firing Range (continued)

Media Location Station Sample ID Customer ID Date Depth (ft) Filtered Field Type Analyte (mg/kg)	Units	Facility-wide Background	Soil 090 FBQss-090 FBQSS-090-0179-SO FBQss-090-0179-SO 11/11/2003 0.0 - 1.0 Total Regular samples	Soil 091 FBQss-091 FBQSS-091-0181-SO FBQss-091-0181-SO 11/11/2003 0.0 - 1.0 Total Regular samples	Soil 092 FBQss-092 FBQSS-092-0183-SO FBQss-092-0183-SO 11/11/2003 0.0 - 1.0 Total Regular samples	Soil 093 FBQss-093 FBQSS-093-0185-SO FBQss-093-0185-SO 11/11/2003 0.0 - 1.0 Total Regular samples
Sodium	mg/kg	123	49.1 B/UJ	118 /=	57.9 /=	52.1 /=
Thallium	mg/kg	0	0.47 U/U	0.48 U/U	0.49 U/U	0.45 U/U
Vanadium	mg/kg	31.1	9.3 /=	16.9 /=	9.2 /=	11.3 /=
Zinc	mg/kg	61.8	57.8 /=	69.3 /=#	63.1 /=#	69.5 /=#
Organic-Semivolatiles						
Bis(2-ethylhexyl)phthalate	mg/kg		NA	NA	NA	NA
Diethyl phthalate	mg/kg		NA	NA	NA	NA
Organic-Volatiles						
1,1,1-Trichloroethane	mg/kg		NA	NA	NA	NA
1,1-Dichloroethene	mg/kg		NA	NA	NA	NA
Acetone	mg/kg		NA	NA	NA	NA
Methylene Chloride	mg/kg		NA	NA	NA	NA
Toluene	mg/kg		NA	NA	NA	NA
Organics-Pesticide/PCB						
4,4'-DDE	mg/kg		NA	NA	NA	NA
Aldrin	mg/kg		NA	NA	NA	NA
Endrin aldehyde	mg/kg		NA	NA	NA	NA
Endrin ketone	mg/kg		NA	NA	NA	NA
Heptachlor	mg/kg		NA	NA	NA	NA
Lindane	mg/kg		NA	NA	NA	NA

Table 4-5. SRCs in Surface Soil at the 40-mm Firing Range (continued)

Media Location Station Sample ID Customer ID Date Depth (ft) Filtered Field Type Analyte (mg/kg)	Units	Facility-wide Background	Soil 094 FBQso-094 FBQSS-094-0187-SO FBQss-094-0187-SO 11/12/2003 0.0 - 1.0 Total Regular samples	Soil 094 FBQso-094 FBQSS-094-0401-SO FBQss-094-0401-SO 11/12/2003 0.0 - 1.0 Total Field Duplicate	Soil 095 FBQso-095 FBQSS-095-0189-SO FBQss-095-0189-SO 11/12/2003 0.0 - 1.0 Total Regular samples	Soil 096 FBQso-096 FBQSS-096-0191-SO FBQss-096-0191-SO 11/12/2003 0.0 - 1.0 Total Regular samples
Explosives						
2,4,6-Trinitrotoluene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
2,4-Dinitrotoluene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
3-Nitrotoluene	mg/kg		0.2 U	0.2 U	0.2 U	0.2 U
HMX	mg/kg		0.2 U	0.2 U	0.2 U	0.2 U
Nitrobenzene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
Nitrocellulose	mg/kg		NA	NA	NA	NA
Tetryl	mg/kg		0.2 U	0.2 U	0.2 U	0.2 U
Inorganics						
Aluminum	mg/kg	17,700	12,900	13,900	143,00	12,200
Antimony	mg/kg	0.96	0.31 UN	0.32 UN	0.36 BN	0.3 UN
Arsenic	mg/kg	15.4	8.3	9.2	10.3	10
Barium	mg/kg	88.4	88.6 N#	84.1 N	97.6 N#	137 N#
Beryllium	mg/kg	0.88	0.75	0.7	0.86	0.82
Cadmium	mg/kg	0	0.066 B#	0.063 B#	0.18 #	0.12 #
Calcium	mg/kg	15,800	153	157	743	279
Chromium	mg/kg	17.4	14.5 N	15.9 N	429 N#	15 N
Cobalt	mg/kg	10.4	11.8 #	12.3 #	12.3 #	11.3 #
Copper	mg/kg	17.7	8.9	10.1	10.4	11.5
Iron	mg/kg	23,100	18,600	20,700	19,700	20,200
Lead	mg/kg	26.1	18.3	17.5	18.4	19.4
Magnesium	mg/kg	3,030	1,850 N	2,150 N	2,150 N	2,090 N
Manganese	mg/kg	1,450	1,000	911	1,300	1,200
Mercury	mg/kg	0.04	0.038 B#	0.042 B#	0.025 B	0.02 B
Nickel	mg/kg	21.1	14.3	15.1	16.7	16.2
Potassium	mg/kg	927	796 N	920 N	878 N	930 N#
Selenium	mg/kg	1.4	0.57 B	0.35 U	0.65 U	0.64 U
Silver	mg/kg	0	0.17 B#	0.16 B#	0.14 U	0.14 U

Table 4-5. SRCs in Surface Soil at the 40-mm Firing Range (continued)

Media Location Station Sample ID Customer ID Date Depth (ft) Filtered Field Type Analyte (mg/kg)	Units	Facility-wide Background	Soil 094 FBQso-094 FBQSS-094-0187-SO FBQss-094-0187-SO 11/12/2003 0.0 - 1.0 Total Regular samples	Soil 094 FBQso-094 FBQSS-094-0401-SO FBQss-094-0401-SO 11/12/2003 0.0 - 1.0 Total Field Duplicate	Soil 095 FBQso-095 FBQSS-095-0189-SO FBQss-095-0189-SO 11/12/2003 0.0 - 1.0 Total Regular samples	Soil 096 FBQso-096 FBQSS-096-0191-SO FBQss-096-0191-SO 11/12/2003 0.0 - 1.0 Total Regular samples
Sodium	mg/kg	123	114	110	80.6	102
Thallium	mg/kg	0	0.52 U	0.54 U	1 U	1 U
Vanadium	mg/kg	31.1	23.1 N	25.3 N	23.5 N	21.2 N
Zinc	mg/kg	61.8	49.7	52.7	60.7	51.5
Organic-Semivolatiles						
Bis(2-ethylhexyl)phthalate	mg/kg		NA	NA	NA	NA
Diethyl phthalate	mg/kg		NA	NA	NA	NA
Organic-Volatiles						
1,1,1-Trichloroethane	mg/kg		NA	NA	NA	NA
1,1-Dichloroethene	mg/kg		NA	NA	NA	NA
Acetone	mg/kg		NA	NA	NA	NA
Methylene Chloride	mg/kg		NA	NA	NA	NA
Toluene	mg/kg		NA	NA	NA	NA
Organics-Pesticide/PCB						
4,4'-DDE	mg/kg		NA	NA	NA	NA
Aldrin	mg/kg		NA	NA	NA	NA
Endrin aldehyde	mg/kg		NA	NA	NA	NA
Endrin ketone	mg/kg		NA	NA	NA	NA
Heptachlor	mg/kg		NA	NA	NA	NA
Lindane	mg/kg		NA	NA	NA	NA

Table 4-5. SRCs in Surface Soil at the 40-mm Firing Range (continued)

Media Location Station Sample ID Customer ID Date Depth (ft) Filtered Field Type Analyte (mg/kg)	Units	Facility-wide Background	Soil 097 FBQso-097 FBQSS-097-0193-SO FBQss-097-0193-SO 11/12/2003 0.0 - 1.0 Total Regular samples	Soil 098 FBQso-098 FBQSS-098-0195-SO FBQss-098-0195-SO 11/12/2003 0.0 - 1.0 Total Regular samples	Soil 099 FBQss-099 FBQSS-099-0197-SO FBQss-099-0197-SO 11/11/2003 0.0 - 1.0 Total Regular samples	Soil 100 FBQso-100 FBQSS-100-0199-SO FBQss-100-0199-SO 11/11/2003 0.0 - 1.0 Total Regular samples
Explosives						
2,4,6-Trinitrotoluene	mg/kg		0.1 U	0.1 U/U	0.1 U/U	0.1 U/U
2,4-Dinitrotoluene	mg/kg		0.1 U	0.1 U/U	0.1 U/U	0.1 U/U
3-Nitrotoluene	mg/kg		0.2 U	0.2 U/U	0.2 U/U	0.2 U/U
HMX	mg/kg		0.2 U	0.2 U/U	0.2 U/U	0.2 U/U
Nitrobenzene	mg/kg		0.1 U	0.037 JB/UJ	0.1 U/U	0.1 U/U
Nitrocellulose	mg/kg		NA	64 /=	NA	NA
Tetryl	mg/kg		0.2 U	0.2 U/U	0.2 U/R	0.2 U/R
Inorganics						
Aluminum	mg/kg	17,700	12,600	13,200 /J	3,530 /=	6,340 /=
Antimony	mg/kg	0.96	0.35 BN	0.33 B/UJ	0.29 UN/U	0.35 BN/UJ
Arsenic	mg/kg	15.4	9.1	8.5 /=	7 /=	11.9 /=
Barium	mg/kg	88.4	86.6 N	64.2 N/=	25.4 /=	34.4 /=
Beryllium	mg/kg	0.88	0.67	0.42 /R	0.81 /=	0.48 /=
Cadmium	mg/kg	0	0.083 #	0.027 U/U	0.23 /=#	0.12 /=#
Calcium	mg/kg	15,800	196	326 /J	663 /=	671 /=
Chromium	mg/kg	17.4	18.9 N#	16.3 /=	9.4 /=	13.5 /=
Cobalt	mg/kg	10.4	10.9 #	10.7 /=#	4.6 /=	6.5 /=
Copper	mg/kg	17.7	8.8	9.8 N/J	7.6 /=	12.2 /=
Iron	mg/kg	23,100	18,600	20,500 /=	26,700 /=#	19,300 /=
Lead	mg/kg	26.1	14.5	11.7 N/=	15.2 /=	16.7 /=
Magnesium	mg/kg	3,030	1,680 N	2,090 /=	757 N/=	1,390 N/=
Manganese	mg/kg	1,450	958	456 /=	271 /=	334 /=
Mercury	mg/kg	0.04	0.024 B	0.025 B/UJ	0.022 B/UJ	0.021 B/UJ
Nickel	mg/kg	21.1	15.8	14.6 /=	9.4 /=	13.7 /=
Potassium	mg/kg	927	739 N	998 N/=#	694 N/=	1,010 N/=#
Selenium	mg/kg	1.4	0.75 B	0.5 B/UJ	0.73 B/UJ	0.32 U/U
Silver	mg/kg	0	0.13 B#	0.046 U/U	0.065 U/U	0.067 U/U

Table 4-5. SRCs in Surface Soil at the 40-mm Firing Range (continued)

Media Location Station Sample ID Customer ID Date Depth (ft) Filtered Field Type Analyte (mg/kg)	Units	Facility-wide Background	Soil 097 FBQso-097 FBQSS-097-0193-SO FBQss-097-0193-SO 11/12/2003 0.0 - 1.0 Total Regular samples	Soil 098 FBQso-098 FBQSS-098-0195-SO FBQss-098-0195-SO 11/12/2003 0.0 - 1.0 Total Regular samples	Soil 099 FBQss-099 FBQSS-099-0197-SO FBQss-099-0197-SO 11/11/2003 0.0 - 1.0 Total Regular samples	Soil 100 FBQso-100 FBQSS-100-0199-SO FBQss-100-0199-SO 11/11/2003 0.0 - 1.0 Total Regular samples
Sodium	mg/kg	123	101	54.3 /=	47.7 B/UJ	59.6 /=
Thallium	mg/kg	0	0.49 U	0.61 B/UJ	0.48 U/U	0.5 U/U
Vanadium	mg/kg	31.1	23.2 N	25.6 /=	12.3 /=	12.8 /=
Zinc	mg/kg	61.8	51.8	51.7 N/=	82.9 /=#	63.5 /=#
Organic-Semivolatiles						
Bis(2-ethylhexyl)phthalate	mg/kg		NA	0.15 J/J	NA	NA
Diethyl phthalate	mg/kg		NA	5.6 /=	NA	NA
Organic-Volatiles						
1,1,1-Trichloroethane	mg/kg		NA	0.0069 U/U	NA	NA
1,1-Dichloroethene	mg/kg		NA	0.0069 U/U	NA	NA
Acetone	mg/kg		NA	0.015 B/R	NA	NA
Methylene Chloride	mg/kg		NA	0.0085 JB/R	NA	NA
Toluene	mg/kg		NA	0.0069 U/U	NA	NA
Organics-Pesticide/PCB						
4,4'-DDE	mg/kg		NA	0.002 U/U	NA	NA
Aldrin	mg/kg		NA	0.002 U/U	NA	NA
Endrin aldehyde	mg/kg		NA	0.002 U/U	NA	NA
Endrin ketone	mg/kg		NA	0.002 U/U	NA	NA
Heptachlor	mg/kg		NA	0.002 U/U	NA	NA
Lindane	mg/kg		NA	0.002 U/U	NA	NA

Table 4-5. SRCs in Surface Soil at the 40-mm Range (continued)

Note: Data qualifiers are presented as laboratory qualifiers/validation qualifiers.
B for inorganics = Result is less than the contract-required detection limit but greater than the instrument detection limit.
B for organics = Compound is detected in the blank as well as the sample.
E = Result is estimated because of the presence of interference.
J = Estimated value is less than the reporting limits.
N = Matrix spike recovery is outside the control limits.
P = Greater than 25% difference between the two GC columns.
R = Data are rejected.
U = Not detected.
# = Value is above the facility-wide background.
* = Duplicate analysis is outside the control limits.
“=” = Analyte present and concentration accurate.
Facility-wide background is determined for the Winklepeck Burning Ground Phase II Remedial Investigation (USACE 2001b).
NA = Not applicable.
PCB = Polychlorinated biphenyl.
SRC = Site-related contaminant.

Table 4-6. Summary Statistics and Determination of SRCs in Subsurface Soil Samples at the Fuze and Booster Quarry Landfill/Ponds

Analyte	Units	Results >Detection Limit	Average Result	Minimum Detect	Maximum Detect	Background Criteria	Site Related?	Justification
Miscellaneous								
Chromium, hexavalent	mg/kg	2/ 5	3.19	3.7	7.9		Yes	No Background Data Available
Metals								
Aluminum	mg/kg	37/ 37	14,000	556	20,900	19,500	Yes	Above Background
Antimony	mg/kg	2/ 37	0.295	1.1	1.9	0.96	Yes	Above Background
Arsenic	mg/kg	36/ 37	14.5	7.3	24.6	19.8	Yes	Above Background
Barium	mg/kg	37/ 37	76.2	11	151	124	Yes	Above Background
Beryllium	mg/kg	37/ 37	0.775	0.2	1.2	0.88	Yes	Above Background
Cadmium	mg/kg	10/ 37	0.0611	0.085	0.72	0	Yes	Above Background
Calcium	mg/kg	37/ 37	5,130	90.6	35,100	35,500	No	Essential Element
Chromium	mg/kg	37/ 37	26.6	3	283	27.2	Yes	Above Background
Cobalt	mg/kg	37/ 37	11.8	0.97	22.5	23.2	No	Below Background
Copper	mg/kg	37/ 37	19.8	0.85	28.2	32.3	No	Below Background
Iron	mg/kg	37/ 37	27,900	13,500	40,800	35,200	No	Essential Element
Lead	mg/kg	37/ 37	17.5	2.2	116	19.1	Yes	Above Background
Magnesium	mg/kg	37/ 37	3,600	95.6	9,080	8,790	No	Essential Element
Manganese	mg/kg	37/ 37	450	190	978	3,030	No	Below Background
Mercury	mg/kg	1/ 37	0.0311	0.76	0.76	0.044	?	<= 5% Detects
Nickel	mg/kg	37/ 37	22.7	2.3	37.4	60.7	No	Below Background
Potassium	mg/kg	37/ 37	1,450	118	3,120	3,350	No	Essential Element
Selenium	mg/kg	24/ 37	1.22	1	3.1	1.5	Yes	Above Background
Sodium	mg/kg	36/ 37	110	67.5	176	145	No	Essential Element
Vanadium	mg/kg	37/ 37	24.5	2.7	40.3	37.6	Yes	Above Background
Zinc	mg/kg	37/ 37	63.4	17.8	156	93.3	Yes	Above Background
Organics-Explosives								
Nitrobenzene	mg/kg	8/ 37	0.0539	0.039	0.1		Yes	No Background Data Available
Nitrocellulose	mg/kg	4/ 5	49	26	110		Yes	No Background Data Available
Organics-Volatile								
Carbon Disulfide	mg/kg	2/ 5	0.0218	0.013	0.087		Yes	No Background Data Available
Methylene Chloride	mg/kg	2/ 3	0.0255	0.017	0.018		Yes	No Background Data Available
Trichloroethene	mg/kg	1/ 5	0.00295	0.0028	0.0028		Yes	No Background Data Available

SRC = Site-related contaminant.

Table 4-7. Summary Statistics and Determination of SRCs in Subsurface Soil Samples at the 40-mm Firing Range

Analyte	Units	Results >Detection Limit	Average Result	Minimum Detect	Maximum Detect	Background Criteria	Site Related?	Justification
Metals								
Aluminum	mg/kg	26/ 26	12,600	6,850	19,600	19,500	Yes	Above Background
Arsenic	mg/kg	26/ 26	17.5	8.1	30.3	19.8	Yes	Above Background
Barium	mg/kg	26/ 26	62	30.5	121	124	No	Below Background
Beryllium	mg/kg	23/ 23	0.709	0.32	1.2	0.88	Yes	Above Background
Cadmium	mg/kg	3/ 26	0.0279	0.077	0.22	0	Yes	Above Background
Calcium	mg/kg	26/ 26	589	144	1,570	35,500	No	Essential Element
Chromium	mg/kg	26/ 26	17.9	10.5	27.7	27.2	Yes	Above Background
Cobalt	mg/kg	26/ 26	10.9	4.7	23.8	23.2	Yes	Above Background
Copper	mg/kg	26/ 26	21.6	9.4	36.5	32.3	Yes	Above Background
Iron	mg/kg	26/ 26	26,800	13,300	36,900	35,200	No	Essential Element
Lead	mg/kg	26/ 26	14.7	8.7	36.1	19.1	Yes	Above Background
Magnesium	mg/kg	26/ 26	2,770	1,430	4,700	8,790	No	Essential Element
Manganese	mg/kg	26/ 26	333	152	840	3,030	No	Below Background
Nickel	mg/kg	26/ 26	22.2	10.2	38.5	60.7	No	Below Background
Potassium	mg/kg	26/ 26	1,310	769	2,400	3,350	No	Essential Element
Sodium	mg/kg	26/ 26	81	46.3	288	145	No	Essential Element
Thallium	mg/kg	6/ 26	0.759	1.9	2.8	0.91	Yes	Above Background
Vanadium	mg/kg	26/ 26	22	13.1	34	37.6	No	Below Background
Zinc	mg/kg	26/ 26	60.5	29.2	77.4	93.3	No	Below Background
Organics-Explosives								
3-Nitrotoluene	mg/kg	1/ 26	0.0999	0.098	0.098		Yes	No Background Data Available
Nitrobenzene	mg/kg	3/ 26	0.0473	0.042	0.07		Yes	No Background Data Available
Nitrocellulose	mg/kg	3/ 3	43	24	59		Yes	No Background Data Available
Organics-Volatile								
1,2-Dimethylbenzene	mg/kg	1/ 3	0.00278	0.002	0.002		Yes	No Background Data Available
Carbon Disulfide	mg/kg	2/ 3	0.00745	0.0031	0.016		Yes	No Background Data Available
M + P Xylene	mg/kg	1/ 3	0.00382	0.0051	0.0051		Yes	No Background Data Available
Toluene	mg/kg	1/ 3	0.00332	0.0036	0.0036		Yes	No Background Data Available

SRC = Site-related contaminant.

Table 4-8. SRCs in Subsurface Soil at the Fuze and Booster Quarry Landfill/Ponds

Media Location Station Sample ID Customer ID Date Depth (ft) Field Type Analyte (mg/kg)	Units	Facility-wide Background	Soil 001 FBQso-001 FBQSO-001-0002-SO FBQso-001-0002-SO 10/14/2003 1.0 - 3.0 Regular samples	Soil 002 FBQso-002 FBQSO-002-0004-SO FBQso-002-0004-SO 10/14/2003 1.0 - 3.0 Regular samples	Soil 003 FBQso-003 FBQSO-003-0006-SO FBQso-003-0006-SO 10/20/2003 1.0 - 3.0 Regular samples	Soil 004 FBQso-004 FBQSO-004-0008-SO FBQso-004-0008-SO 10/20/2003 1.0 - 3.0 Regular samples
Explosives						
Nitrobenzene	mg/kg		0.1 U	0.08 J	0.1	0.1 U
Nitrocellulose	mg/kg		NA	NA	110	NA
Inorganics						
Aluminum	mg/kg	19,500	10,800	16,700	16,500	1,4200
Antimony	mg/kg	0.96	0.46 BN	0.27 UN	0.35 BN	0.28 U
Arsenic	mg/kg	19.8	19.7	12.6	12.3 NE*	13.7
Barium	mg/kg	124	61.1	90.1	88 N	90.6
Beryllium	mg/kg	0.88	0.68	0.78	0.92 #	0.82
Cadmium	mg/kg	0	0.017 U	0.018 U	0.017 U	0.018 U
Calcium	mg/kg	35,500	1490	1,840	34,500 *	35,100
Chromium	mg/kg	27.2	15.8	21.9	23.9 *E	21.2 *E
Chromium, hexavalent	mg/kg		NA	NA	3.7 #	NA
Cobalt	mg/kg	23.2	10.6	12.1	12.9 *	13.8
Copper	mg/kg	32.3	24.4	14.5	22.7	23.2
Iron	mg/kg	35,200	29,400	32,800	30,300	28,800
Lead	mg/kg	19.1	15.4	13.2	12.4 E	13.1
Magnesium	mg/kg	8,790	2,850 N	3,200 N	9,080 N*#	8,360
Manganese	mg/kg	3,030	402	918	369 *	448
Mercury	mg/kg	0.04	0.019 B	0.027 B	0.018 U	0.016 U
Nickel	mg/kg	60.7	24.1	17.5	31.7	31.8
Potassium	mg/kg	3,350	1,100 N	1,480 N	3,120 N	2,620
Selenium	mg/kg	1.5	1.4	1.7 #	1.1	1.2
Silver	mg/kg	0	0.059 U	0.081 B#	0.06 U	0.063 U
Sodium	mg/kg	145	88	104	176 #	167 #
Thallium	mg/kg	0.91	0.44 U	0.46 U	0.81 B	0.47 U
Vanadium	mg/kg	37.6	20.9 N	31.4 N	27.5 N	23.3
Zinc	mg/kg	93.3	59.7	47.2	65.5 E	66.5
Organic-Volatiles						
Acetone	mg/kg		NA	NA	0.0072 JB	NA
Carbon Disulfide	mg/kg		NA	NA	0.0058 U	NA
Methylene Chloride	mg/kg		NA	NA	0.017	NA
Trichloroethene	mg/kg		NA	NA	0.0028 J	NA

Table 4-8. SRCs in Subsurface Soil at the Fuze and Booster Quarry Landfill/Ponds (continued)

Media Location Station Sample ID Customer ID Date Depth (ft) Field Type Analyte (mg/kg)	Units	Facility-wide Background	Soil 005 FBQso-005 FBQSO-005-0010-SO FBQso-005-0010-SO 10/20/2003 1.0 - 3.0 Regular samples	Soil 006 FBQso-006 FBQSO-006-0012-SO FBQso-006-0012-SO 10/20/2003 1.0 - 3.0 Regular samples	Soil 007 FBQso-007 FBQSO-007-0014-SO FBQso-007-0014-SO 10/15/2003 1.0 - 3.0 Regular samples	Soil 008 FBQso-008 FBQSO-008-0016-SO FBQso-008-0016-SO 10/14/2003 1.0 - 3.0 Regular samples
Explosives						
Nitrobenzene	mg/kg		0.049 J	0.052 J	0.1 U	0.1 U
Nitrocellulose	mg/kg		NA	NA	NA	NA
Inorganics						
Aluminum	mg/kg	19,500	14,800	14,200	13,400	15,700
Antimony	mg/kg	0.96	0.3 U	0.4 BN	0.41 BN	0.38 BN
Arsenic	mg/kg	19.8	12.6	16.5 NE*	8.8	12.1
Barium	mg/kg	124	85.5	89.9 N	88.5	90.4
Beryllium	mg/kg	0.88	0.84	0.81	0.66	0.81
Cadmium	mg/kg	0	0.019 U	0.017 U	0.019 U	0.016 U
Calcium	mg/kg	35,500	33,300	3,140 *	1,030	1,670
Chromium	mg/kg	27.2	21.7 *E	19.7 *E	15.3	20.1
Chromium, hexavalent	mg/kg		NA	NA	NA	NA
Cobalt	mg/kg	23.2	12.8	11.8 *	9.5	10.4
Copper	mg/kg	32.3	22.3	26.4	9.8	16
Iron	mg/kg	35,200	28,800	29,200	18,500	26,300
Lead	mg/kg	19.1	11.9	15.1 E	13.4	13.9
Magnesium	mg/kg	8,790	8,210	3,880 N*	2,040 N	3,240 N
Manganese	mg/kg	3,030	410	449 *	805	359
Mercury	mg/kg	0.04	0.017 U	0.016 U	0.036 B	0.027 B
Nickel	mg/kg	60.7	30.7	27.9	16.2	22.7
Potassium	mg/kg	3,350	2,600	1,720 N	663 N	1,310 N
Selenium	mg/kg	1.50	1.5	1.3	1.1 B	1.5
Silver	mg/kg	0	0.067 U	0.06 U	0.067 U	0.067 B#
Sodium	mg/kg	145	148 #	86.1	89	133
Thallium	mg/kg	0.91	0.5 U	0.44 U	0.5 U	0.41 U
Vanadium	mg/kg	37.6	24.1	23.6 N	24.3	27.2 N
Zinc	mg/kg	93.3	61.3	66.1 E	50.4	50.4
Organic-Volatiles						
Acetone	mg/kg		NA	NA	NA	NA
Carbon Disulfide	mg/kg		NA	NA	NA	NA
Methylene Chloride	mg/kg		NA	NA	NA	NA
Trichloroethene	mg/kg		NA	NA	NA	NA

Table 4-8. SRCs in Subsurface Soil at the Fuze and Booster Quarry Landfill/Ponds (continued)

Media Location Station Sample ID Customer ID Date Depth (ft) Field Type Analyte (mg/kg)	Units	Facility-wide Background	Soil 009 FBQso-009 FBQSO-009-0018-SO FBQso-009-0018-SO 10/20/2003 1.0 - 3.0 Regular samples	Soil 010 FBQso-010 FBQSO-010-0020-SO FBQso-010-0020-SO 10/14/2003 1.0 - 3.0 Regular samples	Soil 011 FBQso-011 FBQSO-011-0022-SO FBQso-011-0022-SO 10/15/2003 1.0 - 3.0 Regular samples	Soil 012 FBQso-012 FBQSO-012-0024-SO FBQso-012-0024-SO 10/20/2003 1.0 - 3.0 Regular samples
Explosives						
Nitrobenzene	mg/kg		0.1 J	0.1 U	0.1 U	0.039 J
Nitrocellulose	mg/kg		44	NA	NA	NA
Inorganics						
Aluminum	mg/kg	19,500	14,200	18,400	12,000	12,500
Antimony	mg/kg	0.96	0.3 U	1.1 N#	0.58 BN	0.31 U
Arsenic	mg/kg	19.8	12	12.3	11.6	9.8
Barium	mg/kg	124	95	151 #	64	85.8
Beryllium	mg/kg	0.88	0.81	0.87	0.63	0.66
Cadmium	mg/kg	0	0.019 U	0.019 U	0.017 U	0.02 U
Calcium	mg/kg	35,500	8,110	841	665	147
Chromium	mg/kg	27.2	20.1 *E	22.1	14.3	283 *#
Chromium, hexavalent	mg/kg		7.9 #	NA	NA	NA
Cobalt	mg/kg	23.2	11.2 *	9.7	8.4	9.1
Copper	mg/kg	32.3	18.5	19.1	14.4	9.6
Iron	mg/kg	35,200	26,400	27,900	20,300	17,500
Lead	mg/kg	19.1	11.8	14.2	13	14.8
Magnesium	mg/kg	8,790	4,270	3,350 N	2,000 N	1,980
Manganese	mg/kg	3,030	337 *	190	495	978
Mercury	mg/kg	0.04	0.015 U	0.033 B	0.02 B	0.029 B
Nickel	mg/kg	60.7	27.1	18.7	16.5	15.1
Potassium	mg/kg	3,350	1,820	1,470 N	857 N	789
Selenium	mg/kg	1.5	1.1 B	1.5	0.95 B	0.66 U
Silver	mg/kg	0	0.068 U	0.068 U	0.061 U	0.28 B#
Sodium	mg/kg	145	117	142	91	70.9
Thallium	mg/kg	0.91	0.51 U	0.51 U	0.45 U	1 U
Vanadium	mg/kg	37.6	23.9	33.4 N	21	21.5
Zinc	mg/kg	93.3	59.7	52.6	52.4	51.9
Organic-Volatiles						
Acetone	mg/kg		0.007 JB	NA	NA	NA
Carbon Disulfide	mg/kg		0.0062 U	NA	NA	NA
Methylene Chloride	mg/kg		0.018	NA	NA	NA
Trichloroethene	mg/kg		0.0062 U	NA	NA	NA

Table 4-8. SRCs in Subsurface Soil at the Fuze and Booster Quarry Landfill/Ponds (continued)

Media Location Station Sample ID Customer ID Date Depth (ft) Field Type Analyte (mg/kg)	Units	Facility-wide Background	Soil 013 FBQso-013 FBQSO-013-0026-SO FBQso-013-0026-SO 10/15/2003 1.0 - 3.0 Regular samples	Soil 014 FBQso-014 FBQSO-014-0028-SO FBQso-014-0028-SO 10/14/2003 1.0 - 3.0 Regular samples	Soil 015 FBQso-015 FBQSO-015-0030-SO FBQso-015-0030-SO 10/15/2003 1.0 - 3.0 Regular samples	Soil 017 FBQso-017 FBQSO-017-0034-SO FBQso-017-0034-SO 10/13/2003 1.0 - 3.0 Regular samples
Explosives						
Nitrobenzene	mg/kg		0.044 J	0.1 U	0.1 U	0.1 U/U
Nitrocellulose	mg/kg		NA	NA	NA	NA
Inorganics						
Aluminum	mg/kg	19,500	19,900 #	17,100	9,780	13,000 /=
Antimony	mg/kg	0.96	0.51 BN	0.4 BN	0.53 BN	0.73 BN/UJ
Arsenic	mg/kg	19.8	7.3	14.9	17.1	20.3 /J#
Barium	mg/kg	124	122	124	79.2	53.1 N/J
Beryllium	mg/kg	0.88	0.98 #	1.1 #	0.6	0.65 /=
Cadmium	mg/kg	0	0.018 U	0.019 U	0.019 U	0.019 U/U
Calcium	mg/kg	35,500	34,500	1,440	881	371 /=
Chromium	mg/kg	27.2	27	22.9	14.3	17.5 /J
Chromium, hexavalent	mg/kg		NA	NA	NA	NA
Cobalt	mg/kg	23.2	9.1	22.5	10	9.9 /=
Copper	mg/kg	32.3	18.8	22.4	20.2	20.2 /J
Iron	mg/kg	35,200	28,000	32,100	25,300	29,900 /J
Lead	mg/kg	19.1	10.2	16.7	14.3	19.6 /=#
Magnesium	mg/kg	8,790	7,880 N	4,360 N	2,350 N	2,580 /J
Manganese	mg/kg	3,030	214	416	536	338 /=
Mercury	mg/kg	0.04	0.017 U	0.017 B	0.02 B	0.017 U/U
Nickel	mg/kg	60.7	28.1	34.4	21.1	19.7 /J
Potassium	mg/kg	3,350	2,620 N	1,620 N	951 N	1,170 N/J
Selenium	mg/kg	1.50	1 B	1.5	1.2	2.2 /J#
Silver	mg/kg	0	0.062 U	0.066 U	0.067 U	0.07 B/UJ
Sodium	mg/kg	145	144	96.6	87.1	128 /=
Thallium	mg/kg	0.91	0.46 U	0.49 U	0.5 U	0.48 UN/UJ
Vanadium	mg/kg	37.6	28 N	28.5 N	17.1	23.2 N/J
Zinc	mg/kg	93.3	62.4	63.5	62.2	65.4 /=
Organic-Volatiles						
Acetone	mg/kg		NA	NA	NA	NA
Carbon Disulfide	mg/kg		NA	NA	NA	NA
Methylene Chloride	mg/kg		NA	NA	NA	NA
Trichloroethene	mg/kg		NA	NA	NA	NA

Table 4-8. SRCs in Subsurface Soil at the Fuze and Booster Quarry Landfill/Ponds (continued)

Media Location Station Sample ID Customer ID Date Depth (ft) Field Type Analyte (mg/kg)	Units	Facility-wide Background	Soil 019 FBQso-019 FBQSO-019-0038-SO FBQso-019-0038-SO 10/13/2003 1.0 - 3.0 Regular samples	Soil 020 FBQso-020 FBQSO-020-0040-SO FBQso-020-0040-SO 10/09/2003 1.0 - 3.0 Regular samples	Soil 020 FBQso-020 FBQSO-020-0372-SO FBQso-020-0372-SO 10/09/2003 1.0 - 3.0 Field Duplicate	Soil 021 FBQso-021 FBQSO-021-0042-SO FBQso-021-0042-SO 10/09/2003 1.0 - 3.0 Regular samples
Explosives						
Nitrobenzene	mg/kg		0.081 J/J	0.1 U	0.1 U	0.1 U/U
Nitrocellulose	mg/kg		56 /=	NA	NA	NA
Inorganics						
Aluminum	mg/kg	19,500	20,000 /=#	18,200	18,100	20,900 /=#
Antimony	mg/kg	0.96	0.59 BN/UJ	0.27 UN	0.3 UN	0.71 BN/UJ
Arsenic	mg/kg	19.8	24.3 /J#	15.1	14.5	11.8 /J
Barium	mg/kg	124	115 N/J	82.4 N	80.4 N	98.4 N/J
Beryllium	mg/kg	0.88	1.1 /=#	0.93 #	0.89 #	1.2 /=#
Cadmium	mg/kg	0	0.02 U/U	0.15 #	0.12 #	0.021 U/U
Calcium	mg/kg	35,500	4,370 /=	1,220	1,100	1,600 /=
Chromium	mg/kg	27.2	27.2 /J	23.4	23	30.8 /J#
Chromium, hexavalent	mg/kg		2.9 U/U	NA	NA	NA
Cobalt	mg/kg	23.2	18 /=	13.5	11.9	15.6 /=
Copper	mg/kg	32.3	26.6 /J	25.3	22.6	26.1 /J
Iron	mg/kg	35,200	40,800 /J#	33,400	31,900	33,900 /J
Lead	mg/kg	19.1	20.6 /=#	16.2	14.7	13.6 /=
Magnesium	mg/kg	8,790	5,110 /J	4,090 N	3,870 N	5,110 /J
Manganese	mg/kg	3,030	465 /=	386	305	383 /J
Mercury	mg/kg	0.04	0.028 B/UJ	0.016 B	0.019 B	0.021 B/UJ
Nickel	mg/kg	60.7	34.6 /J	28.7	27.5	33.3 /J
Potassium	mg/kg	3,350	1,910 N/J	1,850 N	1,790 N	2,220 N/J
Selenium	mg/kg	1.5	3.1 /J#	0.53 B	0.47 B	2.4 /J#
Silver	mg/kg	0	0.09 B/UJ	0.061 U	0.068 U	0.073 U/U
Sodium	mg/kg	145	172 /=#	111 E	109 E	169 /=#
Thallium	mg/kg	0.91	0.52 UN/UJ	0.45 U	0.51 U	0.54 UN/UJ
Vanadium	mg/kg	37.6	35.4 N/J	29.9 N	29.7 N	40.3 N/J#
Zinc	mg/kg	93.3	68.9 /=	68.8	65.3	70.7 /=
Organic-Volatiles						
Acetone	mg/kg		0.007 JB/R	NA	NA	NA
Carbon disulfide	mg/kg		0.013 /J	NA	NA	NA
Methylene chloride	mg/kg		0.0084 JB/R	NA	NA	NA
Trichloroethene	mg/kg		0.006 U/UJ	NA	NA	NA

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Table 4-8. SRCs in Subsurface Soil at the Fuze and Booster Quarry Landfill/Ponds (continued)

Media Location Station Sample ID Customer ID Date Depth (ft) Field Type Analyte (mg/kg)	Units	Facility-wide Background	Soil 021 FBQso-021 FBQSO-021-0374-SO FBQso-021-0374-SO 10/09/2003 1.0 - 3.0 Field Duplicate	Soil 022 FBQso-022 FBQSO-022-0044-SO FBQso-022-0044-SO 10/09/2003 1.0 - 3.0 Regular samples	Soil 023 FBQso-023 FBQSO-023-0046-SO FBQso-023-0046-SO 10/10/2003 1.0 - 3.0 Regular samples	Soil 023 FBQso-023 FBQSO-023-0377-SO FBQso-023-0377-SO 10/10/2003 1.0 - 3.0 Field Duplicate
Explosives						
Nitrobenzene	mg/kg		0.1 U/U	0.1 U/U	0.1 U	0.1 U
Nitrocellulose	mg/kg		NA	NA	NA	NA
Inorganics						
Aluminum	mg/kg	19,500	21,200 /=#	16,200 /=	13,100	NA
Antimony	mg/kg	0.96	0.9 BN/UJ	0.57 BN/UJ	0.27 UN	NA
Arsenic	mg/kg	19.8	11.8 /J	13.8 /J	18.3	NA
Barium	mg/kg	124	91.5 N/J	63.1 N/J	75.9	NA
Beryllium	mg/kg	0.88	1.2 /=#	0.83 /=	0.75	NA
Cadmium	mg/kg	0	0.018 U/U	0.019 U/U	0.068 B#	NA
Calcium	mg/kg	35,500	1,510 /=	766 /=	619	NA
Chromium	mg/kg	27.2	30.8 /J#	21 /J	18 E	NA
Chromium, hexavalent	mg/kg		NA	NA	NA	NA
Cobalt	mg/kg	23.2	18.2 /=	15.7 /=	11.5	NA
Copper	mg/kg	32.3	25.1 /J	23.3 /J	23.6	NA
Iron	mg/kg	35,200	33,900 /J	29,100 /J	29,700	NA
Lead	mg/kg	19.1	14.5 /=	16.5 /=	17.5	NA
Magnesium	mg/kg	8,790	5,000 /J	3,420 /J	3,000 N	NA
Manganese	mg/kg	3,030	375 /J	334 /=	338	NA
Mercury	mg/kg	0.04	0.017 U/U	0.038 B/UJ	0.017 U	0.015 U
Nickel	mg/kg	60.7	33.8 /J	23.1 /J	25.2 E	NA
Potassium	mg/kg	3,350	2,230 N/J	1,550 N/J	1,140 N	NA
Selenium	mg/kg	1.5	2.4 /J#	2.1 /J#	0.32 B	NA
Silver	mg/kg	0	0.085 B/UJ	0.067 U/U	0.061 U	NA
Sodium	mg/kg	145	176 /=#	138 /=	96.8	NA
Thallium	mg/kg	0.91	0.47 UN/UJ	0.5 UN/UJ	0.45 U	NA
Vanadium	mg/kg	37.6	37.6 N/J	27.2 N/J	21.6 N	NA
Zinc	mg/kg	93.3	69.6 /=	65 /=	67.4	NA
Organic-Volatiles						
Acetone	mg/kg		NA	NA	NA	NA
Carbon Disulfide	mg/kg		NA	NA	NA	NA
Methylene Chloride	mg/kg		NA	NA	NA	NA
Trichloroethene	mg/kg		NA	NA	NA	NA

1 **Table 4-8. SRCs in Subsurface Soil at the Fuze and Booster Quarry Landfill/Ponds (continued)**

Media Location Station Sample ID Customer ID Date Depth (ft) Field Type Analyte (mg/kg)	Units	Facility-wide Background	Soil 026 FBQso-026 FBQSO-026-0052-SO FBQso-026-0052-SO 10/09/2003 1.0 - 3.0 Regular samples	Soil 028 FBQso-028 FBQSO-028-0056-SO FBQso-028-0056-SO 10/07/2003 1.0 - 3.0 Regular samples	Soil 029 FBQso-029 FBQSO-029-0058-SO FBQso-029-0058-SO 10/08/2003 1.0 - 3.0 Regular samples	Soil 029 FBQso-029 FBQSO-029-0367-SO FBQso-029-0367-SO 10/08/2003 1.0 - 3.0 Field Duplicate
Explosives						
Nitrobenzene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
Nitrocellulose	mg/kg		NA	NA	NA	NA
Inorganics						
Aluminum	mg/kg	19,500	14,300	20,700 #	11,400	11,700
Antimony	mg/kg	0.96	0.27 UN	0.74 BN	0.57 BN	0.6 BN
Arsenic	mg/kg	19.8	24.6 #	14 N	12.8 N	11.9 N
Barium	mg/kg	124	51.2 N	112	61.8	65.2
Beryllium	mg/kg	0.88	0.62	1.1 #	0.6	0.6
Cadmium	mg/kg	0	0.097 #	0.17 #	0.028 B#	0.055 B#
Calcium	mg/kg	35,500	321	12,700	385	397
Chromium	mg/kg	27.2	18.6	27.2	16.7	16.8
Chromium, hexavalent	mg/kg		NA	NA	NA	NA
Cobalt	mg/kg	23.2	19.8	19.4	10.9	9.1
Copper	mg/kg	32.3	21	26.5 E	11 E	10.4 E
Iron	mg/kg	35,200	30,200	33,000	23,600	22,200
Lead	mg/kg	19.1	22.1 #	15.3	12.8	12.3
Magnesium	mg/kg	8,790	2,420 N	6,610 N	2,630 N	2,560 N
Manganese	mg/kg	3,030	594	451	462	494
Mercury	mg/kg	0.04	0.025 B	0.017 B	0.02 B	0.022 B
Nickel	mg/kg	60.7	17.7	37.4	16.9	16.9
Potassium	mg/kg	3,350	1,290 N	2,490 N	1,110 N	1,150 N
Selenium	mg/kg	1.5	0.58 B	0.96 B	1	0.91 B
Silver	mg/kg	0	0.093 B#	0.064 U	0.057 U	0.06 U
Sodium	mg/kg	145	94.7 E	127	94.3	80.2
Thallium	mg/kg	0.91	0.45 U	0.48 U	0.43 U	0.45 U
Vanadium	mg/kg	37.6	24.8 N	31.4	22.8	23.1
Zinc	mg/kg	93.3	70.8	72.8	40.2	42.1
Organic-Volatiles						
Acetone	mg/kg		NA	NA	NA	NA
Carbon Disulfide	mg/kg		NA	NA	NA	NA
Methylene Chloride	mg/kg		NA	NA	NA	NA
Trichloroethene	mg/kg		NA	NA	NA	NA

Table 4-8. SRCs in Subsurface Soil at the Fuze and Booster Quarry Landfill/Ponds (continued)

Media Location Station Sample ID Customer ID Date Depth (ft) Field Type Analyte (mg/kg)	Units	Facility-wide Background	Soil 030 FBQso-030 FBQSO-030-0060-SO FBQso-030-0060-SO 10/08/2003 1.0 - 3.0 Regular samples	Soil 032 FBQso-032 FBQSO-032-0064-SO FBQso-032-0064-SO 10/08/2003 1.0 - 3.0 Regular samples	Soil 033 FBQso-033 FBQSO-033-0066-SO FBQso-033-0066-SO 10/07/2003 1.0 - 3.0 Regular samples	Soil 036 FBQso-036 FBQSO-036-0072-SO FBQso-036-0072-SO 10/07/2003 1.0 - 3.0 Regular samples
Explosives						
Nitrobenzene	mg/kg		0.1 U	0.1 U	0.1 U/U	0.1 U/U
Nitrocellulose	mg/kg		NA	NA	NA	NA
Inorganics						
Aluminum	mg/kg	19,500	6,610	14,400	8,280 /=	17,600 /=
Antimony	mg/kg	0.96	0.7 BN	0.79 BN	0.28 UN/UJ	0.47 B/UJ
Arsenic	mg/kg	19.8	9 N	24.2 N#	9.9 /J	17.1 /J
Barium	mg/kg	124	36.9	49.8	35.7 N/J	83 /J
Beryllium	mg/kg	0.88	0.86	0.62	0.86 /=	0.95 /=#
Cadmium	mg/kg	0	0.039 B#	0.02 U	0.018 U/U	0.018 U/U
Calcium	mg/kg	35,500	128	240	155 /=	625 /=
Chromium	mg/kg	27.2	13.6	19.4	15.8 /J	24.2 /J
Chromium, hexavalent	mg/kg		NA	NA	NA	NA
Cobalt	mg/kg	23.2	12.7	8.1	13.3 /=	13.5 /=
Copper	mg/kg	32.3	16.9 E	19.7 E	23.1 /J	24.9 /J
Iron	mg/kg	35,200	28,000	27,200	35,800 /J#	33,700 /J
Lead	mg/kg	19.1	17	14.5	17 /=	18.3 /=
Magnesium	mg/kg	8,790	1,820 N	2,870 N	2,000 /J	3,910 /J
Manganese	mg/kg	3,030	659	257	732 /=	368 /=
Mercury	mg/kg	0.04	0.022 B	0.028 B	0.029 B/UJ	0.018 U/U
Nickel	mg/kg	60.7	17.9	20.5	20.5 /J	28.2 /J
Potassium	mg/kg	3,350	884 N	1,180 N	986 N/J	1,690 /J
Selenium	mg/kg	1.5	1.1	0.87 B	2.9 /J#	2.6 /J#
Silver	mg/kg	0	0.058 U	0.069 U	0.071 B/UJ	0.063 U/U
Sodium	mg/kg	145	75.4	90.5	104 /=	131 /=
Thallium	mg/kg	0.91	0.43 U	0.57 B	0.47 UN/UJ	0.47 U/UJ
Vanadium	mg/kg	37.6	14.8	23.2	17.5 N/J	29.5 /J
Zinc	mg/kg	93.3	87	60.2	82.4 /=	67.9 /=
Organic-Volatiles						
Acetone	mg/kg		NA	NA	NA	NA
Carbon Disulfide	mg/kg		NA	NA	NA	NA
Methylene Chloride	mg/kg		NA	NA	NA	NA
Trichloroethene	mg/kg		NA	NA	NA	NA

Table 4-8. SRCs in Subsurface Soil at the Fuze and Booster Quarry Landfill/Ponds (continued)

Media Location Station Sample ID Customer ID Date Depth (ft) Field Type Analyte (mg/kg)	Units	Facility-wide Background	Soil 038 FBQso-038 FBQSO-038-0076-SO FBQso-038-0076-SO 10/03/2003 1.0 - 3.0 Regular samples	Soil 040 FBQso-040 FBQSO-040-0080-SO FBQso-040-0080-SO 10/06/2003 1.0 - 3.0 Regular samples	Soil 040 FBQso-040 FBQSO-040-0366-SO FBQso-040-0366-SO 10/06/2003 1.0 - 3.0 Field Duplicate	Soil 048 FBQso-048 FBQSO-048-0096-SO FBQso-048-0096-SO 10/02/2003 1.0 - 3.0 Regular samples
Explosives						
Nitrobenzene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
Nitrocellulose	mg/kg		NA	NA	NA	NA
Inorganics						
Aluminum	mg/kg	19,500	556	19,900 #	20,200 #	15,500
Antimony	mg/kg	0.96	0.33 BN	0.29 UN	0.37 BN	0.66 BN
Arsenic	mg/kg	19.8	0.71 BN	16.4	16.8	12.5
Barium	mg/kg	124	11	107 N	119 N	81.9 N
Beryllium	mg/kg	0.88	0.2	1.1 #	1.2 #	0.78
Cadmium	mg/kg	0	0.037 B#	0.15 #	0.14 #	0.2 #
Calcium	mg/kg	35,500	90.6	1,040	1,140	1,820
Chromium	mg/kg	27.2	3	28 #	26.9	19.8 E
Chromium, hexavalent	mg/kg		NA	NA	NA	NA
Cobalt	mg/kg	23.2	0.97	15.2	19.4	10.3
Copper	mg/kg	32.3	0.85 E	27.2	27.5	17.1
Iron	mg/kg	35,200	13,500	35,700 #	35,800 #	25,100
Lead	mg/kg	19.1	2.2	15.3	15.3	19.6 #
Magnesium	mg/kg	8,790	95.6 N	4,470 N	4,600 N	2,950 N
Manganese	mg/kg	3,030	316	384	409	459
Mercury	mg/kg	0.04	0.014 U	0.033 B	0.018 U	0.02 B
Nickel	mg/kg	60.7	2.3	32.8	33.6	19.9
Potassium	mg/kg	3,350	118 N	2,140 N	2,230 N	1,240 N
Selenium	mg/kg	1.5	0.53 B	0.31 U	0.58 B	1.4
Silver	mg/kg	0	0.074 B#	0.066 U	0.065 U	0.063 U
Sodium	mg/kg	145	20.9 B	122 E	120 E	102
Thallium	mg/kg	0.91	0.38 U	0.49 U	0.49 U	0.47 U
Vanadium	mg/kg	37.6	2.7	34.3 N	34.5 N	28.2 N
Zinc	mg/kg	93.3	17.8	73	76.1	64.8
Organic-Volatiles						
Acetone	mg/kg		NA	NA	NA	NA
Carbon Disulfide	mg/kg		NA	NA	NA	NA
Methylene Chloride	mg/kg		NA	NA	NA	NA
Trichloroethene	mg/kg		NA	NA	NA	NA

Table 4-8. SRCs in Subsurface Soil at the Fuze and Booster Quarry Landfill/Ponds (continued)

Media Location Station Sample ID Customer ID Date Depth (ft) Field Type Analyte (mg/kg)	Units	Facility-wide Background	Soil 051 FBQso-051 FBQSO-051-0102-SO FBQso-051-0102-SO 10/06/2003 1.0 - 3.0 Regular samples	Soil 054 FBQso-054 FBQSO-054-0108-SO FBQso-054-0108-SO 10/02/2003 1.0 - 3.0 Regular samples	Soil 056 FBQso-056 FBQSO-056-0112-SO FBQso-056-0112-SO 10/02/2003 1.0 - 3.0 Regular samples	Soil 057 FBQso-057 FBQSO-057-0114-SO FBQso-057-0114-SO 10/01/2003 1.0 - 3.0 Regular samples
Explosives						
Nitrobenzene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
Nitrocellulose	mg/kg		18 U	NA	NA	NA
Inorganics						
Aluminum	mg/kg	19,500	12,800	14,100	9,650	6,510
Antimony	mg/kg	0.96	0.37 BN	0.42 BN	0.7 BN	0.35 BN
Arsenic	mg/kg	19.8	21 #	19.4	17.8	14.8
Barium	mg/kg	124	52.9 N	47.4 N	39.3 N	31.3 N
Beryllium	mg/kg	0.88	0.63	0.65	0.54	0.47
Cadmium	mg/kg	0	0.085 #	0.14 #	0.14 #	0.11 #
Calcium	mg/kg	35,500	474	341	175	288
Chromium	mg/kg	27.2	18.4 E	18.6 E	14.4 E	10.7 E
Chromium, hexavalent	mg/kg		2.9 U	NA	NA	NA
Cobalt	mg/kg	23.2	7.5	9	8.1	7.5
Copper	mg/kg	32.3	21.6	21.9	15.3	16.9
Iron	mg/kg	35,200	29,300	28,400	22,800	20,700
Lead	mg/kg	19.1	15.2	14.1	15.2	12.8
Magnesium	mg/kg	8,790	2,710 N	2,670 N	1,950 N	1,540 N
Manganese	mg/kg	3,030	295	283	308	335
Mercury	mg/kg	0.04	0.026 B	0.016 U	0.017 B	0.019 B
Nickel	mg/kg	60.7	18.3	18	15.5	17.2
Potassium	mg/kg	3,350	1,100 N	1,180 N	884 N	741 N
Selenium	mg/kg	1.50	1.5	1.4	1.2	0.99 B
Silver	mg/kg	0	0.067 U	0.064 U	0.063 U	0.059 U
Sodium	mg/kg	145	92.1	109	81.1	67.5
Thallium	mg/kg	0.91	0.5 U	0.47 U	0.47 U	0.44 U
Vanadium	mg/kg	37.6	21.7 N	23.8 N	18.1 N	12.3 N
Zinc	mg/kg	93.3	54.1	55.1	58	63
Organic-Volatiles						
Acetone	mg/kg		0.0078 JB	NA	NA	NA
Carbon Disulfide	mg/kg		0.0058 U	NA	NA	NA
Methylene Chloride	mg/kg		0.083 B	NA	NA	NA
Trichloroethene	mg/kg		0.0058 U	NA	NA	NA

Table 4-8. SRCs in Subsurface Soil at the Fuze and Booster Quarry Landfill/Ponds (continued)

Media **Location** **Station** **Sample ID** **Customer ID** **Date** **Depth (ft)** **Field Type** **Analyte (mg/kg)**	**Units**	**Facility-wide Background**	**Soil** **059** **FBQso-059** **FBQSO-059-0118-SO** **FBQso-059-0118-SO** **10/06/2003** **1.0 - 1.5** **Regular samples**	**Soil** **060** **FBQso-060** **FBQSO-060-0120-SO** **FBQso-060-0120-SO** **10/13/2003** **1.0 - 3.0** **Regular samples**
Explosives				
Nitrobenzene	mg/kg		0.1 U	0.1 U/U
Nitrocellulose	mg/kg		NA	26 /=
Inorganics				
Aluminum	mg/kg	19,500	12,100	12,300 /=
Antimony	mg/kg	0.96	1.9 N#	0.27 UN/UJ
Arsenic	mg/kg	19.8	11.1	13.6 /J
Barium	mg/kg	124	79 N	44.5 N/J
Beryllium	mg/kg	0.88	0.73	0.55 /=
Cadmium	mg/kg	0	0.72 #	0.017 U/U
Calcium	mg/kg	35,500	3,280	300 /=
Chromium	mg/kg	27.2	19.6 E	15.5 /J
Chromium, hexavalent	mg/kg		NA	2.9 U/U
Cobalt	mg/kg	23.2	10	11.6 /=
Copper	mg/kg	32.3	28.2	14.2 /J
Iron	mg/kg	35,200	23,100	23,200 /J
Lead	mg/kg	19.1	116 #	13.6 /=
Magnesium	mg/kg	8,790	2,430 N	1,830 /J
Manganese	mg/kg	3,030	781	392 /=
Mercury	mg/kg	0.04	0.76 #	0.015 U/U
Nickel	mg/kg	60.7	15.2	13.3 /J
Potassium	mg/kg	3,350	1,060 N	841 N/J
Selenium	mg/kg	1.5	1.3	2 /J#
Silver	mg/kg	0	0.17 B#	0.067 B/UJ
Sodium	mg/kg	145	119	109 /=
Thallium	mg/kg	0.91	0.49 U	0.45 UN/UJ
Vanadium	mg/kg	37.6	23.4 N	24.7 N/J
Zinc	mg/kg	93.3	156 #	46.1 /=
Organic-Volatiles				
Acetone	mg/kg		NA	0.0073 JB/R
Carbon Disulfide	mg/kg		NA	0.087 /=
Methylene Chloride	mg/kg		NA	0.014 B/R
Trichloroethene	mg/kg		NA	0.0059 U/U

Table 4-8. SRCs in Subsurface Soil at the Fuze and Booster Quarry Ponds/Landfill (continued)

Note: Data qualifiers are presented as laboratory qualifiers/validation qualifiers.
B for inorganics = Result is less than the contract-required detection limit but greater than the instrument detection limit.
B for organics = Compound is detected in the blank as well as the sample.
E = Result estimated because of the presence of interference.
J = Estimated value is less than the reporting limits.
N = Matrix spike recovery is outside the control limits.
P = Greater than 25% difference between the two GC columns.
R = Data are rejected.
U = Not detected.
# = Value is above the facility-wide background.
* = Duplicate analysis is outside the control limits.
"=" = Analyte present and concentration accurate.
Facility-wide background is determined for the Winklepeck Burning Ground Phase II Remedial Investigation (USACE 2001b).
NA = Not applicable.
PCB = Polychlorinated biphenyl.
SRC = Site-related contaminant.

Table 4-9. SRCs in Subsurface Soil at the 40-mm Firing Range

Media Location Station Sample ID Customer ID Date Depth (ft) Filtered Field Type Analyte (mg/kg)	Units	Facility-wide Background	Soil 061 FBQso-061 FBQSO-061-0122-SO FBQso-061-0122-SO 11/14/2003 1.0 - 3.0 Total Regular samples	Soil 062 FBQso-062 FBQSO-062-0124-SO FBQso-062-0124-SO 11/17/2003 1.0 - 3.0 Total Regular samples	Soil 063 FBQso-063 FBQSO-063-0126-SO FBQso-063-0126-SO 11/16/2003 1.0 - 3.0 Total Regular samples	Soil 064 FBQso-064 FBQSO-064-0128-SO FBQso-064-0128-SO 11/14/2003 1.0 - 3.0 Total Regular samples
Explosives						
3-Nitrotoluene	mg/kg		0.2 U	0.2 U	0.2 U	0.2 U
Nitrobenzene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
Nitrocellulose	mg/kg		NA	NA	NA	NA
Inorganics						
Aluminum	mg/kg	19,500	15,200	16,900	19,600 #	14,100
Antimony	mg/kg	0.96	0.37 BN	0.29 U	0.37 BN	0.41 BN
Arsenic	mg/kg	19.8	17.8	17	17.4	13.1
Barium	mg/kg	124	94.3 N	121	116 N	62.1 N
Beryllium	mg/kg	0.88	0.93 E#	1.1 #	1.2 E#	0.6 E
Cadmium	mg/kg	0	0.027 U*	0.061 B#	0.028 U*	0.029 U*
Calcium	mg/kg	35,500	1,570	1,570	1,370	342
Chromium	mg/kg	27.2	23.1 N	23.8	27.7 N#	19.3 N
Cobalt	mg/kg	23.2	23.8 #	15	20.7	10.3
Copper	mg/kg	32.3	24.3	25.3	25.8	17.7
Iron	mg/kg	35,200	32,900	30,700	36,900 #	25,200
Lead	mg/kg	19.1	14.9	14.8	15.9	16.4
Magnesium	mg/kg	8,790	4,190 N	4,700	4,470 N	2,660 N
Manganese	mg/kg	3,030	472	458	418	406
Mercury	mg/kg	0.044	0.021 B	0.018 U	0.018 B	0.022 B
Nickel	mg/kg	60.7	33.1	38.5	35.1	20.1
Potassium	mg/kg	3,350	1,890 N	2,400	2,200 N	1,280 N
Selenium	mg/kg	1.5	0.26 U	0.3 U	0.38 B	0.49 B
Silver	mg/kg	0	0.046 U	0.065 U	0.046 U	0.048 U
Sodium	mg/kg	145	104	91.9	91.1	75.2
Thallium	mg/kg	0.91	0.66 B	2.8 #	0.54 B	0.4 U
Vanadium	mg/kg	37.6	26.6	28.1	34	26.8
Zinc	mg/kg	93.3	69.9	72.6	76.1	55.6
Organic-Volatiles						
1,2-Dimethylbenzene	mg/kg		NA	NA	NA	NA
2-Butanone	mg/kg		NA	NA	NA	NA
Acetone	mg/kg		NA	NA	NA	NA
Carbon Disulfide	mg/kg		NA	NA	NA	NA
M + P Xylene	mg/kg		NA	NA	NA	NA
Methylene Chloride	mg/kg		NA	NA	NA	NA
Toluene	mg/kg		NA	NA	NA	NA

Table 4-9. SRCs in Subsurface Soil at the 40-mm Firing Range (continued)

Media			Soil	Soil	Soil	Soil
Location			065	066	067	068
Station			FBQso-065	FBQso-066	FBQso-067	FBQso-068
Sample ID			FBQSO-065-0130-SO	FBQSO-066-0132-SO	FBQSO-067-0134-SO	FBQSO-068-0136-SO
Customer ID			FBQso-065-0130-SO	FBQso-066-0132-SO	FBQso-067-0134-SO	FBQso-068-0136-SO
Date			11/17/2003	11/17/2003	11/14/2003	11/14/2003
Depth (ft)			1.0 - 3.0	1.0 - 3.0	1.0 - 3.0	1.0 - 3.0
Filtered			Total	Total	Total	Total
Field Type		Facility-wide	Regular samples	Regular samples	Regular samples	Regular samples
Analyte (mg/kg)	Units	Background				
Explosives						
3-Nitrotoluene	mg/kg		0.2 U	0.2 U	0.098 J	0.2 U
Nitrobenzene	mg/kg		0.1 U	0.1 U	0.042 J	0.1 U
Nitrocellulose	mg/kg		NA	NA	NA	NA
Inorganics						
Aluminum	mg/kg	19,500	7,580	12,600	10,800	13,400
Antimony	mg/kg	0.96	0.25 UN	0.26 UN	0.45 BN	0.45 BN
Arsenic	mg/kg	19.8	9.6 N	19.4 N	21 #	13.5
Barium	mg/kg	124	30.5	47	45.4 N	52.2 N
Beryllium	mg/kg	0.88	0.32	0.64	0.57 E	0.53 E
Cadmium	mg/kg	0	0.018 B#	0.028 B#	0.026 U*	0.028 U*
Calcium	mg/kg	35,500	144	491	227	400
Chromium	mg/kg	27.2	10.5	17.6	16.5 N	18.1 N
Cobalt	mg/kg	23.2	4.7	8.6	8.3	6.5
Copper	mg/kg	32.3	9.4	22.7	22.1	16.4
Iron	mg/kg	35,200	13,300	27,000	26,800	25,500
Lead	mg/kg	19.1	8.7	13.2	14.2	12.3
Magnesium	mg/kg	8,790	1,430 N	3,030 N	2,410 N	2,350 N
Manganese	mg/kg	3,030	152	256	275	200
Mercury	mg/kg	0.044	0.019 B	0.017 B	0.016 U	0.017 B
Nickel	mg/kg	60.7	10.2	21.4	20.4	16
Potassium	mg/kg	3,350	769 N	1,200 N	1,170 N	1,060 N
Selenium	mg/kg	1.5	0.27 U	0.28 U	0.4 B	0.59 B
Silver	mg/kg	0	0.057 U	0.059 U	0.043 U	0.046 U
Sodium	mg/kg	145	53.2	60.4	288 #	71.4
Thallium	mg/kg	0.91	0.9 B	1.9 #	0.36 U	0.38 U
Vanadium	mg/kg	37.6	13.1	20.4	19.3	26.3
Zinc	mg/kg	93.3	29.2	57.4	61.8	44.1
Organic-Volatiles						
1,2-Dimethylbenzene	mg/kg		NA	NA	NA	NA
2-Butanone	mg/kg		NA	NA	NA	NA
Acetone	mg/kg		NA	NA	NA	NA
Carbon Disulfide	mg/kg		NA	NA	NA	NA
M + P Xylene	mg/kg		NA	NA	NA	NA
Methylene Chloride	mg/kg		NA	NA	NA	NA
Toluene	mg/kg		NA	NA	NA	NA

1 Table 4-9. SRCs in Subsurface Soil at the 40-mm Firing Range (continued)

Media Location Station Sample ID Customer ID Date Depth (ft) Filtered Field Type Analyte (mg/kg)	Units	Facility-wide Background	Soil 071 FBQso-071 FBQSO-071-0142-SO FBQso-071-0142-SO 11/17/2003 1.0 - 3.0 Total Regular samples	Soil 073 FBQso-073 FBQSO-073-0146-SO FBQso-073-0146-SO 11/17/2003 1.0 - 3.0 Total Regular samples	Soil 074 FBQso-074 FBQSO-074-0148-SO FBQso-074-0148-SO 11/11/2003 1.0 - 3.0 Total Regular samples	Soil 075 FBQso-075 FBQSO-075-0150-SO FBQso-075-0150-SO 11/13/2003 1.0 - 3.0 Total Regular samples
Explosives						
3-Nitrotoluene	mg/kg		0.2 U	0.2 U	0.2 U	0.2 U
Nitrobenzene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
Nitrocellulose	mg/kg		NA	NA	NA	NA
Inorganics						
Aluminum	mg/kg	19,500	10,500	15,300	10,100	9,710
Antimony	mg/kg	0.96	0.27 UN	0.29 UN	0.43 BN	0.24 BN
Arsenic	mg/kg	19.8	19 N	18.4 N	18.7	8.1
Barium	mg/kg	124	38.3	79.2	44.2 N	103 N
Beryllium	mg/kg	0.88	0.65	1 #	0.66	0.56 E
Cadmium	mg/kg	0	0.023 B#	0.047 B#	0.018 U	0.22 *#
Calcium	mg/kg	35,500	349	889	254	290
Chromium	mg/kg	27.2	15.2	20.3	15.1 N	16.2 N
Cobalt	mg/kg	23.2	10.3	20.8	9.9	7.7
Copper	mg/kg	32.3	21.5	24.5	22	36.5 #
Iron	mg/kg	35,200	24,300	28,400	26,000	15,700
Lead	mg/kg	19.1	13.9	14	14.4	11.7
Magnesium	mg/kg	8,790	2,320 N	3,640 N	2,440 N	1,470 N
Manganese	mg/kg	3,030	260	328	280	840
Mercury	mg/kg	0.044	0.017 U	0.019 B	0.013 U	0.018 B
Nickel	mg/kg	60.7	21.2	26.9	20.6	14.3
Potassium	mg/kg	3,350	1,110 N	1,660 N	1,110 N	769 N
Selenium	mg/kg	1.5	0.28 U	0.3 U	0.3 U	0.34 B
Silver	mg/kg	0	0.06 U	0.065 U	0.064 U	0.038 U
Sodium	mg/kg	145	59.9	75.1	76.7	56.9
Thallium	mg/kg	0.91	2.2 #	2.7 #	0.47 U	0.31 U
Vanadium	mg/kg	37.6	17.7	24.5	17.4 N	16.5
Zinc	mg/kg	93.3	62.2	67.2	62.2	49.4
Organic-Volatiles						
1,2-Dimethylbenzene	mg/kg		NA	NA	NA	NA
2-Butanone	mg/kg		NA	NA	NA	NA
Acetone	mg/kg		NA	NA	NA	NA
Carbon Disulfide	mg/kg		NA	NA	NA	NA
M + P Xylene	mg/kg		NA	NA	NA	NA
Methylene Chloride	mg/kg		NA	NA	NA	NA
Toluene	mg/kg		NA	NA	NA	NA

Table 4-9. SRCs in Subsurface Soil at the 40-mm Firing Range (continued)

Media Location Station Sample ID Customer ID Date Depth (ft) Filtered Field Type Analyte (mg/kg)	Units	Facility-wide Background	Soil 077 FBQso-077 FBQSO-077-0154-SO FBQso-077-0154-SO 11/17/2003 1.0 - 3.0 Total Regular samples	Soil 079 FBQso-079 FBQSO-079-0158-SO FBQso-079-0158-SO 11/12/2003 1.0 - 3.0 Total Regular samples	Soil 082 FBQso-082 FBQSO-082-0164-SO FBQso-082-0164-SO 11/11/2003 1.0 - 3.0 Total Regular samples	Soil 083 FBQso-083 FBQSO-083-0166-SO FBQso-083-0166-SO 11/13/2003 1.0 - 3.0 Total Regular samples
Explosives						
3-Nitrotoluene	mg/kg		0.2 U	0.2 U/U	0.2 U/U	0.2 U/U
Nitrobenzene	mg/kg		0.07 J	0.035 JB/UJ	0.052 JB/UJ	0.1 U/U
Nitrocellulose	mg/kg		NA	59 /=	NA	24 /=
Inorganics						
Aluminum	mg/kg	19,500	14,600	11,100 /J	10,000 /=	12,600 /J
Antimony	mg/kg	0.96	0.28 UN	0.36 B/UJ	0.3 BN/UJ	0.22 B/UJ
Arsenic	mg/kg	19.8	30.3 N#	23.1 /=#	20.7 /=#	19.2 /=
Barium	mg/kg	124	68.7	50.1 N/=	49.7 /=	45.8 N/=
Beryllium	mg/kg	0.88	0.88	0.6 /R	0.62 /=	0.55 /R
Cadmium	mg/kg	0	0.051 B#	0.022 U/U	0.016 U/U	0.026 U/U
Calcium	mg/kg	35,500	905	418 /J	1,240 /=	283 /J
Chromium	mg/kg	27.2	19.6	17.2 /=	14.8 /=	18.3 /=
Cobalt	mg/kg	23.2	15.3	9.8 /=	9.5 /=	7.8 /=
Copper	mg/kg	32.3	22	23.1 N/J	19.4 /=	22.1 N/J
Iron	mg/kg	35,200	27,500	28,800 /=	25,000 /=	30,400 /=
Lead	mg/kg	19.1	36.1 #	17.7 N/=	13.8 /=	13 N/=
Magnesium	mg/kg	8,790	3,350 N	2,510 /=	2,590 N/=	2,380 /=
Manganese	mg/kg	3,030	272	313 /=	373 /=	200 /=
Mercury	mg/kg	0.044	0.023 B	0.017 B/UJ	0.016 U/U	0.016 U/U
Nickel	mg/kg	60.7	25.4	22 /=	23.6 /=	19.1 /=
Potassium	mg/kg	3,350	1,630 N	1,260 N/=	1,290 N/=	1,170 N/=
Selenium	mg/kg	1.5	0.3 U	0.38 B/UJ	0.32 B/UJ	0.68 B/UJ
Silver	mg/kg	0	0.063 U	0.037 U/U	0.058 U/U	0.044 U/U
Sodium	mg/kg	145	68.7	47.9 /=	68.4 /=	53.1 /=
Thallium	mg/kg	0.91	2.4 #	0.78 B/UJ	0.43 U/U	0.72 B/UJ
Vanadium	mg/kg	37.6	23.3	19.7 /=	17.6 /=	22.3 /=
Zinc	mg/kg	93.3	60.8	66.8 N/=	67.6 /=	57.2 N/=
Organic-Volatiles						
1,2-Dimethylbenzene	mg/kg		NA	0.0065 U/UJ	NA	0.002 J/J
2-Butanone	mg/kg		NA	0.013 U/R	NA	0.012 U/U
Acetone	mg/kg		NA	0.013 U/R	NA	0.013 B/UJ
Carbon Disulfide	mg/kg		NA	0.0065 U/UJ	NA	0.016 /=
M + P Xylene	mg/kg		NA	0.0065 U/UJ	NA	0.0051 J/J
Methylene Chloride	mg/kg		NA	0.014 B/R	NA	0.007 JB/UJ
Toluene	mg/kg		NA	0.0065 U/UJ	NA	0.0036 J/J

Table 4-9. SRCs in Subsurface Soil at the 40-mm Firing Range (continued)

Media **Location** **Station** **Sample ID** **Customer ID** **Date** **Depth (ft)** **Filtered** **Field Type** **Analyte (mg/kg)**	**Units**	**Facility-wide Background**	**Soil** **085** **FBQso-085** **FBQSO-085-0170-SO** **FBQso-085-0170-SO** **11/13/2003** **1.0 - 3.0** **Total** **Regular samples**	**Soil** **086** **FBQso-086** **FBQSO-086-0172-SO** **FBQso-086-0172-SO** **11/17/2003** **1.0 - 3.0** **Total** **Regular samples**	**Soil** **086** **FBQso-086** **FBQSO-086-0406-SO** **FBQso-086-0406-SO** **11/17/2003** **1.0 - 3.0** **Total** **Field Duplicate**	**Soil** **087** **FBQso-087** **FBQSO-087-0174-SO** **FBQso-087-0174-SO** **11/11/2003** **1.0 - 3.0** **Total** **Regular samples**
Explosives						
3-Nitrotoluene	mg/kg		0.2 U	0.2 U	0.2 U	0.2 U/U
Nitrobenzene	mg/kg		0.047 J	0.1 U	0.1 U	0.1 U/U
Nitrocellulose	mg/kg		NA	46	30	NA
Inorganics						
Aluminum	mg/kg	19,500	12,300	14,800	12,900	11,800 /=
Antimony	mg/kg	0.96	0.18 UN	0.28 UN	0.26 UN	0.27 UN/U
Arsenic	mg/kg	19.8	19.7	20.1 N#	18.2 N	20.6 /=#
Barium	mg/kg	124	52.3 N	59.3	59.8	60.3 /=
Beryllium	mg/kg	0.88	0.69 E	0.76	0.69	0.75 /=
Cadmium	mg/kg	0	0.023 U*	0.028 B#	0.036 B#	0.026 B/UJ
Calcium	mg/kg	35,500	459	389	402	313 /=
Chromium	mg/kg	27.2	18.5 N	20	17.8	16.7 /=
Cobalt	mg/kg	23.2	11.4	10	8.7	11.4 /=
Copper	mg/kg	32.3	23.4	24.2	22	23.3 /=
Iron	mg/kg	35,200	29,600	29,300	24,900	28,100 /=
Lead	mg/kg	19.1	14.4	14.1	13.1	15.1 /=
Magnesium	mg/kg	8,790	3,000 N	3,260 N	2,880 N	2,840 N/=
Manganese	mg/kg	3,030	285	240	235	352 /=
Mercury	mg/kg	0.044	0.018 B	0.016 U	0.015 U	0.017 U/U
Nickel	mg/kg	60.7	23.3	23.6	22.7	26.3 /=
Potassium	mg/kg	3,350	1,320 N	1,440 N	1,260 N	1,150 N/=
Selenium	mg/kg	1.5	0.22 B	0.3 U	0.28 U	0.31 B/UJ
Silver	mg/kg	0	0.038 U	0.064 U	0.059 U	0.061 U/U
Sodium	mg/kg	145	71	65.9	67.7	62.5 /=
Thallium	mg/kg	0.91	0.4 B	2.7 #	2.3 #	0.45 U/U
Vanadium	mg/kg	37.6	21.3	24.2	21.1	19.6 /=
Zinc	mg/kg	93.3	64.6	77.4	62.9	68 /=
Organic-Volatiles						
1,2-Dimethylbenzene	mg/kg		NA	0.0062 U/UJ	0.0061 U/UJ	NA
2-Butanone	mg/kg		NA	0.0054 J/R	0.012 U/R	NA
Acetone	mg/kg		NA	0.012 JB/R	0.01 JB/R	NA
Carbon Disulfide	mg/kg		NA	0.0031 J/J	0.0061 U/UJ	NA
M + P Xylene	mg/kg		NA	0.0062 U/UJ	0.0061 U/UJ	NA
Methylene Chloride	mg/kg		NA	0.0092 JB/R	0.016 B/R	NA
Toluene	mg/kg		NA	0.0062 U/UJ	0.0061 U/UJ	NA

Table 4-9. SRCs in Subsurface Soil at the 40-mm Firing Range (continued)

Media Location Station Sample ID Customer ID Date Depth (ft) Filtered Field Type Analyte (mg/kg)	Units	Facility-wide Background	Soil 088 FBQso-088 FBQSO-088-0176-SO FBQso-088-0176-SO 11/11/2003 1.0 - 3.0 Total Regular samples	Soil 088 FBQso-088 FBQSO-088-0400-SO FBQso-088-0400-SO 11/11/2003 1.0 - 3.0 Total Field Duplicate	Soil 094 FBQso-094 FBQSO-094-0188-SO FBQso-094-0188-SO 11/12/2003 1.0 - 3.0 Total Regular samples	Soil 094 FBQso-094 FBQSO-094-0402-SO FBQso-094-0402-SO 11/12/2003 1.0 - 3.0 Total Field Duplicate
Explosives						
3-Nitrotoluene	mg/kg		0.2 U	0.2 U	0.2 U	0.2 U
Nitrobenzene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
Nitrocellulose	mg/kg		NA	NA	NA	NA
Inorganics						
Aluminum	mg/kg	19,500	11,300	12,600	13,900	14,200
Antimony	mg/kg	0.96	0.24 UN	0.25 BN	0.35 BN	0.27 UN
Arsenic	mg/kg	19.8	17.5	18.3	14.5	16.5
Barium	mg/kg	124	60.2 N	63.8 N	51.4 N	50.9 N
Beryllium	mg/kg	0.88	0.66	0.73	0.6	0.61
Cadmium	mg/kg	0	0.077 #	0.081 #	0.083 #	0.03 B#
Calcium	mg/kg	35,500	506	562	241	260
Chromium	mg/kg	27.2	15.6 N	16.6 N	17.7 N	18.1 N
Cobalt	mg/kg	23.2	9.9	9.5	8	7.8
Copper	mg/kg	32.3	23.1	23.5	17.2	18.9
Iron	mg/kg	35,200	26,400	28,500	28,900	28,900
Lead	mg/kg	19.1	14.3	14.4	14.7	14.3
Magnesium	mg/kg	8,790	2,510 N	2,570 N	2,370 N	2,420 N
Manganese	mg/kg	3,030	328	281	369	282
Mercury	mg/kg	0.044	0.017 U	0.015 U	0.021 B	0.021 B
Nickel	mg/kg	60.7	22	21.9	16.1	16.7
Potassium	mg/kg	3,350	1,110 N	1,220 N	1,150 N	1,200 N
Selenium	mg/kg	1.5	0.29 B	0.27 U	0.69 B	0.51 B
Silver	mg/kg	0	0.053 U	0.057 U	0.079 B#	0.068 B#
Sodium	mg/kg	145	72.1	70.6	100	98.3
Thallium	mg/kg	0.91	0.39 U	0.42 U	0.47 U	0.46 U
Vanadium	mg/kg	37.6	20.3 N	23.1 N	25 N	25.4 N
Zinc	mg/kg	93.3	64	62.8	51.2	53.8
Organic-Volatiles						
1,2-Dimethylbenzene	mg/kg		NA	NA	NA	NA
2-Butanone	mg/kg		NA	NA	NA	NA
Acetone	mg/kg		NA	NA	NA	NA
Carbon Disulfide	mg/kg		NA	NA	NA	NA
M + P Xylene	mg/kg		NA	NA	NA	NA
Methylene Chloride	mg/kg		NA	NA	NA	NA
Toluene	mg/kg		NA	NA	NA	NA

Table 4-9. SRCs in Subsurface Soil at the 40-mm Firing Range (continued)

Media Location Station Sample ID Customer ID Date Depth (ft) Filtered Field Type Analyte (mg/kg)	Units	Facility-wide Background	Soil 095 FBQso-095 FBQSO-095-0190-SO FBQso-095-0190-SO 11/12/2003 1.0 - 3.0 Total Regular samples	Soil 096 FBQso-096 FBQSO-096-0192-SO FBQso-096-0192-SO 11/12/2003 1.0 - 3.0 Total Regular samples	Soil 097 FBQso-097 FBQSO-097-0194-SO FBQso-097-0194-SO 11/12/2003 1.0 - 3.0 Total Regular samples	Soil 098 FBQso-098 FBQSO-098-0196-SO FBQso-098-0196-SO 11/12/2003 1.0 - 3.0 Total Regular samples
Explosives						
3-Nitrotoluene	mg/kg		0.2 U	0.2 U	0.2 U	0.2 U/U
Nitrobenzene	mg/kg		0.1 U	0.1 U	0.1 U	0.052 JB/UJ
Nitrocellulose	mg/kg		NA	NA	NA	NA
Inorganics						
Aluminum	mg/kg	19,500	14,000	16,200	11,800	11,300 /J
Antimony	mg/kg	0.96	0.32 BN	0.3 UN	0.26 UN	0.34 B/UJ
Arsenic	mg/kg	19.8	20.6 #	13.2	12.5	15.9 /=
Barium	mg/kg	124	67.4 N	85.7 N	44.4 N	52.9 N/=
Beryllium	mg/kg	0.88	0.91 #	0.66	0.51	0.56 /R
Cadmium	mg/kg	0	0.027 B#	0.036 B#	0.019 B#	0.026 U/U
Calcium	mg/kg	35,500	816	739	293	322 /J
Chromium	mg/kg	27.2	18.6 N	20.7 N	14.7 N	15.9 /=
Cobalt	mg/kg	23.2	12.3	8.4	7.6	8.6 /=
Copper	mg/kg	32.3	23	19.4	14.6	20.9 N/J
Iron	mg/kg	35,200	30,400	29,600	22,600	25,800 /=
Lead	mg/kg	19.1	14.1	13.1	10.2	15.1 N/=
Magnesium	mg/kg	8,790	3,230 N	3,160 N	2,000 N	2,280 /=
Manganese	mg/kg	3,030	302	331	307	281 /=
Mercury	mg/kg	0.044	0.016 U	0.018 B	0.016 U	0.023 B/UJ
Nickel	mg/kg	60.7	26.7	20.6	15	20.2 /=
Potassium	mg/kg	3,350	1,320 N	1,470 N	1,050 N	1,120 N/=
Selenium	mg/kg	1.5	0.34 B	0.49 B	0.61 B	0.38 B/UJ
Silver	mg/kg	0	0.065 U	0.076 B#	0.071 B#	0.043 U/U
Sodium	mg/kg	145	88.3	117	90.5	50.5 /=
Thallium	mg/kg	0.91	0.49 U	0.51 U	0.44 U	0.57 B/UJ
Vanadium	mg/kg	37.6	22.8 N	28 N	23.6 N	21 /=
Zinc	mg/kg	93.3	69	52.7	45.6	60.1 N/=
Organic-Volatiles						
1,2-Dimethylbenzene	mg/kg		NA	NA	NA	NA
2-Butanone	mg/kg		NA	NA	NA	NA
Acetone	mg/kg		NA	NA	NA	NA
Carbon Disulfide	mg/kg		NA	NA	NA	NA
M + P Xylene	mg/kg		NA	NA	NA	NA
Methylene Chloride	mg/kg		NA	NA	NA	NA
Toluene	mg/kg		NA	NA	NA	NA

Table 4-9. SRCs in Subsurface Soil at the 40-mm Firing Range (continued)

Media Location Station Sample ID Customer ID Date Depth (ft) Filtered Field Type Analyte (mg/kg)	Units	Facility-wide Background	Soil 100 FBQso-100 FBQSO-100-0200-SO FBQso-100-0200-SO 11/11/2003 1.0 - 3.0 Total Regular samples
Explosives			
3-Nitrotoluene	mg/kg		0.2 U/U
Nitrobenzene	mg/kg		0.1 U/U
Nitrocellulose	mg/kg		NA
Inorganics			
Aluminum	mg/kg	19,500	6,850 /=
Antimony	mg/kg	0.96	0.23 UN/U
Arsenic	mg/kg	19.8	13 /=
Barium	mg/kg	124	31.8 /=
Beryllium	mg/kg	0.88	0.51 /=
Cadmium	mg/kg	0	0.059 B/UJ
Calcium	mg/kg	35,500	490 /=
Chromium	mg/kg	27.2	12.9 /=
Cobalt	mg/kg	23.2	7.2 /=
Copper	mg/kg	32.3	16.6 /=
Iron	mg/kg	35,200	20,700 /=
Lead	mg/kg	19.1	12.8 /=
Magnesium	mg/kg	8,790	1,470 N/=
Manganese	mg/kg	3,030	347 /=
Mercury	mg/kg	0.044	0.022 B/UJ
Nickel	mg/kg	60.7	16 /=
Potassium	mg/kg	3,350	956 N/=
Selenium	mg/kg	1.5	0.25 U/U
Silver	mg/kg	0	0.053 U/U
Sodium	mg/kg	145	46.3 /=
Thallium	mg/kg	0.91	0.39 U/U
Vanadium	mg/kg	37.6	13.2 /=
Zinc	mg/kg	93.3	59.8 /=
Organic-Volatiles			
1,2-Dimethylbenzene	mg/kg		NA
2-Butanone	mg/kg		NA
Acetone	mg/kg		NA
Carbon Disulfide	mg/kg		NA
M + P Xylene	mg/kg		NA
Methylene Chloride	mg/kg		NA
Toluene	mg/kg		NA

Table 4-9. SRCs in Subsurface Soil at the 40-mm Range (continued)

Note: Data qualifiers are presented as laboratory qualifiers/validation qualifiers.
B for inorganics = Result is less than the contract-required detection limit but greater than the instrument detection limit.
B for organics = Compound is detected in the blank as well as the sample.
E = Result estimated because of the presence of interference.
J = Estimated value is less than the reporting limits.
N = Matrix spike recovery is outside the control limits.
P = Greater than 25% difference between the two GC columns.
R = Data are rejected.
U = Not detected.
# = Value is above the facility-wide background.
* = Duplicate analysis is outside the control limits.
"=" = Analyte present and concentration accurate.
Facility-wide background is determined for the Winklepeck Burning Ground Phase II Remedial Investigation (USACE 2001b).
NA = Not applicable.
PCB = Polychlorinated biphenyl.
SRC = Site-related contaminant.

Table 4-10. Summary Statistics and Determination of SRCs in Sediment Samples at the Fuze and Booster Quarry Landfill/Ponds

Analyte	Units	Results >Detection Limit	Average Result	Minimum Detect	Maximum Detect	Background Criteria	Site Related?	Justification
Miscellaneous								
Chromium, hexavalent	mg/kg	23/ 40	8.5	1.9	33		Yes	No Background Data Available
Total Organic Carbon	mg/kg	38/ 38	44,000	12,000	120,000		Yes	No Background Data Available
Metals								
Aluminum	mg/kg	40/ 40	14,000	2,940	22,100	13,900	Yes	Above Background
Antimony	mg/kg	16/ 40	7.99	1	128	0	Yes	No Background Data Available
Arsenic	mg/kg	40/ 40	12.2	3.2	33.3	19.5	Yes	Above Background
Barium	mg/kg	40/ 40	157	27.3	976	123	Yes	Above Background
Beryllium	mg/kg	39/ 40	0.778	0.21	1.2	0.38	Yes	Above Background
Cadmium	mg/kg	32/ 40	1.39	0.081	18.9	0	Yes	No Background Data Available
Calcium	mg/kg	40/ 40	5,430	278	55,500	5,510	No	Essential Element
Chromium	mg/kg	40/ 40	55.1	5.5	1,140	18.1	Yes	Above Background
Cobalt	mg/kg	40/ 40	10.4	3.3	18	9.1	Yes	Above Background
Copper	mg/kg	40/ 40	68.3	11.2	660	27.6	Yes	Above Background
Iron	mg/kg	40/ 40	32,200	7,840	138,000	28,200	No	Essential Element
Lead	mg/kg	40/ 40	198	15.4	1,490	27.4	Yes	Above Background
Magnesium	mg/kg	40/ 40	3,280	510	8,590	2,760	No	Essential Element
Manganese	mg/kg	40/ 40	541	69.6	4,100	1,950	Yes	Above Background
Mercury	mg/kg	31/ 40	1.65	0.066	35	0.059	Yes	Above Background
Nickel	mg/kg	40/ 40	26	7.2	80.5	17.7	Yes	Above Background
Potassium	mg/kg	40/ 40	1,520	337	3,680	1,950	No	Essential Element
Selenium	mg/kg	15/ 40	1.27	1.1	8.2	1.7	Yes	Above Background
Silver	mg/kg	7/ 40	0.627	0.27	12.4	0	Yes	No Background Data Available
Sodium	mg/kg	37/ 40	173	60.8	814	112	No	Essential Element
Vanadium	mg/kg	40/ 40	24.8	5.9	42	26.1	Yes	Above Background
Zinc	mg/kg	40/ 40	454	59	3,620	532	Yes	Above Background
Organics-Explosives								
1,3,5-Trinitrobenzene	mg/kg	1/ 40	0.0512	0.098	0.098		Yes	No Background Data Available
1,3-Dinitrobenzene	mg/kg	1/ 40	0.0515	0.11	0.11		Yes	No Background Data Available
2,4,6-Trinitrotoluene	mg/kg	5/ 40	0.0571	0.033	0.3		Yes	No Background Data Available
2,6-Dinitrotoluene	mg/kg	1/ 40	0.0509	0.085	0.085		Yes	No Background Data Available
2-Amino-4,6-Dinitrotoluene	mg/kg	1/ 40	0.0506	0.073	0.073		Yes	No Background Data Available
3-Nitrotoluene	mg/kg	3/ 40	0.101	0.078	0.15		Yes	No Background Data Available

Table 4-10. Summary Statistics and Determination of SRCs in Sediment Samples at the Fuze and Booster Quarry Landfill/Ponds (continued)

Analyte	Units	Results >Detection Limit	Average Result	Minimum Detect	Maximum Detect	Background Criteria	Site Related?	Justification
4-Amino-2,6-Dinitrotoluene	mg/kg	3/ 40	0.062	0.11	0.39		Yes	No Background Data Available
HMX	mg/kg	2/ 40	0.102	0.11	0.16		Yes	No Background Data Available
Nitrobenzene	mg/kg	5/ 40	0.0511	0.049	0.11		Yes	No Background Data Available
Nitrocellulose	mg/kg	23/ 40	39	23	110		Yes	No Background Data Available
Nitroglycerin	mg/kg	1/ 38	6.16	49	49		Yes	No Background Data Available
				Organics-Pesticide/PCB				
4,4'-DDD	mg/kg	5/ 40	0.00177	0.00053	0.013		Yes	No Background Data Available
4,4'-DDE	mg/kg	6/ 40	0.00136	0.00052	0.0015		Yes	No Background Data Available
4,4'-DDT	mg/kg	1/ 40	0.00149	0.0016	0.0016		?	<= 5% Detects
Dieldrin	mg/kg	3/ 40	0.00143	0.00041	0.00088		Yes	No Background Data Available
Endosulfan I	mg/kg	1/ 40	0.00147	0.00052	0.00052		?	<= 5% Detects
Endrin	mg/kg	2/ 40	0.00145	0.00055	0.00071		?	<= 5% Detects
Endrin aldehyde	mg/kg	1/ 40	0.0015	0.0018	0.0018		?	<= 5% Detects
Heptachlor epoxide	mg/kg	1/ 40	0.00147	0.00057	0.00057		?	<= 5% Detects
Lindane	mg/kg	1/ 40	0.00148	0.00086	0.00086		?	<= 5% Detects
Methoxychlor	mg/kg	4/ 40	0.0015	0.0011	0.003		Yes	No Background Data Available
beta-BHC	mg/kg	1/ 40	0.00147	0.00066	0.00066		?	<= 5% Detects
				Organics-Semivolatile				
2-Methylnaphthalene	mg/kg	5/ 40	0.3	0.032	1.6		Yes	No Background Data Available
4-Methylphenol	mg/kg	2/ 40	0.303	0.26	0.51		?	<= 5% Detects
Acenaphthylene	mg/kg	1/ 40	0.293	0.11	0.11		?	<= 5% Detects
Anthracene	mg/kg	2/ 40	0.3	0.23	0.46		?	<= 5% Detects
Benz(*a*)anthracene	mg/kg	12/ 40	0.315	0.074	2.1		Yes	No Background Data Available
Benzo(*a*)pyrene	mg/kg	16/ 40	0.279	0.053	2		Yes	No Background Data Available
Benzo(*b*)fluoranthene	mg/kg	16/ 40	0.306	0.083	2.3		Yes	No Background Data Available
Benzo(*ghi*)perylene	mg/kg	4/ 40	0.317	0.21	1.2		Yes	No Background Data Available
Benzo(*k*)fluoranthene	mg/kg	3/ 40	0.306	0.16	0.95		Yes	No Background Data Available
Bis(2-ethylhexyl)phthalate	mg/kg	4/ 40	0.192	0.061	0.1		Yes	No Background Data Available
Carbazole	mg/kg	2/ 40	0.291	0.11	0.23		?	<= 5% Detects
Chrysene	mg/kg	15/ 40	0.268	0.061	1.3		Yes	No Background Data Available
Dibenzofuran	mg/kg	2/ 40	0.285	0.11	0.43		?	<= 5% Detects
Fluoranthene	mg/kg	18/ 40	0.371	0.073	3.2		Yes	No Background Data Available
Fluorene	mg/kg	1/ 40	0.293	0.12	0.12		?	<= 5% Detects

Table 4-10. Summary Statistics and Determination of SRCs in Sediment Samples at the Fuze and Booster Quarry Landfill/Ponds (continued)

Analyte	Units	Results >Detection Limit	Average Result	Minimum Detect	Maximum Detect	Background Criteria	Site Related?	Justification
Indeno(1,2,3-*cd*)pyrene	mg/kg	6/ 40	0.287	0.066	1		Yes	No Background Data Available
Naphthalene	mg/kg	4/ 40	0.289	0.083	0.97		Yes	No Background Data Available
Phenanthrene	mg/kg	11/ 40	0.317	0.092	1.7		Yes	No Background Data Available
Pyrene	mg/kg	14/ 40	0.34	0.1	2.3		Yes	No Background Data Available
Organics-Volatile								
2-Butanone	mg/kg	11/ 40	0.0101	0.0042	0.043		Yes	No Background Data Available
Acetone	mg/kg	5/ 40	0.0158	0.016	0.064		Yes	No Background Data Available
Carbon Disulfide	mg/kg	3/ 40	0.00429	0.0023	0.0036		Yes	No Background Data Available
Methylene Chloride	mg/kg	6/ 40	0.00944	0.01	0.037		Yes	No Background Data Available
Toluene	mg/kg	6/ 40	0.00696	0.002	0.09		Yes	No Background Data Available
Trichloroethene	mg/kg	1/ 40	0.00442	0.0028	0.0028		?	<= 5% Detects

Analytes may have been eliminated as SRCs because they were detected at concentrations less than facility-wide backgroundcriteria.

PCB = Polychlorinated biphenyl.
SRC = Site-related contaminant.

Table 4-11. SRCs in Sediment at the Fuze and Booster Quarry Landfill/Ponds

Media Location Station Sample ID Customer ID Date Depth (ft) Filtered Field Type Analyte (mg/kg)	Units	Facility-wide Background	Sediment FBQ FBQsd-126 FBQSD-126-0251-SD FBQsd-126-0251-SD 10/23/2003 0.0 - 0.5 Total Regular samples	Sediment FBQ FBQsd-127 FBQSD-127-0252-SD FBQsd-127-0252-SD 10/23/2003 0.0 - 0.5 Total Regular samples	Sediment FBQ FBQsd-128 FBQSD-128-0253-SD FBQsd-128-0253-SD 10/23/2003 0.0 - 0.5 Total Regular samples	Sediment FBQ FBQsd-129 FBQSD-129-0254-SD FBQsd-129-0254-SD 11/05/2003 0.0 - 0.5 Total Regular samples
Explosives						
1,3,5-Trinitrobenzene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
1,3-Dinitrobenzene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
2,4,6-Trinitrotoluene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
2,6-Dinitrotoluene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
2-Amino-4,6-dinitrotoluene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
3-Nitrotoluene	mg/kg		0.2 U	0.2 U	0.2 U	0.2 U
4-Amino-2,6-dinitrotoluene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
HMX	mg/kg		0.2 U	0.2 U	0.2 U	0.2 U
Nitrobenzene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
Nitrocellulose	mg/kg		37 U	33 U	39	110
Nitroglycerin	mg/kg		10 U	10 U	10 U	10 U
Inorganics						
Aluminum	mg/kg	13,900	17,800 #	15,400 #	9,210	17,100 #
Antimony	mg/kg	0	1.6 BN#	1 BN#	0.43 BN#	0.46 BN#
Arsenic	mg/kg	19.5	17.5	15.5	9.1	8
Barium	mg/kg	123	228 #	154 #	75	153 N#
Beryllium	mg/kg	0.38	1.1 #	0.95 #	0.71 #	1.1 #
Cadmium	mg/kg	0	0.92 #	0.58 #	0.11 #	0.48 #
Calcium	mg/kg	5,510	3,700	3,600	1,400	3,100
Chromium	mg/kg	18.1	1,140 #	19.6 #	12.4	22.9 E#
Chromium, hexavalent	mg/kg		18 #	15 #	8.5 #	1.8 U
Cobalt	mg/kg	9.1	17.8 #	12.6 #	7.1	7.9
Copper	mg/kg	27.6	26.3	24	15.7	34.5 #
Iron	mg/kg	28,200	36,000 #	29,300 #	18,600	18,800
Lead	mg/kg	27.4	37 #	43.6 #	45.5 #	142 #
Magnesium	mg/kg	2760	4,630 N#	3,340 N#	1,720 N	3,470 N#
Manganese	mg/kg	1950	2,560 #	917	305	246
Mercury	mg/kg	0.06	0.15 #	0.19 #	0.075 #	0.17 #
Nickel	mg/kg	17.7	32.9 #	22.7 #	11.9	21.8 E#

Table 4-11. SRCs in Sediment at the Fuze and Booster Quarry Landfill/Ponds (continued)

Media Location Station Sample ID Customer ID Date Depth (ft) Filtered Field Type Analyte (mg/kg)	Units	Facility-wide Background	Sediment FBQ FBQsd-126 FBQSD-126-0251-SD FBQsd-126-0251-SD 10/23/2003 0.0 - 0.5 Total Regular samples	Sediment FBQ FBQsd-127 FBQSD-127-0252-SD FBQsd-127-0252-SD 10/23/2003 0.0 - 0.5 Total Regular samples	Sediment FBQ FBQsd-128 FBQSD-128-0253-SD FBQsd-128-0253-SD 10/23/2003 0.0 - 0.5 Total Regular samples	Sediment FBQ FBQsd-129 FBQSD-129-0254-SD FBQsd-129-0254-SD 11/05/2003 0.0 - 0.5 Total Regular samples
Potassium	mg/kg	1,950	2,360 N#	1,780 N	921 N	1,530 NE
Selenium	mg/kg	1.7	3 B#	2.2 #	1.1 B	1.1 B
Silver	mg/kg	0	0.27 B#	0.16 B#	0.066 U	0.11 B#
Sodium	mg/kg	112	191 #	152 #	97.9	150 #
Thallium	mg/kg	0.89	1.6 U	0.71 U	0.49 U	0.58 U
Vanadium	mg/kg	26.1	30.9 #	28.1 #	19.4	31.6 N#
Zinc	mg/kg	532	205	162	77.5	152
Miscellaneous						
Total Organic Carbon	mg/kg		54,000	62,000	47,000	56,000
Organic-Semivolatiles						
2-Methylnaphthalene	mg/kg		0.84 U	0.71 U	0.51 U	0.11 J
4-Methylphenol	mg/kg		0.84 U	0.71 U	0.51 U	0.62 U
Acenaphthylene	mg/kg		0.84 U	0.71 U	0.51 U	0.62 U
Anthracene	mg/kg		0.84 U	0.71 U	0.51 U	0.62 U
Benz(*a*)anthracene	mg/kg		0.84 U	0.71 U	0.11 J	0.096 J
Benzo(*a*)pyrene	mg/kg		0.84 U	0.71 U	0.074 J	0.11 J
Benzo(*b*)fluoranthene	mg/kg		0.84 U	0.71 U	0.099 J	0.16 J
Benzo(*ghi*)perylene	mg/kg		0.84 U	0.71 U	0.51 U	0.62 U
Benzo(*k*)fluoranthene	mg/kg		0.84 U	0.71 U	0.51 U	0.62 U
Bis(2-ethylhexyl)phthalate	mg/kg		0.21 JB	0.21 JB	0.14 JB	0.62 U
Carbazole	mg/kg		0.84 U	0.71 U	0.51 U	0.62 U
Chrysene	mg/kg		0.84 U	0.71 U	0.08 J	0.11 J
Di-n-butyl phthalate	mg/kg		0.96 B	0.29 JB	0.17 JB	0.62 U
Dibenzofuran	mg/kg		0.84 U	0.71 U	0.51 U	0.62 U
Fluoranthene	mg/kg		0.84 U	0.71 U	0.13 J	0.18 J
Fluorene	mg/kg		0.84 U	0.71 U	0.51 U	0.62 U
Indeno(1,2,3-*cd*)pyrene	mg/kg		0.84 U	0.71 U	0.51 U	0.62 U
Naphthalene	mg/kg		0.84 U	0.71 U	0.51 U	0.083 J
Phenanthrene	mg/kg		0.84 U	0.71 U	0.51 U	0.14 J

Table 4-11. SRCs in Sediment at the Fuze and Booster Quarry Landfill/Ponds (continued)

Media Location Station Sample ID Customer ID Date Depth (ft) Filtered Field Type Analyte (mg/kg)	Units	Facility-wide Background	Sediment FBQ FBQsd-126 FBQSD-126-0251-SD FBQsd-126-0251-SD 10/23/2003 0.0 - 0.5 Total Regular samples	Sediment FBQ FBQsd-127 FBQSD-127-0252-SD FBQsd-127-0252-SD 10/23/2003 0.0 - 0.5 Total Regular samples	Sediment FBQ FBQsd-128 FBQSD-128-0253-SD FBQsd-128-0253-SD 10/23/2003 0.0 - 0.5 Total Regular samples	Sediment FBQ FBQsd-129 FBQSD-129-0254-SD FBQsd-129-0254-SD 11/05/2003 0.0 - 0.5 Total Regular samples
Pyrene	mg/kg		0.84 U	0.71 U	0.13 J	0.14 J
Organic-Volatiles						
2-Butanone	mg/kg		0.025 U	0.021 U	0.015 U	0.018 U
Acetone	mg/kg		0.016 JB	0.021 U	0.015 U	0.0092 JB
Carbon Disulfide	mg/kg		0.013 U	0.011 U	0.0076 U	0.0092 U
Methylene Chloride	mg/kg		0.015 JB	0.013 JB	0.0081 JB	0.012 JB
Toluene	mg/kg		0.013 U	0.011 U	0.0076 U	0.0092 U
Trichloroethene	mg/kg		0.013 U	0.011 U	0.0076 U	0.0092 U
Organics-Pesticide/PCB						
4,4'-DDD	mg/kg		0.0042 U	0.0036 U	0.0025 U	0.0031 U
4,4'-DDE	mg/kg		0.0042 U	0.0036 U	0.0025 U	0.0031 U
4,4'-DDT	mg/kg		0.0042 U	0.0036 U	0.0025 U	0.0031 U
Dieldrin	mg/kg		0.0042 U	0.0036 U	0.0025 U	0.0031 U
Endosulfan I	mg/kg		0.0042 U	0.0036 U	0.0025 U	0.0031 U
Endrin	mg/kg		0.0042 U	0.0036 U	0.0025 U	0.0031 U
Endrin aldehyde	mg/kg		0.0042 U	0.0036 U	0.0025 U	0.0031 U
Heptachlor epoxide	mg/kg		0.0042 U	0.0036 U	0.0025 U	0.0031 U
Lindane	mg/kg		0.0042 U	0.0036 U	0.0025 U	0.0031 U
Methoxychlor	mg/kg		0.0042 U	0.0036 U	0.0025 U	0.0022 J
beta-BHC	mg/kg		0.0042 U	0.0036 U	0.0025 U	0.0031 U

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Table 4-11. SRCs in Sediment at the Fuze and Booster Quarry Landfill/Ponds (continued)

Media Location Station Sample ID Customer ID Date Depth (ft) Filtered Field Type Analyte (mg/kg)	Units	Facility-wide Background	Sediment FBQ FBQsd-130 FBQSD-130-0255-SD FBQsd-130-0255-SD 11/03/2003 0.0 - 0.5 Total Regular samples	Sediment FBQ FBQsd-130 FBQSD-130-0389-SD FBQsd-130-0389-SD 11/03/2003 0.0 - 0.5 Total Field Duplicate	Sediment FBQ FBQsd-131 FBQSD-131-0256-SD FBQsd-131-0256-SD 11/03/2003 0.0 - 0.5 Total Regular samples	Sediment FBQ FBQsd-132 FBQSD-132-0257-SD FBQsd-132-0257-SD 11/03/2003 0.0 - 0.5 Total Regular samples
Explosives						
1,3,5-Trinitrobenzene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
1,3-Dinitrobenzene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
2,4,6-Trinitrotoluene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
2,6-Dinitrotoluene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
2-Amino-4,6-dinitrotoluene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
3-Nitrotoluene	mg/kg		0.2 U	0.2 U	0.2 U	0.2 U
4-Amino-2,6-dinitrotoluene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
HMX	mg/kg		0.2 U	0.2 U	0.2 U	0.2 U
Nitrobenzene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
Nitrocellulose	mg/kg		41 U	71	29 U	81
Nitroglycerin	mg/kg		10 U	10 U	10 U	10 U
Inorganics						
Aluminum	mg/kg	13,900	21,500 #	20,100 #	14,900 #	22,100 #
Antimony	mg/kg	0	0.61 BN#	0.46 UN	0.37 UN	0.45 BN#
Arsenic	mg/kg	19.5	8.7	9.2	5.8	7.1
Barium	mg/kg	123	138 #	128 #	53.1	104
Beryllium	mg/kg	0.38	1.2 #	1.1 #	0.52 #	0.88 #
Cadmium	mg/kg	0	0.33 #	0.32 #	0.11 #	0.69 #
Calcium	mg/kg	5,510	3,030	2,830	816	1,230
Chromium	mg/kg	18.1	31.6 #	29.2 #	19 #	27 #
Chromium, hexavalent	mg/kg		2.5 U	2.4 U	4.4 #	1.9 U
Cobalt	mg/kg	9.1	11.6 *#	10.8 *#	5.1 *	8.5 *
Copper	mg/kg	27.6	41.4 #	38.8 #	14.4	22.1
Iron	mg/kg	28,200	25,800	24,600	16,800	20,900
Lead	mg/kg	27.4	61.8 #	58.3 #	32.5 #	455 #
Magnesium	mg/kg	2,760	5,530 N#	5,100 N#	2,810 N#	4,000 N#
Manganese	mg/kg	1,950	210 N*	194 N*	94.9 N*	143 N*
Mercury	mg/kg	0.06	0.17 #	0.17 #	0.076 B#	0.11 #

Table 4-11. SRCs in Sediment at the Fuze and Booster Quarry Landfill/Ponds (continued)

Media Location Station Sample ID Customer ID Date Depth (ft) Filtered Field Type Analyte (mg/kg)	Units	Facility-wide Background	Sediment FBQ FBQsd-130 FBQSD-130-0255-SD FBQsd-130-0255-SD 11/03/2003 0.0 - 0.5 Total Regular samples	Sediment FBQ FBQsd-130 FBQSD-130-0389-SD FBQsd-130-0389-SD 11/03/2003 0.0 - 0.5 Total Field Duplicate	Sediment FBQ FBQsd-131 FBQSD-131-0256-SD FBQsd-131-0256-SD 11/03/2003 0.0 - 0.5 Total Regular samples	Sediment FBQ FBQsd-132 FBQSD-132-0257-SD FBQsd-132-0257-SD 11/03/2003 0.0 - 0.5 Total Regular samples
Nickel	mg/kg	17.7	33.4 #	30.9 #	14.8	22.7 #
Potassium	mg/kg	1,950	3,680 N#	3,520 N#	1,420 N	2,060 N#
Selenium	mg/kg	1.7	0.95 B	1.3 B	0.39 U	0.71 B
Silver	mg/kg	0	0.098 U	0.1 U	0.083 U	0.078 U
Sodium	mg/kg	112	108	119 #	59.5 B	90.6
Thallium	mg/kg	0.89	0.73 U	0.76 U	0.62 U	0.58 U
Vanadium	mg/kg	26.1	36 N#	33.7 N#	26.9 N#	34.9 N#
Zinc	mg/kg	532	148	134	69.3	127
Miscellaneous						
Total Organic Carbon	mg/kg		80,000	87,000	35,000	33,000
Organic-Semivolatiles						
2-Methylnaphthalene	mg/kg		0.88 U	0.8 U	0.65 U	0.64 U
4-Methylphenol	mg/kg		0.88 U	0.8 U	0.65 U	0.64 U
Acenaphthylene	mg/kg		0.88 U	0.8 U	0.65 U	0.64 U
Anthracene	mg/kg		0.88 U	0.8 U	0.65 U	0.64 U
Benz(*a*)anthracene	mg/kg		0.88 U	0.8 U	0.12 J	0.64 U
Benzo(*a*)pyrene	mg/kg		0.1 J	0.082 J	0.1 J	0.078 J
Benzo(*b*)fluoranthene	mg/kg		0.16 J	0.12 J	0.15 J	0.12 J
Benzo(*ghi*)perylene	mg/kg		0.88 U	0.8 U	0.65 U	0.64 U
Benzo(*k*)fluoranthene	mg/kg		0.88 U	0.8 U	0.65 U	0.64 U
Bis(2-ethylhexyl)phthalate	mg/kg		0.88 U	0.093 J	0.076 J	0.64 U
Carbazole	mg/kg		0.88 U	0.8 U	0.65 U	0.64 U
Chrysene	mg/kg		0.11 J	0.089 J	0.1 J	0.08 J
Di-n-butyl phthalate	mg/kg		0.88 U	0.8 U	0.65 U	0.64 U
Dibenzofuran	mg/kg		0.88 U	0.8 U	0.65 U	0.64 U
Fluoranthene	mg/kg		0.17 J	0.16 J	0.19 J	0.14 J
Fluorene	mg/kg		0.88 U	0.8 U	0.65 U	0.64 U
Indeno(1,2,3-*cd*)pyrene	mg/kg		0.88 U	0.8 U	0.066 J	0.64 U
Naphthalene	mg/kg		0.88 U	0.8 U	0.65 U	0.64 U
Phenanthrene	mg/kg		0.88 U	0.8 U	0.12 J	0.64 U

Table 4-11. SRCs in Sediment at the Fuze and Booster Quarry Landfill/Ponds (continued)

Media Location Station Sample ID Customer ID Date Depth (ft) Filtered Field Type Analyte (mg/kg)	Units	Facility-wide Background	Sediment FBQ FBQsd-130 FBQSD-130-0255-SD FBQsd-130-0255-SD 11/03/2003 0.0 - 0.5 Total Regular samples	Sediment FBQ FBQsd-130 FBQSD-130-0389-SD FBQsd-130-0389-SD 11/03/2003 0.0 - 0.5 Total Field Duplicate	Sediment FBQ FBQsd-131 FBQSD-131-0256-SD FBQsd-131-0256-SD 11/03/2003 0.0 - 0.5 Total Regular samples	Sediment FBQ FBQsd-132 FBQSD-132-0257-SD FBQsd-132-0257-SD 11/03/2003 0.0 - 0.5 Total Regular samples
Pyrene	mg/kg		0.2 J	0.8 U	0.2 J	0.15 J
Organic-Volatiles						
2-Butanone	mg/kg		0.026 U	0.024 U	0.02 U	0.019 U
Acetone	mg/kg		0.026 U	0.024 U	0.009 JB	0.01 JB
Carbon Disulfide	mg/kg		0.013 U	0.012 U	0.0098 U	0.0095 U
Methylene Chloride	mg/kg		0.018 JB	0.016 JB	0.014 JB	0.014 JB
Toluene	mg/kg		0.013 U	0.012 U	0.0098 U	0.0095 U
Trichloroethene	mg/kg		0.013 U	0.012 U	0.0098 U	0.0095 U
Organics-Pesticide/PCB						
4,4'-DDD	mg/kg		0.0044 U	0.004 U	0.0033 U	0.0032 U
4,4'-DDE	mg/kg		0.0044 U	0.004 U	0.0033 U	0.0032 U
4,4'-DDT	mg/kg		0.0044 U	0.004 U	0.0033 U	0.0016 J
Dieldrin	mg/kg		0.0044 U	0.004 U	0.0033 U	0.0032 U
Endosulfan I	mg/kg		0.0044 U	0.004 U	0.0033 U	0.0032 U
Endrin	mg/kg		0.0044 U	0.004 U	0.0033 U	0.0032 U
Endrin aldehyde	mg/kg		0.0044 U	0.004 U	0.0033 U	0.0032 U
Heptachlor epoxide	mg/kg		0.0044 U	0.004 U	0.0033 U	0.0032 U
Lindane	mg/kg		0.0044 U	0.004 U	0.0033 U	0.0032 U
Methoxychlor	mg/kg		0.0044 U	0.004 U	0.0033 U	0.0032 U
beta-BHC	mg/kg		0.0044 U	0.004 U	0.0033 U	0.0032 U

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Table 4-11. SRCs in Sediment at the Fuze and Booster Quarry Landfill/Ponds (continued)

Media **Location** **Station** **Sample ID** **Customer ID** **Date** **Depth (ft)** **Filtered** **Field Type** **Analyte (mg/kg)**	**Units**	**Facility-wide Background**	**Sediment** **FBQ** **FBQsd-133** **FBQSD-133-0258-SD** **FBQsd-133-0258-SD** **11/05/2003** **0.0 - 0.5** **Total** **Regular samples**	**Sediment** **FBQ** **FBQsd-133** **FBQSD-133-0394-SD** **FBQsd-133-0394-SD** **11/05/2003** **0.0 - 0.5** **Total** **Field Duplicate**	**Sediment** **FBQ** **FBQsd-134** **FBQSD-134-0259-SD** **FBQsd-134-0259-SD** **11/05/2003** **0.0 - 0.5** **Total** **Regular samples**	**Sediment** **FBQ** **FBQsd-135** **FBQSD-135-0260-SD** **FBQsd-135-0260-SD** **11/05/2003** **0.0 - 0.5** **Total** **Regular samples**
Explosives						
1,3,5-Trinitrobenzene	mg/kg		0.1 U	0.1 U	0.098 J	0.1 U
1,3-Dinitrobenzene	mg/kg		0.1 U	0.1 U	0.11	0.1 U
2,4,6-Trinitrotoluene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
2,6-Dinitrotoluene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
2-Amino-4,6-dinitrotoluene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
3-Nitrotoluene	mg/kg		0.2 U	0.081 J	0.2 U	0.2 U
4-Amino-2,6-dinitrotoluene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
HMX	mg/kg		0.2 U	0.2 U	0.2 U	0.2 U
Nitrobenzene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
Nitrocellulose	mg/kg		66	29 U	23 U	23 U
Nitroglycerin	mg/kg		10 U	10 U	10 U	10 U
Inorganics						
Aluminum	mg/kg	13,900	11,300	14,900 #	20,200 #	15,200 #
Antimony	mg/kg	0	0.32 UN	0.32 UN	0.3 UN	0.32 UN
Arsenic	mg/kg	19.5	3.2	5	16.5	13.3
Barium	mg/kg	123	60.9 N	77.5 N	63.4 N	59.5 N
Beryllium	mg/kg	0.38	0.6 #	0.73 #	1 #	0.69 #
Cadmium	mg/kg	0	0.15 #	0.093 #	0.019 U	0.23 #
Calcium	mg/kg	5,510	1,640	1,810	928	838
Chromium	mg/kg	18.1	14.3 E	19 E#	27.1 E#	20.3 E#
Chromium, hexavalent	mg/kg		4.2 #	5.1 #	3.4 U	3.7 U
Cobalt	mg/kg	9.1	5.5	7.3	11.4 #	7.3
Copper	mg/kg	27.6	11.2	12.9	26	28.2 #
Iron	mg/kg	28,200	12,600	17,700	47,400 #	19,900
Lead	mg/kg	27.4	28.9 #	35.6 #	15.4	34.2 #
Magnesium	mg/kg	2,760	2,170 N	2,920 N#	5,090 N#	3,110 N#
Manganese	mg/kg	1,950	131	167	233	126
Mercury	mg/kg	0.06	0.051 B	0.057 B	0.031 B	0.071 #

Table 4-11. SRCs in Sediment at the Fuze and Booster Quarry Landfill/Ponds (continued)

Media Location Station Sample ID Customer ID Date Depth (ft) Filtered Field Type Analyte (mg/kg)	Units	Facility-wide Background	Sediment FBQ FBQsd-133 FBQSD-133-0258-SD FBQsd-133-0258-SD 11/05/2003 0.0 - 0.5 Total Regular samples	Sediment FBQ FBQsd-133 FBQSD-133-0394-SD FBQsd-133-0394-SD 11/05/2003 0.0 - 0.5 Total Field Duplicate	Sediment FBQ FBQsd-134 FBQSD-134-0259-SD FBQsd-134-0259-SD 11/05/2003 0.0 - 0.5 Total Regular samples	Sediment FBQ FBQsd-135 FBQSD-135-0260-SD FBQsd-135-0260-SD 11/05/2003 0.0 - 0.5 Total Regular samples
Nickel	mg/kg	17.7	13.6 E	17.6 E	32 E#	19.8 E#
Potassium	mg/kg	1,950	1,070 NE	1,300 NE	2,200 NE#	1,590 NE
Selenium	mg/kg	1.7	0.66 B	0.57 B	1.4	0.73 B
Silver	mg/kg	0	0.071 U	0.072 U	0.11 B#	0.092 B#
Sodium	mg/kg	112	116 #	138 #	124 #	117 #
Thallium	mg/kg	0.89	0.53 U	0.54 U	0.51 U	0.53 U
Vanadium	mg/kg	26.1	20.6 N	26.5 N#	31.6 N#	23.6 N
Zinc	mg/kg	532	59	73.5	78	68.1
Miscellaneous						
Total Organic Carbon	mg/kg		41,000	51,000	19,000	34,000
Organic-Semivolatiles						
2-Methylnaphthalene	mg/kg		0.56 U	0.61 U	0.47 U	0.5 U
4-Methylphenol	mg/kg		0.51 J	0.44 J	0.47 U	0.5 U
Acenaphthylene	mg/kg		0.56 U	0.61 U	0.47 U	0.5 U
Anthracene	mg/kg		0.56 U	0.61 U	0.47 U	0.5 U
Benz(*a*)anthracene	mg/kg		0.56 U	0.61 U	0.47 U	0.5 U
Benzo(*a*)pyrene	mg/kg		0.56 U	0.61 U	0.47 U	0.054 J
Benzo(*b*)fluoranthene	mg/kg		0.56 U	0.61 U	0.47 U	0.1 J
Benzo(*ghi*)perylene	mg/kg		0.56 U	0.61 U	0.47 U	0.5 U
Benzo(*k*)fluoranthene	mg/kg		0.56 U	0.61 U	0.47 U	0.5 U
Bis(2-ethylhexyl)phthalate	mg/kg		0.11 JB	0.072 JB	0.47 U	0.5 U
Carbazole	mg/kg		0.56 U	0.61 U	0.47 U	0.5 U
Chrysene	mg/kg		0.56 U	0.61 U	0.47 U	0.063 J
Di-n-butyl phthalate	mg/kg		0.56 U	0.61 U	0.47 U	0.5 U
Dibenzofuran	mg/kg		0.56 U	0.61 U	0.47 U	0.5 U
Fluoranthene	mg/kg		0.56 U	0.61 U	0.47 U	0.12 J
Fluorene	mg/kg		0.56 U	0.61 U	0.47 U	0.5 U
Indeno(1,2,3-*cd*)pyrene	mg/kg		0.56 U	0.61 U	0.47 U	0.5 U
Naphthalene	mg/kg		0.56 U	0.61 U	0.47 U	0.5 U
Phenanthrene	mg/kg		0.56 U	0.61 U	0.47 U	0.5 U

Table 4-11. SRCs in Sediment at the Fuze and Booster Quarry Landfill/Ponds (continued)

Media Location Station Sample ID Customer ID Date Depth (ft) Filtered Field Type Analyte (mg/kg)	Units	Facility-wide Background	Sediment FBQ FBQsd-133 FBQSD-133-0258-SD FBQsd-133-0258-SD 11/05/2003 0.0 - 0.5 Total Regular samples	Sediment FBQ FBQsd-133 FBQSD-133-0394-SD FBQsd-133-0394-SD 11/05/2003 0.0 - 0.5 Total Field Duplicate	Sediment FBQ FBQsd-134 FBQSD-134-0259-SD FBQsd-134-0259-SD 11/05/2003 0.0 - 0.5 Total Regular samples	Sediment FBQ FBQsd-135 FBQSD-135-0260-SD FBQsd-135-0260-SD 11/05/2003 0.0 - 0.5 Total Regular samples
Pyrene	mg/kg		0.56 U	0.61 U	0.47 U	0.5 U
Organic-Volatiles						
2-Butanone	mg/kg		0.017 U	0.018 U	0.014 U	0.015 U
Acetone	mg/kg		0.018 B	0.013 JB	0.0083 JB	0.012 JB
Carbon Disulfide	mg/kg		0.0085 U	0.0091 U	0.0071 U	0.0075 U
Methylene Chloride	mg/kg		0.011 JB	0.012 JB	0.01 JB	0.011 JB
Toluene	mg/kg		0.09	0.053	0.0071 U	0.0075 U
Trichloroethene	mg/kg		0.0085 U	0.0091 U	0.0071 U	0.0075 U
Organics-Pesticide/PCB						
4,4'-DDD	mg/kg		0.0028 U	0.0031 U	0.0024 U	0.0025 U
4,4'-DDE	mg/kg		0.0028 U	0.0031 U	0.0024 U	0.0025 U
4,4'-DDT	mg/kg		0.0028 U	0.0031 U	0.0024 U	0.0025 U
Dieldrin	mg/kg		0.0028 U	0.0031 U	0.0024 U	0.0025 U
Endosulfan I	mg/kg		0.0028 U	0.0031 U	0.0024 U	0.0025 U
Endrin	mg/kg		0.0028 U	0.0031 U	0.0024 U	0.0025 U
Endrin aldehyde	mg/kg		0.0028 U	0.0031 U	0.0024 U	0.0025 U
Heptachlor epoxide	mg/kg		0.0028 U	0.0031 U	0.0024 U	0.0025 U
Lindane	mg/kg		0.0028 U	0.0031 U	0.0024 U	0.0025 U
Methoxychlor	mg/kg		0.0028 U	0.0011 J	0.0024 U	0.0025 U
beta-BHC	mg/kg		0.0028 U	0.0031 U	0.0024 U	0.0025 U

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Table 4-11. SRCs in Sediment at the Fuze and Booster Quarry Landfill/Ponds (continued)

Media Location Station Sample ID Customer ID Date Depth (ft) Filtered Field Type Analyte (mg/kg)	Units	Facility-wide Background	Sediment FBQ FBQsd-136 FBQSD-136-0261-SD FBQsd-136-0261-SD 11/06/2003 0.0 - 0.5 Total Regular samples	Sediment FBQ FBQsd-137 FBQSD-137-0262-SD FBQsd-137-0262-SD 11/05/2003 0.0 - 0.5 Total Regular samples	Sediment FBQ FBQsd-138 FBQSD-138-0263-SD FBQsd-138-0263-SD 11/05/2003 0.0 - 0.5 Total Regular samples	Sediment FBQ FBQsd-138 FBQSD-138-0393-SD FBQsd-138-0393-SD 11/05/2003 0.0 - 0.5 Total Field Duplicate
Explosives						
1,3,5-Trinitrobenzene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
1,3-Dinitrobenzene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
2,4,6-Trinitrotoluene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
2,6-Dinitrotoluene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
2-Amino-4,6-dinitrotoluene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
3-Nitrotoluene	mg/kg		0.2 U	0.2 U	0.078 J	0.2 U
4-Amino-2,6-dinitrotoluene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
HMX	mg/kg		0.11 J	0.2 U	0.2 U	0.2 U
Nitrobenzene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
Nitrocellulose	mg/kg		57	28 U	100	69
Nitroglycerin	mg/kg		10 U	10 U	10 U	10 U
Inorganics						
Aluminum	mg/kg	13,900	14,700 #	19,400 #	15,100 #	14,500 #
Antimony	mg/kg	0	0.38 BN#	0.33 U	0.36 BN#	0.43 BN#
Arsenic	mg/kg	19.5	5.9	9.8	10.9	4.9
Barium	mg/kg	123	69.1 N	82.7	70.7 N	69.6 N
Beryllium	mg/kg	0.38	0.71 #	0.87 #	0.71 #	0.63 #
Cadmium	mg/kg	0	0.081 #	0.29 #	0.02 U	0.15 #
Calcium	mg/kg	5,510	1,190	1,790	845	938
Chromium	mg/kg	18.1	18.9 #	25.1 #	19.4 E#	18.7 E#
Chromium, hexavalent	mg/kg		4.1 #	1.6 U	1.5 U	1.7 #
Cobalt	mg/kg	9.1	7.4	9.7 #	7.8	7.4
Copper	mg/kg	27.6	16.7	20.2	15.6	17.4
Iron	mg/kg	28,200	18,700	29,100 #	24,600	16,500
Lead	mg/kg	27.4	22.8	32.5 #	23.8	23.3
Magnesium	mg/kg	2,760	3,110 N#	4,030 #	3,090 N#	2,920 N#
Manganese	mg/kg	1,950	123	166	159	154
Mercury	mg/kg	0.06	0.05 B	0.058 B	0.038 B	0.042

Table 4-11. SRCs in Sediment at the Fuze and Booster Quarry Landfill/Ponds (continued)

Media Location Station Sample ID Customer ID Date Depth (ft) Filtered Field Type Analyte (mg/kg)	Units	Facility-wide Background	Sediment FBQ FBQsd-136 FBQSD-136-0261-SD FBQsd-136-0261-SD 11/06/2003 0.0 - 0.5 Total Regular samples	Sediment FBQ FBQsd-137 FBQSD-137-0262-SD FBQsd-137-0262-SD 11/05/2003 0.0 - 0.5 Total Regular samples	Sediment FBQ FBQsd-138 FBQSD-138-0263-SD FBQsd-138-0263-SD 11/05/2003 0.0 - 0.5 Total Regular samples	Sediment FBQ FBQsd-138 FBQSD-138-0393-SD FBQsd-138-0393-SD 11/05/2003 0.0 - 0.5 Total Field Duplicate
Nickel	mg/kg	17.7	18.5 #	26.3 #	18.6 E#	17.2 E
Potassium	mg/kg	1,950	1,660 N	2,090 #	1,530 NE	1,630 NE
Selenium	mg/kg	1.7	0.66 B	1.1 B	1 B	0.6 B
Silver	mg/kg	0	0.065 U	0.075 U	0.069 U	0.061 B#
Sodium	mg/kg	112	114 #	127 #	102	107
Thallium	mg/kg	0.89	0.48 U	0.55 U	0.52 U	0.45 U
Vanadium	mg/kg	26.1	25.6 N	30.6 #	27.2 N#	23.6 N
Zinc	mg/kg	532	71.7	72	70.8	69.3
Miscellaneous						
Total Organic Carbon	mg/kg		34,000	49,000	53,000	44,000
Organic-Semivolatiles						
2-Methylnaphthalene	mg/kg		0.48 U	0.56 U	0.5 U	0.56 U
4-Methylphenol	mg/kg		0.48 U	0.26 J	0.5 U	0.56 U
Acenaphthylene	mg/kg		0.48 U	0.56 U	0.5 U	0.56 U
Anthracene	mg/kg		0.48 U	0.56 U	0.5 U	0.56 U
Benz(*a*)anthracene	mg/kg		0.48 U	0.083 J	0.074 J	0.56 U
Benzo(*a*)pyrene	mg/kg		0.48 U	0.063 J	0.072 J	0.06 J
Benzo(*b*)fluoranthene	mg/kg		0.48 U	0.083 J	0.12 J	0.096 J
Benzo(*ghi*)perylene	mg/kg		0.48 U	0.56 U	0.5 U	0.56 U
Benzo(*k*)fluoranthene	mg/kg		0.48 U	0.56 U	0.5 U	0.56 U
Bis(2-ethylhexyl)phthalate	mg/kg		0.48 U	0.16 JB	0.5 U	0.56 U
Carbazole	mg/kg		0.48 U	0.56 U	0.5 U	0.56 U
Chrysene	mg/kg		0.48 U	0.061 J	0.081 J	0.067 J
Di-n-butyl phthalate	mg/kg		0.48 U	0.56 U	0.5 U	0.56 U
Dibenzofuran	mg/kg		0.48 U	0.56 U	0.5 U	0.56 U
Fluoranthene	mg/kg		0.073 J	0.15 J	0.18 J	0.14 J
Fluorene	mg/kg		0.48 U	0.56 U	0.5 U	0.56 U
Indeno(1,2,3-*cd*)pyrene	mg/kg		0.48 U	0.56 U	0.5 U	0.56 U
Naphthalene	mg/kg		0.48 U	0.56 U	0.5 U	0.56 U
Phenanthrene	mg/kg		0.48 U	0.11 J	0.097 J	0.095 J

Table 4-11. SRCs in Sediment at the Fuze and Booster Quarry Landfill/Ponds (continued)

Media Location Station Sample ID Customer ID Date Depth (ft) Filtered Field Type Analyte (mg/kg)	Units	Facility-wide Background	Sediment FBQ FBQsd-136 FBQSD-136-0261-SD FBQsd-136-0261-SD 11/06/2003 0.0 - 0.5 Total Regular samples	Sediment FBQ FBQsd-137 FBQSD-137-0262-SD FBQsd-137-0262-SD 11/05/2003 0.0 - 0.5 Total Regular samples	Sediment FBQ FBQsd-138 FBQSD-138-0263-SD FBQsd-138-0263-SD 11/05/2003 0.0 - 0.5 Total Regular samples	Sediment FBQ FBQsd-138 FBQSD-138-0393-SD FBQsd-138-0393-SD 11/05/2003 0.0 - 0.5 Total Field Duplicate
Pyrene	mg/kg		0.48 U	0.11 J	0.13 J	0.56 U
Organic-Volatiles						
2-Butanone	mg/kg		0.014 U	0.017 U	0.015 U	0.017 U
Acetone	mg/kg		0.02	0.0076 JB	0.012 JB	0.014 JB
Carbon Disulfide	mg/kg		0.0072 U	0.0084 U	0.0075 U	0.0085 U
Methylene Chloride	mg/kg		0.014 U	0.013 JB	0.0087 JB	0.013 JB
Toluene	mg/kg		0.0072 U	0.012	0.0075 U	0.0026 J
Trichloroethene	mg/kg		0.0072 U	0.0084 U	0.0075 U	0.0085 U
Organics-Pesticide/PCB						
4,4'-DDD	mg/kg		0.0024 U	0.0028 U	0.0025 U	0.0028 U
4,4'-DDE	mg/kg		0.0024 U	0.0028 U	0.0025 U	0.0028 U
4,4'-DDT	mg/kg		0.0024 U	0.0028 U	0.0025 U	0.0028 U
Dieldrin	mg/kg		0.0024 U	0.0028 U	0.0025 U	0.0028 U
Endosulfan I	mg/kg		0.0024 U	0.0028 U	0.0025 U	0.0028 U
Endrin	mg/kg		0.0024 U	0.0028 U	0.0025 U	0.0028 U
Endrin aldehyde	mg/kg		0.0024 U	0.0028 U	0.0025 U	0.0028 U
Heptachlor epoxide	mg/kg		0.0024 U	0.0028 U	0.0025 U	0.0028 U
Lindane	mg/kg		0.0024 U	0.0028 U	0.0025 U	0.0028 U
Methoxychlor	mg/kg		0.0024 U	0.0028 U	0.0025 U	0.00094 J
beta-BHC	mg/kg		0.0024 U	0.0028 U	0.0025 U	0.0028 U

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Table 4-11. SRCs in Sediment at the Fuze and Booster Quarry Landfill/Ponds (continued)

Media Location Station Sample ID Customer ID Date Depth (ft) Filtered Field Type Analyte (mg/kg)	Units	Facility-wide Background	Sediment FBQ FBQsd-139 FBQSD-139-0264-SD FBQsd-139-0264-SD 11/06/2003 0.0 - 0.5 Total Regular samples	Sediment FBQ FBQsd-140 FBQSD-140-0265-SD FBQsd-140-0265-SD 11/06/2003 0.0 - 0.5 Total Regular samples	Sediment FBQ FBQsd-140 FBQSD-140-0395-SD FBQsd-140-0395-SD 11/06/2003 0.0 - 0.5 Total Field Duplicate	Sediment FBQ FBQsd-141 FBQSD-141-0266-SD FBQsd-141-0266-SD 11/06/2003 0.0 - 0.5 Total Regular samples
Explosives						
1,3,5-Trinitrobenzene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
1,3-Dinitrobenzene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
2,4,6-Trinitrotoluene	mg/kg		0.1 U	0.1 U	0.1 U	0.033 J
2,6-Dinitrotoluene	mg/kg		0.085 J	0.1 U	0.1 U	0.1 U
2-Amino-4,6-dinitrotoluene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
3-Nitrotoluene	mg/kg		0.2 U	0.2 U	0.2 U	0.2 U
4-Amino-2,6-dinitrotoluene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
HMX	mg/kg		0.2 U	0.2 U	0.2 U	0.2 U
Nitrobenzene	mg/kg		0.1 U	0.1 U	0.1 U	0.071 J
Nitrocellulose	mg/kg		54	46	23 U	74 U
Nitroglycerin	mg/kg		10 U	10 U	10 U	10 U
Inorganics						
Aluminum	mg/kg	13,900	20,000 #	21,400 #	18,800 #	11,500
Antimony	mg/kg	0	0.44 BN#	0.4 BN#	0.27 UN	3.8 N#
Arsenic	mg/kg	19.5	3.3	11.6	20.3 #	11.1
Barium	mg/kg	123	80.8 N	157 N#	109 N	507 N#
Beryllium	mg/kg	0.38	0.81 #	0.93 #	0.74 #	0.71 #
Cadmium	mg/kg	0	0.021 U	0.1 #	0.018 U	2.3 #
Calcium	mg/kg	5,510	859	3,020	2,150	7,780 #
Chromium	mg/kg	18.1	25.3 #	25.8 #	22.4 #	18 E
Chromium, hexavalent	mg/kg		5 #	6.6 #	1.4 U	11 U
Cobalt	mg/kg	9.1	8.9	11.6 #	8.5	9.7 #
Copper	mg/kg	27.6	17.9	18.7	17.2	63.2 #
Iron	mg/kg	28,200	20,000	29,200 #	35,600 #	27,700
Lead	mg/kg	27.4	32.6 #	29.9 #	17.9	58.7 #
Magnesium	mg/kg	2,760	4,220 N#	3,590 N#	3,190 N#	2,860 N#
Manganese	mg/kg	1,950	145	330	258	4,100 #
Mercury	mg/kg	0.06	0.048 B	0.06 B#	0.031 B	0.78 #

Table 4-11. SRCs in Sediment at the Fuze and Booster Quarry Landfill/Ponds (continued)

Media Location Station Sample ID Customer ID Date Depth (ft) Filtered Field Type Analyte (mg/kg)	Units	Facility-wide Background	Sediment FBQ FBQsd-139 FBQSD-139-0264-SD FBQsd-139-0264-SD 11/06/2003 0.0 - 0.5 Total Regular samples	Sediment FBQ FBQsd-140 FBQSD-140-0265-SD FBQsd-140-0265-SD 11/06/2003 0.0 - 0.5 Total Regular samples	Sediment FBQ FBQsd-140 FBQSD-140-0395-SD FBQsd-140-0395-SD 11/06/2003 0.0 - 0.5 Total Field Duplicate	Sediment FBQ FBQsd-141 FBQSD-141-0266-SD FBQsd-141-0266-SD 11/06/2003 0.0 - 0.5 Total Regular samples
Nickel	mg/kg	17.7	24.4 #	23.4 #	19 #	25.1 E#
Potassium	mg/kg	1,950	2,350 N#	1,900 N	1,580 N	1,920 NE
Selenium	mg/kg	1.7	0.64 B	1.2 B	1.5	1.7 U
Silver	mg/kg	0	0.073 U	0.1 B#	0.12 B#	1.2 B#
Sodium	mg/kg	112	126 #	158 #	126 #	285 #
Thallium	mg/kg	0.89	0.54 U	0.61 U	0.46 U	2.7 U
Vanadium	mg/kg	26.1	28.6 N#	42 N#	36.9 N#	19.8 N
Zinc	mg/kg	532	84.2	90	60.5	418
Miscellaneous						
Total Organic Carbon	mg/kg		22,000	57,000	52,000	96,000
Organic-Semivolatiles						
2-Methylnaphthalene	mg/kg		0.52 U	0.63 U	0.48 U	1.6
4-Methylphenol	mg/kg		0.52 U	0.63 U	0.48 U	1.5 U
Acenaphthylene	mg/kg		0.52 U	0.63 U	0.48 U	1.5 U
Anthracene	mg/kg		0.52 U	0.63 U	0.48 U	1.5 U
Benz(*a*)anthracene	mg/kg		0.52 U	0.63 U	0.48 U	0.34 J
Benzo(*a*)pyrene	mg/kg		0.52 U	0.63 U	0.48 U	0.3 J
Benzo(*b*)fluoranthene	mg/kg		0.52 U	0.63 U	0.48 U	0.38 J
Benzo(*ghi*)perylene	mg/kg		0.52 U	0.63 U	0.48 U	1.5 U
Benzo(*k*)fluoranthene	mg/kg		0.52 U	0.63 U	0.48 U	1.5 U
Bis(2-ethylhexyl)phthalate	mg/kg		0.061 J	0.63 U	0.48 U	1.5 U
Carbazole	mg/kg		0.52 U	0.63 U	0.48 U	1.5 U
Chrysene	mg/kg		0.52 U	0.63 U	0.48 U	0.32 J
Di-n-butyl phthalate	mg/kg		0.52 U	0.63 U	0.48 U	1.5 U
Dibenzofuran	mg/kg		0.52 U	0.63 U	0.48 U	0.43 J
Fluoranthene	mg/kg		0.52 U	0.63 U	0.48 U	0.59 J
Fluorene	mg/kg		0.52 U	0.63 U	0.48 U	1.5 U
Indeno(1,2,3-*cd*)pyrene	mg/kg		0.52 U	0.63 U	0.48 U	0.15 J
Naphthalene	mg/kg		0.52 U	0.63 U	0.48 U	0.97 J
Phenanthrene	mg/kg		0.52 U	0.63 U	0.48 U	0.96 J

Table 4-11. SRCs in Sediment at the Fuze and Booster Quarry Landfill/Ponds (continued)

Media Location Station Sample ID Customer ID Date Depth (ft) Filtered Field Type Analyte (mg/kg)	Units	Facility-wide Background	Sediment FBQ FBQsd-139 FBQSD-139-0264-SD FBQsd-139-0264-SD 11/06/2003 0.0 - 0.5 Total Regular samples	Sediment FBQ FBQsd-140 FBQSD-140-0265-SD FBQsd-140-0265-SD 11/06/2003 0.0 - 0.5 Total Regular samples	Sediment FBQ FBQsd-140 FBQSD-140-0395-SD FBQsd-140-0395-SD 11/06/2003 0.0 - 0.5 Total Field Duplicate	Sediment FBQ FBQsd-141 FBQSD-141-0266-SD FBQsd-141-0266-SD 11/06/2003 0.0 - 0.5 Total Regular samples
Pyrene	mg/kg		0.52 U	0.63 U	0.48 U	0.47 J
Organic-Volatiles						
2-Butanone	mg/kg		0.011 JB	0.013 JB	0.0098 JB	0.026 J
Acetone	mg/kg		0.016 U	0.036	0.032	0.082 B
Carbon Disulfide	mg/kg		0.0079 U	0.0095 U	0.0072 U	0.022 U
Methylene Chloride	mg/kg		0.016 U	0.018 JB	0.014 U	0.034 JB
Toluene	mg/kg		0.01	0.0095 U	0.0072 U	0.022 U
Trichloroethene	mg/kg		0.0079 U	0.0095 U	0.0072 U	0.022 U
Organics-Pesticide/PCB						
4,4'-DDD	mg/kg		0.00085 J	0.0032 U	0.0024 U	0.0075 U
4,4'-DDE	mg/kg		0.00076 J	0.00079 JP	0.00057 J	0.001 J
4,4'-DDT	mg/kg		0.0026 U	0.0032 U	0.0024 U	0.0075 U
Dieldrin	mg/kg		0.00055 JP	0.0032 U	0.0024 U	0.0075 U
Endosulfan I	mg/kg		0.00052 J	0.0032 U	0.0024 U	0.0075 U
Endrin	mg/kg		0.00055 J	0.0032 U	0.0024 U	0.0075 U
Endrin aldehyde	mg/kg		0.0026 U	0.0032 U	0.0024 U	0.0075 U
Heptachlor epoxide	mg/kg		0.00057 J	0.0032 U	0.0024 U	0.0075 U
Lindane	mg/kg		0.00086 J	0.0032 U	0.0024 U	0.0075 U
Methoxychlor	mg/kg		0.0026 U	0.0032 U	0.0024 U	0.0023 J
beta-BHC	mg/kg		0.00066 J	0.0032 U	0.0024 U	0.0075 U

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Table 4-11. SRCs in Sediment at the Fuze and Booster Quarry Landfill/Ponds (continued)

Media Location Station Sample ID Customer ID Date Depth (ft) Filtered Field Type Analyte (mg/kg)	Units	Facility-wide Background	Sediment FBQ FBQsd-142 FBQSD-142-0267-SD FBQsd-142-0267-SD 11/06/2003 0.0 - 0.5 Total Regular samples	Sediment FBQ FBQsd-143 FBQSD-143-0268-SD FBQsd-143-0268-SD 11/06/2003 0.0 - 0.5 Total Regular samples	Sediment FBQ FBQsd-144 FBQSD-144-0269-SD FBQsd-144-0269-SD 10/21/2003 0.0 - 0.5 Total Regular samples	Sediment FBQ FBQsd-145 FBQSD-145-0270-SD FBQsd-145-0270-SD 10/21/2003 0.0 - 0.5 Total Regular samples
Explosives						
1,3,5-Trinitrobenzene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
1,3-Dinitrobenzene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
2,4,6-Trinitrotoluene	mg/kg		0.1 U	0.06 J	0.1 U	0.1 U
2,6-Dinitrotoluene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
2-Amino-4,6-dinitrotoluene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
3-Nitrotoluene	mg/kg		0.2 U	0.2 U	0.2 U	0.2 U
4-Amino-2,6-dinitrotoluene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
HMX	mg/kg		0.2 U	0.2 U	0.2 U	0.2 U
Nitrobenzene	mg/kg		0.1 U	0.044 JB	0.11	0.1 U
Nitrocellulose	mg/kg		32 U	100	35 U	23
Nitroglycerin	mg/kg		10 U	10 U	10 U	NA
Inorganics						
Aluminum	mg/kg	13,900	16,900 #	7,580	8,640	2,940
Antimony	mg/kg	0	1.1 BN#	11.5 N#	12.5 N#	1.5 N#
Arsenic	mg/kg	19.5	13.7	33.3 #	6.7	3.3 NE*
Barium	mg/kg	123	194 N#	153 N#	123	27.3 N
Beryllium	mg/kg	0.38	0.86 #	0.62 #	0.52 #	0.21
Cadmium	mg/kg	0	0.54 #	0.81 #	2.2 #	0.56 #
Calcium	mg/kg	5,510	2,650	2,160	2,070	278 *
Chromium	mg/kg	18.1	21.4 E#	15.9	16.6	5.5 *E
Chromium, hexavalent	mg/kg		1.9 #	2.4 U	30 #	7.1 #
Cobalt	mg/kg	9.1	15.8 #	13.4 #	5.2	3.3 *
Copper	mg/kg	27.6	23.3	49 #	102 #	14.8
Iron	mg/kg	28,200	30,800 #	55,200 #	12,900	7,840
Lead	mg/kg	27.4	30.1 #	80 #	138 #	28.6 E#
Magnesium	mg/kg	2,760	3,600 N#	1,570 N	1,690 N	510 N*
Manganese	mg/kg	1,950	2,180 #	607	121	69.6 *
Mercury	mg/kg	0.06	0.13 #	0.8 #	3.1 #	0.28 #

Table 4-11. SRCs in Sediment at the Fuze and Booster Quarry Landfill/Ponds (continued)

Media			**Sediment**	**Sediment**	**Sediment**	**Sediment**
Location			**FBQ**	**FBQ**	**FBQ**	**FBQ**
Station			**FBQsd-142**	**FBQsd-143**	**FBQsd-144**	**FBQsd-145**
Sample ID			**FBQSD-142-0267-SD**	**FBQSD-143-0268-SD**	**FBQSD-144-0269-SD**	**FBQSD-145-0270-SD**
Customer ID			**FBQsd-142-0267-SD**	**FBQsd-143-0268-SD**	**FBQsd-144-0269-SD**	**FBQsd-145-0270-SD**
Date			**11/06/2003**	**11/06/2003**	**10/21/2003**	**10/21/2003**
Depth (ft)			**0.0 - 0.5**	**0.0 - 0.5**	**0.0 - 0.5**	**0.0 - 0.5**
Filtered			**Total**	**Total**	**Total**	**Total**
Field Type			**Regular samples**	**Regular samples**	**Regular samples**	**Regular samples**
Analyte (mg/kg)	**Units**	**Facility-wide Background**				
Nickel	mg/kg	17.7	26.3 E#	21.4 #	18.8 #	7.2
Potassium	mg/kg	1,950	1,610 NE	1,060 N	1,090 N	337 N
Selenium	mg/kg	1.7	1.8 U	2.3 #	1.4 B	0.66 B
Silver	mg/kg	0	0.69 B#	0.51 #	0.44 B#	0.087 B#
Sodium	mg/kg	112	171 #	197 #	228 #	60.8
Thallium	mg/kg	0.89	2.9 U	0.74 U	1.2 U	0.43 U
Vanadium	mg/kg	26.1	30.7 N#	15.9 N	16.7	5.9 N
Zinc	mg/kg	532	172	544 #	419	141 E
Miscellaneous						
Total Organic Carbon	mg/kg		50,000	44,000	83,000	NA
Organic-Semivolatiles						
2-Methylnaphthalene	mg/kg		0.64 U	0.81 U	0.74 U	0.47 /U
4-Methylphenol	mg/kg		0.64 U	0.81 U	0.74 U	0.47 /U
Acenaphthylene	mg/kg		0.64 U	0.81 U	0.74 U	0.47 /U
Anthracene	mg/kg		0.64 U	0.81 U	0.74 U	0.47 /U
Benz(*a*)anthracene	mg/kg		0.64 U	0.81 U	0.74 U	0.47 /U
Benzo(*a*)pyrene	mg/kg		0.64 U	0.81 U	0.74 U	0.47 /U
Benzo(*b*)fluoranthene	mg/kg		0.64 U	0.81 U	0.74 U	0.47 /U
Benzo(*ghi*)perylene	mg/kg		0.64 U	0.81 U	0.74 U	0.47 /U
Benzo(*k*)fluoranthene	mg/kg		0.64 U	0.81 U	0.74 U	0.47 /U
Bis(2-ethylhexyl)phthalate	mg/kg		0.64 U	0.81 U	0.14 JB	0.47 /U
Carbazole	mg/kg		0.64 U	0.81 U	0.74 U	0.47 /U
Chrysene	mg/kg		0.64 U	0.81 U	0.74 U	0.47 /U
Di-n-butyl phthalate	mg/kg		0.64 U	0.81 U	1.3 B	0.47 /U
Dibenzofuran	mg/kg		0.64 U	0.81 U	0.74 U	0.47 /U
Fluoranthene	mg/kg		0.64 U	0.81 U	0.74 U	0.47 /U
Fluorene	mg/kg		0.64 U	0.81 U	0.74 U	0.47 /U
Indeno(1,2,3-*cd*)pyrene	mg/kg		0.64 U	0.81 U	0.74 U	0.47 /U
Naphthalene	mg/kg		0.64 U	0.81 U	0.74 U	0.47 /U
Phenanthrene	mg/kg		0.64 U	0.81 U	0.74 U	0.47 /U

Table 4-11. SRCs in Sediment at the Fuze and Booster Quarry Landfill/Ponds (continued)

Media Location Station Sample ID Customer ID Date Depth (ft) Filtered Field Type Analyte (mg/kg)	Units	Facility-wide Background	Sediment FBQ FBQsd-142 FBQSD-142-0267-SD FBQsd-142-0267-SD 11/06/2003 0.0 - 0.5 Total Regular samples	Sediment FBQ FBQsd-143 FBQSD-143-0268-SD FBQsd-143-0268-SD 11/06/2003 0.0 - 0.5 Total Regular samples	Sediment FBQ FBQsd-144 FBQSD-144-0269-SD FBQsd-144-0269-SD 10/21/2003 0.0 - 0.5 Total Regular samples	Sediment FBQ FBQsd-145 FBQSD-145-0270-SD FBQsd-145-0270-SD 10/21/2003 0.0 - 0.5 Total Regular samples
Pyrene	mg/kg		0.64 U	0.81 U	0.74 U	0.47 /U
Organic-Volatiles						
2-Butanone	mg/kg		0.011 J	0.024 JB	0.039 U	0.019
Acetone	mg/kg		0.035 B	0.026 B	0.064	0.051 B
Carbon Disulfide	mg/kg		0.0023 J	0.0036 J	0.02 U	0.007 U
Methylene Chloride	mg/kg		0.013 JB	0.02 JB	0.043 B	0.037
Toluene	mg/kg		0.0095 U	0.012 U	0.02 U	0.007 U
Trichloroethene	mg/kg		0.0095 U	0.0028 J	0.02 U	0.007 U
Organics-Pesticide/PCB						
4,4'-DDD	mg/kg		0.0032 U	0.013	0.0037 U	0.0023 U
4,4'-DDE	mg/kg		0.0032 U	0.004 U	0.0037 U	0.0023 U
4,4'-DDT	mg/kg		0.0032 U	0.004 U	0.0037 U	0.0023 U
Dieldrin	mg/kg		0.0032 U	0.004 U	0.0037 U	0.0023 U
Endosulfan I	mg/kg		0.0032 U	0.004 U	0.0037 U	0.0023 U
Endrin	mg/kg		0.0032 U	0.004 U	0.0037 U	0.0023 U
Endrin aldehyde	mg/kg		0.0032 U	0.004 U	0.0037 U	0.0023 U
Heptachlor epoxide	mg/kg		0.0032 U	0.004 U	0.0037 U	0.0023 U
Lindane	mg/kg		0.0032 U	0.004 U	0.0037 U	0.0023 U
Methoxychlor	mg/kg		0.0032 U	0.004 U	0.0037 U	0.0023 U
beta-BHC	mg/kg		0.0032 U	0.004 U	0.0037 U	0.0023 U

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Table 4-11. SRCs in Sediment at the Fuze and Booster Quarry Landfill/Ponds (continued)

Media Location Station Sample ID Customer ID Date Depth (ft) Filtered Field Type Analyte (mg/kg)	Units	Facility-wide Background	Sediment FBQ FBQsd-146 FBQSD-146-0271-SD FBQsd-146-0271-SD 11/03/2003 0.0 - 0.5 Total Regular samples	Sediment FBQ FBQsd-147 FBQSD-147-0272-SD FBQsd-147-0272-SD 10/21/2003 0.0 - 0.5 Total Regular samples	Sediment FBQ FBQsd-148 FBQSD-148-0273-SD FBQsd-148-0273-SD 10/21/2003 0.0 - 0.5 Total Regular samples	Sediment FBQ FBQsd-149 FBQSD-149-0274-SD FBQsd-149-0274-SD 10/21/2003 0.0 - 0.5 Total Regular samples
Explosives						
1,3,5-Trinitrobenzene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
1,3-Dinitrobenzene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
2,4,6-Trinitrotoluene	mg/kg		0.3	0.1 U	0.1 U	0.1 U
2,6-Dinitrotoluene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
2-Amino-4,6-dinitrotoluene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
3-Nitrotoluene	mg/kg		0.2 U	0.2 U	0.2 U	0.2 U
4-Amino-2,6-dinitrotoluene	mg/kg		0.39	0.1 U	0.11	0.1 U
HMX	mg/kg		0.16 J	0.2 U	0.2 U	0.2 U
Nitrobenzene	mg/kg		0.1 U	0.1 U	0.1 U	0.057 J
Nitrocellulose	mg/kg		21 U	20 U	32	24 U
Nitroglycerin	mg/kg		10 U	NA	10 U	10 U
Inorganics						
Aluminum	mg/kg	13,900	7,760	10,800	10,800	15,900 #
Antimony	mg/kg	0	128 N#	2 N#	12.3 N#	0.68 BN#
Arsenic	mg/kg	19.5	14.1	10.1 NE*	21.3 #	13.7
Barium	mg/kg	123	389 N#	82.2 N	374 #	106
Beryllium	mg/kg	0.38	0.16 BE	0.59 #	0.98 #	0.88 #
Cadmium	mg/kg	0	11.5 #	0.085 #	18.9 #	0.017 U
Calcium	mg/kg	5,510	13,600 #	1,380 *	6,170 #	10,100 #
Chromium	mg/kg	18.1	71.8 #	14.7 *E	72.3 #	23 #
Chromium, hexavalent	mg/kg		1.3 U	7.2 #	33 #	7.6 #
Cobalt	mg/kg	9.1	9.4 #	8.6 *	12.8 #	12.5 #
Copper	mg/kg	27.6	340 #	13	350 #	22.8
Iron	mg/kg	28,200	52,800 #	19,400	63,900 #	30,500 #
Lead	mg/kg	27.4	1,300 N#	32.1 E#	1,490 #	15.7
Magnesium	mg/kg	2,760	2,580 N	1,940 N*	2,420 N	5,270 N#
Manganese	mg/kg	1,950	741	218 *	686	539
Mercury	mg/kg	0.06	35 #	0.13 #	3.4 #	0.11 #

Table 4-11. SRCs in Sediment at the Fuze and Booster Quarry Landfill/Ponds (continued)

Media Location Station Sample ID Customer ID Date Depth (ft) Filtered Field Type Analyte (mg/kg)	Units	Facility-wide Background	Sediment FBQ FBQsd-146 FBQSD-146-0271-SD FBQsd-146-0271-SD 11/03/2003 0.0 - 0.5 Total Regular samples	Sediment FBQ FBQsd-147 FBQSD-147-0272-SD FBQsd-147-0272-SD 10/21/2003 0.0 - 0.5 Total Regular samples	Sediment FBQ FBQsd-148 FBQSD-148-0273-SD FBQsd-148-0273-SD 10/21/2003 0.0 - 0.5 Total Regular samples	Sediment FBQ FBQsd-149 FBQSD-149-0274-SD FBQsd-149-0274-SD 10/21/2003 0.0 - 0.5 Total Regular samples
Nickel	mg/kg	17.7	31.3 #	12.9	35.2 #	30.7 #
Potassium	mg/kg	1,950	696 N	833 N	1,200 N	2,040 N#
Selenium	mg/kg	1.7	2.4 U	1.4	3.2 #	1.3
Silver	mg/kg	0	12.4 #	0.057 U	2.8 #	0.077 B#
Sodium	mg/kg	112	75.7 U	78.8	806 #	133 #
Thallium	mg/kg	0.89	3.4 U	0.43 U	0.64 U	0.43 U
Vanadium	mg/kg	26.1	11.4 N	23.1 N	24.7	25.9
Zinc	mg/kg	532	2,870 #	69.4 E	3,620 #	63.9
Miscellaneous						
Total Organic Carbon	mg/kg		29,000	NA	65,000	12,000
Organic-Semivolatiles						
2-Methylnaphthalene	mg/kg		0.032 J	0.43 /U	0.051 J	0.5 U
4-Methylphenol	mg/kg		0.43 U	0.43 /U	0.59 U	0.5 U
Acenaphthylene	mg/kg		0.43 U	0.43 /U	0.59 U	0.5 U
Anthracene	mg/kg		0.43 U	0.43 /U	0.23 J	0.5 U
Benz(*a*)anthracene	mg/kg		0.15 J	0.43 /U	2.1	0.5 U
Benzo(*a*)pyrene	mg/kg		0.2 J	0.43 /U	2	0.5 U
Benzo(*b*)fluoranthene	mg/kg		0.21 J	0.43 /U	2.3	0.5 U
Benzo(*ghi*)perylene	mg/kg		0.21 J	0.43 /U	1.2	0.5 U
Benzo(*k*)fluoranthene	mg/kg		0.43 U	0.43 /U	0.95	0.5 U
Bis(2-ethylhexyl)phthalate	mg/kg		0.077 J	0.43 /U	0.17 JB	0.13 JB
Carbazole	mg/kg		0.43 U	0.43 /U	0.11 J	0.5 U
Chrysene	mg/kg		0.16 J	0.43 /U	1.3	0.5 U
Di-n-butyl phthalate	mg/kg		0.43 U	0.43 /U	0.3 JB	0.81 B
Dibenzofuran	mg/kg		0.43 U	0.43 /U	0.59 U	0.5 U
Fluoranthene	mg/kg		0.2 J	0.43 /U	3.2	0.5 U
Fluorene	mg/kg		0.43 U	0.43 /U	0.59 U	0.5 U
Indeno(1,2,3-*cd*)pyrene	mg/kg		0.11 J	0.43 /U	1	0.5 U
Naphthalene	mg/kg		0.43 U	0.43 /U	0.12 J	0.5 U
Phenanthrene	mg/kg		0.13 J	0.43 /U	0.68	0.5 U

Table 4-11. SRCs in Sediment at the Fuze and Booster Quarry Landfill/Ponds (continued)

Media Location Station Sample ID Customer ID Date Depth (ft) Filtered Field Type Analyte (mg/kg)	Units	Facility-wide Background	Sediment FBQ FBQsd-146 FBQSD-146-0271-SD FBQsd-146-0271-SD 11/03/2003 0.0 - 0.5 Total Regular samples	Sediment FBQ FBQsd-147 FBQSD-147-0272-SD FBQsd-147-0272-SD 10/21/2003 0.0 - 0.5 Total Regular samples	Sediment FBQ FBQsd-148 FBQSD-148-0273-SD FBQsd-148-0273-SD 10/21/2003 0.0 - 0.5 Total Regular samples	Sediment FBQ FBQsd-149 FBQSD-149-0274-SD FBQsd-149-0274-SD 10/21/2003 0.0 - 0.5 Total Regular samples
Pyrene	mg/kg		0.35 J	0.43 /U	2.3	0.5 U
Organic-Volatiles						
2-Butanone	mg/kg		0.013 U	0.01 J	0.0057 J	0.0051 J
Acetone	mg/kg		0.013 U	0.032 B	0.01 U	0.018 B
Carbon Disulfide	mg/kg		0.0064 U	0.0065 U	0.005 U	0.0066 U
Methylene Chloride	mg/kg		0.013 U	0.024	0.015	0.015
Toluene	mg/kg		0.0064 U	0.0065 U	0.005 U	0.0066 U
Trichloroethene	mg/kg		0.0064 U	0.0065 U	0.005 U	0.0066 U
Organics-Pesticide/PCB						
4,4'-DDD	mg/kg		0.0021 U	0.0022 U	0.0027 J*P	0.0025 U
4,4'-DDE	mg/kg		0.0021 U	0.0022 U	0.003 U	0.00052 JP
4,4'-DDT	mg/kg		0.0021 U	0.0022 U	0.003 U	0.0025 U
Dieldrin	mg/kg		0.0021 U	0.0022 U	0.003 U	0.0025 U
Endosulfan I	mg/kg		0.0021 U	0.0022 U	0.003 U	0.0025 U
Endrin	mg/kg		0.0021 U	0.0022 U	0.003 U	0.0025 U
Endrin aldehyde	mg/kg		0.0021 U	0.0022 U	0.003 U	0.0025 U
Heptachlor epoxide	mg/kg		0.0021 U	0.0022 U	0.003 U	0.0025 U
Lindane	mg/kg		0.0021 U	0.0022 U	0.003 U	0.0025 U
Methoxychlor	mg/kg		0.0021 U	0.0022 U	0.003 P	0.0025 U
beta-BHC	mg/kg		0.0021 U	0.0022 U	0.003 U	0.0025 U

Table 4-11. SRCs in Sediment at the Fuze and Booster Quarry Landfill/Ponds (continued)

Media Location Station Sample ID Customer ID Date Depth (ft) Filtered Field Type Analyte (mg/kg)	Units	Facility-wide Background	Sediment FBQ FBQsd-150 FBQSD-150-0275-SD FBQsd-150-0275-SD 10/21/2003 0.0 - 0.5 Total Regular samples	Sediment FBQ FBQsd-151 FBQSD-151-0276-SD FBQsd-151-0276-SD 10/21/2003 0.0 - 0.5 Total Regular samples	Sediment FBQ FBQsd-152 FBQSD-152-0277-SD FBQsd-152-0277-SD 10/21/2003 0.0 - 0.5 Total Regular samples	Sediment FBQ FBQsd-153 FBQSD-153-0278-SD FBQsd-153-0278-SD 10/21/2003 0.0 - 0.5 Total Regular samples
Explosives						
1,3,5-Trinitrobenzene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
1,3-Dinitrobenzene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
2,4,6-Trinitrotoluene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
2,6-Dinitrotoluene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
2-Amino-4,6-dinitrotoluene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
3-Nitrotoluene	mg/kg		0.2 U	0.2 U	0.2 U	0.2 U
4-Amino-2,6-dinitrotoluene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
HMX	mg/kg		0.2 U	0.2 U	0.2 U	0.2 U
Nitrobenzene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
Nitrocellulose	mg/kg		33	54	38	42
Nitroglycerin	mg/kg		10 U	10 U	10 U	10 U
Inorganics						
Aluminum	mg/kg	13,900	12,900	10,400	12,300	11,100
Antimony	mg/kg	0	10.3 N#	1.6 N#	16.5 N#	6.7 N#
Arsenic	mg/kg	19.5	14	5.2	7.5	9.7
Barium	mg/kg	123	97.6	83.2	120	93.7
Beryllium	mg/kg	0.38	0.71 #	0.57 #	0.65 #	0.64 #
Cadmium	mg/kg	0	0.18 #	0.017 U	0.46 #	0.38 #
Calcium	mg/kg	5,510	2,230	1,540	1,490	3,740
Chromium	mg/kg	18.1	20.2 #	14.3	23 #	18.1
Chromium, hexavalent	mg/kg		25 #	18 #	30 #	26 #
Cobalt	mg/kg	9.1	10.2 #	8.7	9.2 #	9
Copper	mg/kg	27.6	26.1	14.9	51.7 #	25.9
Iron	mg/kg	28,200	25,200	18,500	21,600	23,000
Lead	mg/kg	27.4	68.5 #	18.5	120 #	64.5 #
Magnesium	mg/kg	2,760	2,460 N	2,400 N	2,610 N	2,830 N#
Manganese	mg/kg	1,950	469	178	223	365
Mercury	mg/kg	0.06	2.7 #	0.15 #	4.4 #	3.5 #

Table 4-11. SRCs in Sediment at the Fuze and Booster Quarry Landfill/Ponds (continued)

Media Location Station Sample ID Customer ID Date Depth (ft) Filtered Field Type Analyte (mg/kg)	Units	Facility-wide Background	Sediment FBQ FBQsd-150 FBQSD-150-0275-SD FBQsd-150-0275-SD 10/21/2003 0.0 - 0.5 Total Regular samples	Sediment FBQ FBQsd-151 FBQSD-151-0276-SD FBQsd-151-0276-SD 10/21/2003 0.0 - 0.5 Total Regular samples	Sediment FBQ FBQsd-152 FBQSD-152-0277-SD FBQsd-152-0277-SD 10/21/2003 0.0 - 0.5 Total Regular samples	Sediment FBQ FBQsd-153 FBQSD-153-0278-SD FBQsd-153-0278-SD 10/21/2003 0.0 - 0.5 Total Regular samples
Nickel	mg/kg	17.7	16.7	17.1	19.3 #	18.7 #
Potassium	mg/kg	1,950	1,120 N	1,120 N	1,160 N	1,300 N
Selenium	mg/kg	1.7	1.6	1.2	1.5	1.3
Silver	mg/kg	0	0.14 B#	0.059 U	0.26 B#	0.27 #
Sodium	mg/kg	112	117 #	98.9	134 #	139 #
Thallium	mg/kg	0.89	0.41 U	0.43 U	0.57 U	0.45 U
Vanadium	mg/kg	26.1	25	18.8	22.8	20.2
Zinc	mg/kg	532	122	60.2	214	180
Miscellaneous						
Total Organic Carbon	mg/kg		46,000	21,000	22,000	63,000
Organic-Semivolatiles						
2-Methylnaphthalene	mg/kg		0.5 U	0.49 U	0.51 U	0.54 U
4-Methylphenol	mg/kg		0.5 U	0.49 U	0.51 U	0.54 U
Acenaphthylene	mg/kg		0.5 U	0.49 U	0.51 U	0.54 U
Anthracene	mg/kg		0.5 U	0.49 U	0.51 U	0.54 U
Benz(*a*)anthracene	mg/kg		0.5 U	0.49 U	0.51 U	0.54 U
Benzo(*a*)pyrene	mg/kg		0.5 U	0.49 U	0.51 U	0.54 U
Benzo(*b*)fluoranthene	mg/kg		0.5 U	0.49 U	0.51 U	0.54 U
Benzo(*ghi*)perylene	mg/kg		0.5 U	0.49 U	0.51 U	0.54 U
Benzo(*k*)fluoranthene	mg/kg		0.5 U	0.49 U	0.51 U	0.54 U
Bis(2-ethylhexyl)phthalate	mg/kg		0.1 JB	0.14 JB	0.11 JB	0.12 JB
Carbazole	mg/kg		0.5 U	0.49 U	0.51 U	0.54 U
Chrysene	mg/kg		0.5 U	0.49 U	0.51 U	0.54 U
Di-n-butyl phthalate	mg/kg		3.1 B	16 EB	1.3 B	0.19 JB
Dibenzofuran	mg/kg		0.5 U	0.49 U	0.51 U	0.54 U
Fluoranthene	mg/kg		0.5 U	0.49 U	0.51 U	0.54 U
Fluorene	mg/kg		0.5 U	0.49 U	0.51 U	0.54 U
Indeno(1,2,3-*cd*)pyrene	mg/kg		0.5 U	0.49 U	0.51 U	0.54 U
Naphthalene	mg/kg		0.5 U	0.49 U	0.51 U	0.54 U
Phenanthrene	mg/kg		0.5 U	0.49 U	0.51 U	0.54 U

Table 4-11. SRCs in Sediment at the Fuze and Booster Quarry Landfill/Ponds (continued)

Media Location Station Sample ID Customer ID Date Depth (ft) Filtered Field Type Analyte (mg/kg)	Units	Facility-wide Background	Sediment FBQ FBQsd-150 FBQSD-150-0275-SD FBQsd-150-0275-SD 10/21/2003 0.0 - 0.5 Total Regular samples	Sediment FBQ FBQsd-151 FBQSD-151-0276-SD FBQsd-151-0276-SD 10/21/2003 0.0 - 0.5 Total Regular samples	Sediment FBQ FBQsd-152 FBQSD-152-0277-SD FBQsd-152-0277-SD 10/21/2003 0.0 - 0.5 Total Regular samples	Sediment FBQ FBQsd-153 FBQSD-153-0278-SD FBQsd-153-0278-SD 10/21/2003 0.0 - 0.5 Total Regular samples
Pyrene	mg/kg		0.5 U	0.49 U	0.51 U	0.54 U
Organic-Volatiles						
2-Butanone	mg/kg		0.014 U	0.0096 J	0.017	0.014 U
Acetone	mg/kg		0.021 B	0.027 B	0.057	0.014 U
Carbon Disulfide	mg/kg		0.007 U	0.0071 U	0.0078 U	0.0068 U
Methylene Chloride	mg/kg		0.016	0.01 J	0.019 B	0.013 JB
Toluene	mg/kg		0.007 U	0.0071 U	0.0078 U	0.0068 U
Trichloroethene	mg/kg		0.007 U	0.0071 U	0.0078 U	0.0068 U
Organics-Pesticide/PCB						
4,4'-DDD	mg/kg		0.0025 U	0.0024 U	0.0026 U	0.00053 J
4,4'-DDE	mg/kg		0.0025 U	0.0024 U	0.0026 U	0.0027 U
4,4'-DDT	mg/kg		0.0025 U	0.0024 U	0.0026 U	0.0027 U
Dieldrin	mg/kg		0.0025 U	0.0024 U	0.0026 U	0.00088 J
Endosulfan I	mg/kg		0.0025 U	0.0024 U	0.0026 U	0.0027 U
Endrin	mg/kg		0.0025 U	0.0024 U	0.0026 U	0.00071 J
Endrin aldehyde	mg/kg		0.0025 U	0.0024 U	0.0026 U	0.0027 U
Heptachlor epoxide	mg/kg		0.0025 U	0.0024 U	0.0026 U	0.0027 U
Lindane	mg/kg		0.0025 U	0.0024 U	0.0026 U	0.0027 U
Methoxychlor	mg/kg		0.0025 U	0.0024 U	0.0026 U	0.0027 U
beta-BHC	mg/kg		0.0025 U	0.0024 U	0.0026 U	0.0027 U

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Table 4-11. SRCs in Sediment at the Fuze and Booster Quarry Landfill/Ponds (continued)

Media Location Station Sample ID Customer ID Date Depth (ft) Filtered Field Type Analyte (mg/kg)	Units	Facility-wide Background	Sediment FBQ FBQsd-154 FBQSD-154-0279-SD FBQsd-154-0279-SD 10/21/2003 0.0 - 0.5 Total Regular samples	Sediment FBQ FBQsd-155 FBQSD-155-0280-SD FBQsd-155-0280-SD 10/21/2003 0.0 - 0.5 Total Regular samples	Sediment FBQ FBQsd-156 FBQSD-156-0281-SD FBQsd-156-0281-SD 11/03/2003 0.0 - 0.5 Total Regular samples	Sediment FBQ FBQsd-157 FBQSD-157-0282-SD FBQsd-157-0282-SD 10/21/2003 0.0 - 0.5 Total Regular samples
Explosives						
1,3,5-Trinitrobenzene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
1,3-Dinitrobenzene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
2,4,6-Trinitrotoluene	mg/kg		0.1 U	0.1	0.1 U	0.1 U
2,6-Dinitrotoluene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
2-Amino-4,6-dinitrotoluene	mg/kg		0.1 U	0.073 J	0.1 U	0.1 U
3-Nitrotoluene	mg/kg		0.2 U	0.2 U	0.2 U	0.2 U
4-Amino-2,6-dinitrotoluene	mg/kg		0.1 U	0.13	0.1 U	0.1 U
HMX	mg/kg		0.2 U	0.2 U	0.2 U	0.2 U
Nitrobenzene	mg/kg		0.065 J	0.1 U	0.1 U	0.1 U
Nitrocellulose	mg/kg		55	43	39 U	25
Nitroglycerin	mg/kg		10 U	10 U	49	10 U
Inorganics						
Aluminum	mg/kg	13,900	14,300 #	11,500	11,600	13,900
Antimony	mg/kg	0	1 N#	40.9 N#	48.7 N#	4 N#
Arsenic	mg/kg	19.5	11.5	31.3 #	32.4 #	18
Barium	mg/kg	123	86.5	976 #	134 N#	99.4
Beryllium	mg/kg	0.38	0.86 #	1.1 #	0.4 E#	0.86 #
Cadmium	mg/kg	0	0.015 U	3.1 #	4.3 #	0.58 #
Calcium	mg/kg	5,510	8,750 #	23,300 #	55,500 #	12,100 #
Chromium	mg/kg	18.1	21.1 #	108 #	47.7 #	22.7 #
Chromium, hexavalent	mg/kg		23 #	11 #	2.5 U	14 #
Cobalt	mg/kg	9.1	14.6 #	18 #	15.5 #	14.4 #
Copper	mg/kg	27.6	24	660 #	129 #	63.1 #
Iron	mg/kg	28,200	34,300 #	138,000 #	97,000 #	35,800 #
Lead	mg/kg	27.4	16.5	1,430 #	572 N#	122 #
Magnesium	mg/kg	2,760	4,620 N#	3,470 N#	3,130 N#	2,930 N#
Manganese	mg/kg	1,950	249	850	872	270
Mercury	mg/kg	0.06	0.17 #	1.5 #	5.2 #	0.79 #

Table 4-11. SRCs in Sediment at the Fuze and Booster Quarry Landfill/Ponds (continued)

Media Location Station Sample ID Customer ID Date Depth (ft) Filtered Field Type Analyte (mg/kg)	Units	Facility-wide Background	Sediment FBQ FBQsd-154 FBQSD-154-0279-SD FBQsd-154-0279-SD 10/21/2003 0.0 - 0.5 Total Regular samples	Sediment FBQ FBQsd-155 FBQSD-155-0280-SD FBQsd-155-0280-SD 10/21/2003 0.0 - 0.5 Total Regular samples	Sediment FBQ FBQsd-156 FBQSD-156-0281-SD FBQsd-156-0281-SD 11/03/2003 0.0 - 0.5 Total Regular samples	Sediment FBQ FBQsd-157 FBQSD-157-0282-SD FBQsd-157-0282-SD 10/21/2003 0.0 - 0.5 Total Regular samples
Nickel	mg/kg	17.7	35.3 #	68.4 #	36.4 #	43.3 #
Potassium	mg/kg	1,950	2,140 N#	1,030 N	1,680 N	1,410 N
Selenium	mg/kg	1.7	1.4	8.2 #	3.1 B#	2.5 #
Silver	mg/kg	0	0.052 U	4 #	1.8 #	0.35 #
Sodium	mg/kg	112	143 #	814 #	151 B#	162 #
Thallium	mg/kg	0.89	0.39 U	3.3 U	3.1 B#	0.58 U
Vanadium	mg/kg	26.1	23.3	24.7	21 N	25.2
Zinc	mg/kg	532	71.6	3,080 #	1,780 #	261
Miscellaneous						
Total Organic Carbon	mg/kg		15,000	74,000	120,000	32,000
Organic-Semivolatiles						
2-Methylnaphthalene	mg/kg		0.43 U	0.64 U	0.87 U	0.46 U
4-Methylphenol	mg/kg		0.43 U	0.64 U	0.87 U	0.46 U
Acenaphthylene	mg/kg		0.43 U	0.64 U	0.87 U	0.46 U
Anthracene	mg/kg		0.43 U	0.64 U	0.87 U	0.46 U
Benz(*a*)anthracene	mg/kg		0.43 U	0.11 J	0.3 J	0.46 U
Benzo(*a*)pyrene	mg/kg		0.43 U	0.086 J	0.31 J	0.46 U
Benzo(*b*)fluoranthene	mg/kg		0.43 U	0.12 J	0.39 J	0.46 U
Benzo(*ghi*)perylene	mg/kg		0.43 U	0.64 U	0.23 J	0.46 U
Benzo(*k*)fluoranthene	mg/kg		0.43 U	0.64 U	0.16 J	0.46 U
Bis(2-ethylhexyl)phthalate	mg/kg		0.31 JB	0.22 JB	0.1 J	0.12 JB
Carbazole	mg/kg		0.43 U	0.64 U	0.87 U	0.46 U
Chrysene	mg/kg		0.43 U	0.079 J	0.28 J	0.46 U
Di-n-butyl phthalate	mg/kg		0.8 B	0.8 B	0.87 U	0.29 JB
Dibenzofuran	mg/kg		0.43 U	0.64 U	0.87 U	0.46 U
Fluoranthene	mg/kg		0.43 U	0.15 J	0.51 J	0.46 U
Fluorene	mg/kg		0.43 U	0.64 U	0.87 U	0.46 U
Indeno(1,2,3-*cd*)pyrene	mg/kg		0.43 U	0.64 U	0.19 J	0.46 U
Naphthalene	mg/kg		0.43 U	0.64 U	0.87 U	0.46 U
Phenanthrene	mg/kg		0.43 U	0.092 J	0.39 J	0.46 U

Table 4-11. SRCs in Sediment at the Fuze and Booster Quarry Landfill/Ponds (continued)

Media Location Station Sample ID Customer ID Date Depth (ft) Filtered Field Type Analyte (mg/kg)	Units	Facility-wide Background	Sediment FBQ FBQsd-154 FBQSD-154-0279-SD FBQsd-154-0279-SD 10/21/2003 0.0 - 0.5 Total Regular samples	Sediment FBQ FBQsd-155 FBQSD-155-0280-SD FBQsd-155-0280-SD 10/21/2003 0.0 - 0.5 Total Regular samples	Sediment FBQ FBQsd-156 FBQSD-156-0281-SD FBQsd-156-0281-SD 11/03/2003 0.0 - 0.5 Total Regular samples	Sediment FBQ FBQsd-157 FBQSD-157-0282-SD FBQsd-157-0282-SD 10/21/2003 0.0 - 0.5 Total Regular samples
Pyrene	mg/kg		0.43 U	0.12 J	0.56 J	0.46 U
Organic-Volatiles						
2-Butanone	mg/kg		0.015 U	0.0066 J	0.043	0.015 U
Acetone	mg/kg		0.013 JB	0.018 JB	0.18 B	0.016
Carbon Disulfide	mg/kg		0.0073 U	0.0094 U	0.0029 J	0.0077 U
Methylene Chloride	mg/kg		0.015 U	0.014 JB	0.022 JB	0.022 B
Toluene	mg/kg		0.0073 U	0.0094 U	0.013 U	0.0077 U
Trichloroethene	mg/kg		0.0073 U	0.0094 U	0.013 U	0.0077 U
Organics-Pesticide/PCB						
4,4'-DDD	mg/kg		0.0021 U	0.0032 U	0.0043 U	0.0023 U
4,4'-DDE	mg/kg		0.0021 U	0.0032 U	0.0043 U	0.0023 U
4,4'-DDT	mg/kg		0.0021 U	0.0032 U	0.0043 U	0.0023 U
Dieldrin	mg/kg		0.0021 U	0.0032 U	0.0043 U	0.0023 U
Endosulfan I	mg/kg		0.0021 U	0.0032 U	0.0043 U	0.0023 U
Endrin	mg/kg		0.0021 U	0.0032 U	0.0043 U	0.0023 U
Endrin aldehyde	mg/kg		0.0021 U	0.0032 U	0.0043 U	0.0023 U
Heptachlor epoxide	mg/kg		0.0021 U	0.0032 U	0.0043 U	0.0023 U
Lindane	mg/kg		0.0021 U	0.0032 U	0.0043 U	0.0023 U
Methoxychlor	mg/kg		0.0021 U	0.0032 U	0.0043 U	0.0023 U
beta-BHC	mg/kg		0.0021 U	0.0032 U	0.0043 U	0.0023 U

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Table 4-11. SRCs in Sediment at the Fuze and Booster Quarry Landfill/Ponds (continued)

Media Location Station Sample ID Customer ID Date Depth (ft) Filtered Field Type Analyte (mg/kg)	Units	Facility-wide Background	Sediment FBQ FBQsd-158 FBQSD-158-0283-SD FBQsd-158-0283-SD 10/21/2003 0.0 - 0.5 Total Regular samples	Sediment FBQ FBQsd-159 FBQSD-159-0284-SD FBQsd-159-0284-SD 11/06/2003 0.0 - 0.5 Total Regular samples	Sediment FBQ FBQsd-160 FBQSD-160-0285-SD FBQsd-160-0285-SD 11/06/2003 0.0 - 0.5 Total Regular samples	Sediment FBQ FBQsd-161 FBQSD-161-0286-SD FBQsd-161-0286-SD 11/06/2003 0.0 - 0.5 Total Regular samples
Explosives						
1,3,5-Trinitrobenzene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
1,3-Dinitrobenzene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
2,4,6-Trinitrotoluene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
2,6-Dinitrotoluene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
2-Amino-4,6-dinitrotoluene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
3-Nitrotoluene	mg/kg		0.2 U	0.2 U	0.2 U	0.2 U
4-Amino-2,6-dinitrotoluene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
HMX	mg/kg		0.2 U	0.2 U	0.2 U	0.2 U
Nitrobenzene	mg/kg		0.049 J	0.038 JB	0.1 U	0.1 U
Nitrocellulose	mg/kg		40	32	88	27 U
Nitroglycerin	mg/kg		10 U	10 U	10 U	10 U
Inorganics						
Aluminum	mg/kg	13,900	12,600	16,100 #	14,500 #	14,600 #
Antimony	mg/kg	0	11.4 N#	0.7 B#	0.52 BN#	0.56 BN#
Arsenic	mg/kg	19.5	13.9	11.7	8.7	7
Barium	mg/kg	123	270 #	110	98 N	87.5 N
Beryllium	mg/kg	0.38	0.63 #	0.94 #	0.85 #	0.76 #
Cadmium	mg/kg	0	4.3 #	0.032 B#	0.046 B#	0.43 #
Calcium	mg/kg	5,510	15,500 #	1,380	1,380	1,040
Chromium	mg/kg	18.1	88.2 #	18.4 #	17.2	18.4 E#
Chromium, hexavalent	mg/kg		15 #	1.5 U	1.5 U	4.1 U
Cobalt	mg/kg	9.1	13.5 #	9.5 #	7.7	9.8 #
Copper	mg/kg	27.6	268 #	15.5	15.1	27
Iron	mg/kg	28,200	54,700 #	23,300	20,000	21,900
Lead	mg/kg	27.4	1,060 #	27	30.8 #	37.8 #
Magnesium	mg/kg	2,760	8,590 N#	2,540	2,340 N	3,670 N#
Manganese	mg/kg	1,950	373	693	373	149
Mercury	mg/kg	0.06	2 #	0.087 #	0.09 #	0.066 #

Table 4-11. SRCs in Sediment at the Fuze and Booster Quarry Landfill/Ponds (continued)

Media Location Station Sample ID Customer ID Date Depth (ft) Filtered Field Type Analyte (mg/kg)	Units	Facility-wide Background	Sediment FBQ FBQsd-158 FBQSD-158-0283-SD FBQsd-158-0283-SD 10/21/2003 0.0 - 0.5 Total Regular samples	Sediment FBQ FBQsd-159 FBQSD-159-0284-SD FBQsd-159-0284-SD 11/06/2003 0.0 - 0.5 Total Regular samples	Sediment FBQ FBQsd-160 FBQSD-160-0285-SD FBQsd-160-0285-SD 11/06/2003 0.0 - 0.5 Total Regular samples	Sediment FBQ FBQsd-161 FBQSD-161-0286-SD FBQsd-161-0286-SD 11/06/2003 0.0 - 0.5 Total Regular samples
Nickel	mg/kg	17.7	80.5 #	20.2 #	17.6	20.5 E#
Potassium	mg/kg	1,950	1,000 N	1,240	1,170 N	1,510 NE
Selenium	mg/kg	1.7	5.5 #	0.99 B	0.91 B	0.92 B
Silver	mg/kg	0	0.55 B#	0.078 B#	0.075 U	0.083 B#
Sodium	mg/kg	112	490 #	125 #	136 #	116 #
Thallium	mg/kg	0.89	2.3 U	0.53 U	0.55 U	0.5 U
Vanadium	mg/kg	26.1	19.7	28.7 #	26.2 N#	24.9 N
Zinc	mg/kg	532	1,830 #	109	89	111
Miscellaneous						
Total Organic Carbon	mg/kg		17,000	29,000	43,000	23,000
Organic-Semivolatiles						
2-Methylnaphthalene	mg/kg		0.52 U	0.49 U	0.51 U	0.56 U
4-Methylphenol	mg/kg		0.52 U	0.49 U	0.51 U	0.56 U
Acenaphthylene	mg/kg		0.52 U	0.49 U	0.51 U	0.56 U
Anthracene	mg/kg		0.52 U	0.49 U	0.51 U	0.56 U
Benz(*a*)anthracene	mg/kg		0.52 U	0.49 U	0.51 U	0.56 U
Benzo(*a*)pyrene	mg/kg		0.52 U	0.49 U	0.51 U	0.053 J
Benzo(*b*)fluoranthene	mg/kg		0.52 U	0.49 U	0.51 U	0.089 J
Benzo(*ghi*)perylene	mg/kg		0.52 U	0.49 U	0.51 U	0.56 U
Benzo(*k*)fluoranthene	mg/kg		0.52 U	0.49 U	0.51 U	0.56 U
Bis(2-ethylhexyl)phthalate	mg/kg		0.12 JB	0.49 U	0.51 U	0.56 U
Carbazole	mg/kg		0.52 U	0.49 U	0.51 U	0.56 U
Chrysene	mg/kg		0.52 U	0.49 U	0.51 U	0.56 U
Di-n-butyl phthalate	mg/kg		0.26 JB	0.49 U	0.51 U	0.56 U
Dibenzofuran	mg/kg		0.52 U	0.49 U	0.51 U	0.56 U
Fluoranthene	mg/kg		0.098 J	0.49 U	0.51 U	0.097 J
Fluorene	mg/kg		0.52 U	0.49 U	0.51 U	0.56 U
Indeno(1,2,3-*cd*)pyrene	mg/kg		0.52 U	0.49 U	0.51 U	0.56 U
Naphthalene	mg/kg		0.52 U	0.49 U	0.51 U	0.56 U
Phenanthrene	mg/kg		0.11 J	0.49 U	0.51 U	0.56 U

Table 4-11. SRCs in Sediment at the Fuze and Booster Quarry Landfill/Ponds (continued)

Media Location Station Sample ID Customer ID Date Depth (ft) Filtered Field Type Analyte (mg/kg)	Units	Facility-wide Background	Sediment FBQ FBQsd-158 FBQSD-158-0283-SD FBQsd-158-0283-SD 10/21/2003 0.0 - 0.5 Total Regular samples	Sediment FBQ FBQsd-159 FBQSD-159-0284-SD FBQsd-159-0284-SD 11/06/2003 0.0 - 0.5 Total Regular samples	Sediment FBQ FBQsd-160 FBQSD-160-0285-SD FBQsd-160-0285-SD 11/06/2003 0.0 - 0.5 Total Regular samples	Sediment FBQ FBQsd-161 FBQSD-161-0286-SD FBQsd-161-0286-SD 11/06/2003 0.0 - 0.5 Total Regular samples
Pyrene	mg/kg		0.52 U	0.49 U	0.51 U	0.56 U
Organic-Volatiles						
2-Butanone	mg/kg		0.015 U	0.007 JB	0.015 B	0.017 U
Acetone	mg/kg		0.015 U	0.017 B	0.04 B	0.01 JB
Carbon Disulfide	mg/kg		0.0076 U	0.0073 U	0.0076 U	0.0084 U
Methylene Chloride	mg/kg		0.012 JB	0.015 U	0.015 U	0.012 JB
Toluene	mg/kg		0.0076 U	0.0073 U	0.0028 J	0.002 J
Trichloroethene	mg/kg		0.0076 U	0.0073 U	0.0076 U	0.0084 U
Organics-Pesticide/PCB						
4,4'-DDD	mg/kg		0.0026 U	0.0015 JP	0.0025 U	0.0028 U
4,4'-DDE	mg/kg		0.0026 U	0.0024 U	0.0015 J	0.0028 U
4,4'-DDT	mg/kg		0.0026 U	0.0024 U	0.0025 U	0.0028 U
Dieldrin	mg/kg		0.0026 U	0.0024 U	0.0025 U	0.0028 U
Endosulfan I	mg/kg		0.0026 U	0.0024 U	0.0025 U	0.0028 U
Endrin	mg/kg		0.0026 U	0.0024 U	0.0025 U	0.0028 U
Endrin aldehyde	mg/kg		0.0026 U	0.0024 U	0.0025 U	0.0028 U
Heptachlor epoxide	mg/kg		0.0026 U	0.0024 U	0.0025 U	0.0028 U
Lindane	mg/kg		0.0026 U	0.0024 U	0.0025 U	0.0028 U
Methoxychlor	mg/kg		0.0026 U	0.0024 U	0.0025 U	0.0028 U
beta-BHC	mg/kg		0.0026 U	0.0024 U	0.0025 U	0.0028 U

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Table 4-11. SRCs in Sediment at the Fuze and Booster Quarry Landfill/Ponds (continued)

Media **Location** **Station** **Sample ID** **Customer ID** **Date** **Depth (ft)** **Filtered** **Field Type** **Analyte (mg/kg)**	**Units**	**Facility-wide Background**	**Sediment** **FBQ** **FBQsd-162** **FBQSD-162-0287-SD** **FBQsd-162-0287-SD** **11/06/2003** **0.0 - 0.5** **Total** **Regular samples**	**Sediment** **FBQ** **FBQsd-163** **FBQSD-163-0288-SD** **FBQsd-163-0288-SD** **11/06/2003** **0.0 - 0.5** **Total** **Regular samples**	**Sediment** **FBQ** **FBQsd-164** **FBQSD-164-0289-SD** **FBQsd-164-0289-SD** **11/06/2003** **0.0 - 0.5** **Total** **Regular samples**	**Sediment** **FBQ** **FBQsd-165** **FBQSD-165-0290-SD** **FBQsd-165-0290-SD** **11/06/2003** **0.0 - 0.5** **Total** **Regular samples**
Explosives						
1,3,5-Trinitrobenzene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
1,3-Dinitrobenzene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
2,4,6-Trinitrotoluene	mg/kg		0.041 J	0.1 U	0.1 U	0.1 U
2,6-Dinitrotoluene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
2-Amino-4,6-dinitrotoluene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
3-Nitrotoluene	mg/kg		0.15 J	0.1 J	0.2 U	0.2 U
4-Amino-2,6-dinitrotoluene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
HMX	mg/kg		0.2 U	0.2 U	0.2 U	0.2 U
Nitrobenzene	mg/kg		0.1 U	0.1 U	0.1 U	0.1 U
Nitrocellulose	mg/kg		74	59	28 U	25 U
Nitroglycerin	mg/kg		10 U	10 U	10 U	10 U
Inorganics						
Aluminum	mg/kg	13,900	12,500	14,000 #	14,500 #	16,000 #
Antimony	mg/kg	0	0.52 BN#	0.37 BN#	0.58 BN#	1.1 BN#
Arsenic	mg/kg	19.5	10.6	11.1	12.6	8.5
Barium	mg/kg	123	111 N	174 N#	125 N#	89.7 N
Beryllium	mg/kg	0.38	0.86 #	1.1 #	1.1 #	0.84 #
Cadmium	mg/kg	0	0.19 #	0.1 #	0.18 #	0.36 #
Calcium	mg/kg	5,510	2,800	2,440	9,240 #	782
Chromium	mg/kg	18.1	19 E#	20.1 E#	17.6 E	20.5 E#
Chromium, hexavalent	mg/kg		3.4 U	1.9 #	1.6 U	1.5 U
Cobalt	mg/kg	9.1	10 #	12.4 #	14.9 #	8
Copper	mg/kg	27.6	22.2	35.4 #	18.9	25
Iron	mg/kg	28,200	24,000	32,800 #	28,600 #	22,100
Lead	mg/kg	27.4	25.9	25.2	20	55.4 #
Magnesium	mg/kg	2,760	2,790 N#	3,350 N#	4,340 N#	2,730 N
Manganese	mg/kg	1,950	411	209	558	241
Mercury	mg/kg	0.06	0.14 #	0.048 B	0.085 #	0.24 #

Table 4-11. SRCs in Sediment at the Fuze and Booster Quarry Landfill/Ponds (continued)

Media Location Station Sample ID Customer ID Date Depth (ft) Filtered Field Type Analyte (mg/kg)	Units	Facility-wide Background	Sediment FBQ FBQsd-162 FBQSD-162-0287-SD FBQsd-162-0287-SD 11/06/2003 0.0 - 0.5 Total Regular samples	Sediment FBQ FBQsd-163 FBQSD-163-0288-SD FBQsd-163-0288-SD 11/06/2003 0.0 - 0.5 Total Regular samples	Sediment FBQ FBQsd-164 FBQSD-164-0289-SD FBQsd-164-0289-SD 11/06/2003 0.0 - 0.5 Total Regular samples	Sediment FBQ FBQsd-165 FBQSD-165-0290-SD FBQsd-165-0290-SD 11/06/2003 0.0 - 0.5 Total Regular samples
Nickel	mg/kg	17.7	20.8 E#	30.2 E#	23.8 E#	24 E#
Potassium	mg/kg	1,950	1,460 NE	1,590 NE	1,420 NE	1,390 NE
Selenium	mg/kg	1.7	0.78 B	0.86 B	1.1	0.97 B
Silver	mg/kg	0	0.13 B#	0.093 B#	0.13 B#	0.18 B#
Sodium	mg/kg	112	117 #	135 #	197 #	127 #
Thallium	mg/kg	0.89	0.45 U	0.53 U	0.45 U	0.53 U
Vanadium	mg/kg	26.1	22.4 N	26.5 N#	22.5 N	28 N#
Zinc	mg/kg	532	82.9	127	90.7	109
Miscellaneous						
Total Organic Carbon	mg/kg		28,000	32,000	29,000	23,000
Organic-Semivolatiles						
2-Methylnaphthalene	mg/kg		0.46 U	0.19 J	0.54 U	0.5 U
4-Methylphenol	mg/kg		0.46 U	0.59 U	0.54 U	0.5 U
Acenaphthylene	mg/kg		0.46 U	0.11 J	0.54 U	0.5 U
Anthracene	mg/kg		0.46 U	0.46 J	0.54 U	0.5 U
Benz(*a*)anthracene	mg/kg		0.46 U	1.1	0.54 U	0.084 J
Benzo(*a*)pyrene	mg/kg		0.46 U	0.84	0.54 U	0.086 J
Benzo(*b*)fluoranthene	mg/kg		0.46 U	0.98	0.54 U	0.15 J
Benzo(*ghi*)perylene	mg/kg		0.46 U	0.39 J	0.54 U	0.5 U
Benzo(*k*)fluoranthene	mg/kg		0.46 U	0.25 J	0.54 U	0.5 U
Bis(2-ethylhexyl)phthalate	mg/kg		0.46 U	0.59 U	0.54 U	0.5 U
Carbazole	mg/kg		0.46 U	0.23 J	0.54 U	0.5 U
Chrysene	mg/kg		0.46 U	0.89	0.54 U	0.083 J
Di-n-butyl phthalate	mg/kg		0.46 U	0.59 U	0.54 U	0.5 U
Dibenzofuran	mg/kg		0.46 U	0.11 J	0.54 U	0.5 U
Fluoranthene	mg/kg		0.46 U	2.4	0.54 U	0.13 J
Fluorene	mg/kg		0.46 U	0.12 J	0.54 U	0.5 U
Indeno(1,2,3-*cd*)pyrene	mg/kg		0.46 U	0.4 J	0.54 U	0.5 U
Naphthalene	mg/kg		0.46 U	0.14 J	0.54 U	0.5 U
Phenanthrene	mg/kg		0.46 U	1.7	0.54 U	0.5 U

Table 4-11. SRCs in Sediment at the Fuze and Booster Quarry Landfill/Ponds (continued)

Media **Location** **Station** **Sample ID** **Customer ID** **Date** **Depth (ft)** **Filtered** **Field Type** **Analyte (mg/kg)**	**Units**	**Facility-wide Background**	**Sediment** **FBQ** **FBQsd-162** **FBQSD-162-0287-SD** **FBQsd-162-0287-SD** **11/06/2003** **0.0 - 0.5** **Total** **Regular samples**	**Sediment** **FBQ** **FBQsd-163** **FBQSD-163-0288-SD** **FBQsd-163-0288-SD** **11/06/2003** **0.0 - 0.5** **Total** **Regular samples**	**Sediment** **FBQ** **FBQsd-164** **FBQSD-164-0289-SD** **FBQsd-164-0289-SD** **11/06/2003** **0.0 - 0.5** **Total** **Regular samples**	**Sediment** **FBQ** **FBQsd-165** **FBQSD-165-0290-SD** **FBQsd-165-0290-SD** **11/06/2003** **0.0 - 0.5** **Total** **Regular samples**
Pyrene	mg/kg		0.46 U	1.5	0.54 U	0.1 J
Organic-Volatiles						
2-Butanone	mg/kg		0.014 U	0.018 U	0.0042 J	0.015 U
Acetone	mg/kg		0.022 B	0.018 U	0.025 B	0.014 JB
Carbon Disulfide	mg/kg		0.0069 U	0.0089 U	0.008 U	0.0075 U
Methylene Chloride	mg/kg		0.012 JB	0.0086 JB	0.013 JB	0.01 JB
Toluene	mg/kg		0.0069 U	0.0089 U	0.008 U	0.0056 J
Trichloroethene	mg/kg		0.0069 U	0.0089 U	0.008 U	0.0075 U
Organics-Pesticide/PCB						
4,4'-DDD	mg/kg		0.0023 U	0.003 U	0.0027 U	0.0025 U
4,4'-DDE	mg/kg		0.0023 U	0.003 U	0.0027 U	0.00066 J
4,4'-DDT	mg/kg		0.0023 U	0.003 U	0.0027 U	0.0025 U
Dieldrin	mg/kg		0.0023 U	0.003 U	0.0027 U	0.00041 J
Endosulfan I	mg/kg		0.0023 U	0.003 U	0.0027 U	0.0025 U
Endrin	mg/kg		0.0023 U	0.003 U	0.0027 U	0.0025 U
Endrin aldehyde	mg/kg		0.0023 U	0.003 U	0.0027 U	0.0018 J
Heptachlor epoxide	mg/kg		0.0023 U	0.003 U	0.0027 U	0.0025 U
Lindane	mg/kg		0.0023 U	0.003 U	0.0027 U	0.0025 U
Methoxychlor	mg/kg		0.0023 U	0.003 U	0.0027 U	0.0011 JP
beta-BHC	mg/kg		0.0023 U	0.003 U	0.0027 U	0.0025 U

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Table 4-11. SRCs in Sediment at the Fuze and Booster Quarry Ponds/Landfill (continued)

Note: Data qualifiers are presented as laboratory qualifiers/validation qualifiers.
B for inorganics = Result is less than the contract-required detection limit but greater than the instrument detection limit.
B for organics = Compound is detected in the blank as well as the sample.
E = Result estimated because of the presence of interference.
J = Estimated value is less than the reporting limits.
N = Matrix spike recovery is outside the control limits.
P = Greater than 25% difference between the two GC columns.
R = Data are rejected.
U = Not detected.
# = Value is above the facility-wide background.
* = Duplicate analysis is outside the control limits.
“=” = Analyte present and concentration accurate.
Facility-wide background is determined for the Winklepeck Burning Ground Phase II Remedial Investigation (USACE 2001b).
NA = Not applicable.
PCB = Polychlorinated biphenyl.
SRC = Site-related contaminant.

Table 4-12. Summary Statistics and Determination of SRCs in Surface Water Samples at the Fuze and Booster Quarry Landfill/Ponds

Analyte	Units	Results >Detection Limit	Average Result	Minimum Detect	Maximum Detect	Background Criteria	Site Related?	Justification
Miscellaneous								
Chromium, hexavalent	mg/L	5/ 15	0.0133	0.01	0.05		Yes	No Background Data Available
Perchlorate	mg/L	2/ 11	0.00336	0.0075	0.025		Yes	No Background Data Available
Metals								
Aluminum	mg/L	11/ 15	0.876	0.174	7.01	3.37	Yes	Above Background
Arsenic	mg/L	1/ 15	0.00493	0.0197	0.0197	0.0032	Yes	Above Background
Barium	mg/L	15/ 15	0.115	0.019	1.03	0.0475	Yes	Above Background
Beryllium	mg/L	1/ 15	0.000161	0.00077	0.00077	0	Yes	No Background Data Available
Calcium	mg/L	15/ 15	18.1	6.13	44.6	41.4	No	Essential Element
Chromium	mg/L	4/ 15	0.00171	0.0018	0.0122	0	Yes	No Background Data Available
Cobalt	mg/L	9/ 15	0.00485	0.0021	0.0173	0	Yes	No Background Data Available
Copper	mg/L	8/ 15	0.00556	0.0036	0.0418	0.0079	Yes	Above Background
Iron	mg/L	15/ 15	10.6	0.107	24.5	2.56	No	Essential Element
Lead	mg/L	3/ 15	0.00321	0.0033	0.0249	0	Yes	No Background Data Available
Magnesium	mg/L	15/ 15	4.93	2.29	9.22	10.8	No	Essential Element
Manganese	mg/L	15/ 15	1.64	0.0117	11	0.391	Yes	Above Background
Nickel	mg/L	1/ 15	0.00248	0.0259	0.0259	0	Yes	No Background Data Available
Potassium	mg/L	15/ 15	5.26	1.15	13.9	3.17	No	Essential Element
Sodium	mg/L	15/ 15	2.02	0.945	4.09	21.3	No	Essential Element
Vanadium	mg/L	5/ 15	0.00244	0.002	0.0191	0	Yes	No Background Data Available
Zinc	mg/L	8/ 15	0.0182	0.0123	0.107	0.042	Yes	Above Background
Organics-Explosives								
2-Amino-4,6-dinitrotoluene	mg/L	1/ 15	0.000167	0.00068	0.00068		Yes	No Background Data Available
4-Amino-2,6-dinitrotoluene	mg/L	1/ 15	0.00145	0.02	0.02		Yes	No Background Data Available
Nitrocellulose	mg/L	12/ 15	0.438	0.25	1.1		Yes	No Background Data Available
Organics-Semivolatile								
4-Methylphenol	mg/L	4/ 15	0.029	0.002	0.17		Yes	No Background Data Available
Bis(2-ethylhexyl)phthalate	mg/L	11/ 15	0.00269	0.0014	0.011		Yes	No Background Data Available
Phenol	mg/L	3/ 15	0.0178	0.034	0.12		Yes	No Background Data Available
Organics-Volatile								
2-Butanone	mg/L	3/ 15	0.0049	0.0034	0.0051		Yes	No Background Data Available
Carbon Disulfide	mg/L	3/ 15	0.0023	0.00094	0.0018		Yes	No Background Data Available
Methylene Chloride	mg/L	2/ 15	0.00348	0.0045	0.0047		Yes	No Background Data Available
Styrene	mg/L	1/ 15	0.00241	0.0011	0.0011		Yes	No Background Data Available
Toluene	mg/L	10/ 15	0.00768	0.0022	0.02		Yes	No Background Data Available

SRC = Site-related contaminant.

Table 4-13. SRCs in Surface Water at the Fuze and Booster Quarry Landfill/Ponds

Media Location Station Sample ID Customer ID Date Filtered Field Type Analyte (mg/L)	Units	Facility-wide Background	Surface Water FBQ FBQsw-130 FBQSW-130-0295-SW FBQsw-130-0295-SW 11/03/2003 Total Regular samples	Surface Water FBQ FBQsw-131 FBQSW-131-0296-SW FBQsw-131-0296-SW 11/03/2003 Total Regular samples	Surface Water FBQ FBQsw-132 FBQSW-132-0297-SW FBQsw-132-0297-SW 11/03/2003 Total Regular samples	Surface Water FBQ FBQsw-132 FBQSW-132-0414-SW FBQsw-132-0414-SW 06/30/2004 Total Regular samples
Explosives						
2-Amino-4,6-dinitrotoluene	mg/L		0.00026 U	0.00026 U	0.00026 U	NA
4-Amino-2,6-dinitrotoluene	mg/L		0.00026 U	0.00026 U	0.00026 U	NA
Nitrocellulose	mg/L		0.25	0.29	0.18 U	NA
Inorganics						
Aluminum	mg/L	3.37	7.01 #	0.558	0.293	NA
Antimony	mg/L	0	0.0027 B#	0.0026 U	0.0026 U	NA
Arsenic	mg/L	0.0032	0.0197 #	0.0048 U	0.0125 B#	NA
Barium	mg/L	0.0475	0.0936 #	0.0245	0.0528 #	NA
Beryllium	mg/L	0	0.00077 #	0.0002 U	0.0002 U	NA
Cadmium	mg/L	0	0.00058 B#	0.0003 U	0.0003 U	NA
Calcium	mg/L	41.4	22.4	7.89	9.58	NA
Chromium	mg/L	0	0.0122 #	0.0017 B#	0.001 B#	NA
Chromium, hexavalent	mg/L		0.01 U	0.01 U	0.01 U	NA
Cobalt	mg/L	0	0.0173 #	0.0025 B#	0.0079 #	NA
Copper	mg/L	0.0079	0.0418 #	0.0044	0.0038	NA
Iron	mg/L	2.56	22.6 #	9.78 E#	15.3 E#	NA
Lead	mg/L	0	0.0249 #	0.0042 #	0.0033 #	NA
Magnesium	mg/L	10.8	7.23	4.49	4.55	NA
Manganese	mg/L	0.391	0.852 #	1.01 #	1.39 #	NA
Mercury	mg/L	0	0.00013 B#	0.0001 U	0.0001 U	NA
Nickel	mg/L	0	0.0259 #	0.0013 B#	0.0016 B#	NA
Potassium	mg/L	3.17	6.22 #	9.45 #	9.27 #	NA
Silver	mg/L	0	0.0007 U	0.0007 U*	0.0007 U*	NA
Sodium	mg/L	21.3	2.44	0.949	1.26	NA
Vanadium	mg/L	0	0.0191 #	0.0021 B#	0.0013 B#	NA
Zinc	mg/L	0.042	0.107 #	0.0123	0.0139	NA
Miscellaneous						
Perchlorate	mg/L		0.001 U	0.001 U	0.0075	0.001 U/U
Organic-Semivolatiles						
4-Methylphenol	mg/L		0.002 J	0.16	0.043	NA

Table 4-13. SRCs in Surface Water at the Fuze and Booster Quarry Landfill/Ponds (continued)

Media Location Station Sample ID Customer ID Date Filtered Field Type Analyte (mg/L)	Units	Facility-wide Background	Surface Water FBQ FBQsw-130 FBQSW-130-0295-SW FBQsw-130-0295-SW 11/03/2003 Total Regular samples	Surface Water FBQ FBQsw-131 FBQSW-131-0296-SW FBQsw-131-0296-SW 11/03/2003 Total Regular samples	Surface Water FBQ FBQsw-132 FBQSW-132-0297-SW FBQsw-132-0297-SW 11/03/2003 Total Regular samples	Surface Water FBQ FBQsw-132 FBQSW-132-0414-SW FBQsw-132-0414-SW 06/30/2004 Total Regular samples
Bis(2-ethylhexyl)phthalate	mg/L		0.0015 J	0.0022 J	0.0037 J	NA
Phenol	mg/L		0.012 U	0.046	0.034	NA
Organic-Volatiles						
2-Butanone	mg/L		0.01 U	0.0051 J	0.005 J	NA
Acetone	mg/L		0.011 B	0.015 B	0.011 B	NA
Carbon Disulfide	mg/L		0.005 U	0.005 U	0.005 U	NA
Methylene Chloride	mg/L		0.007 JB	0.007 JB	0.0072 JB	NA
Styrene	mg/L		0.005 U	0.005 U	0.0011 J	NA
Toluene	mg/L		0.0084	0.02	0.017	NA

Table 4-13. SRCs in Surface Water at the Fuze and Booster Quarry Landfill/Ponds (continued)

Media Location Station Sample ID Customer ID Date Filtered Field Type Analyte (mg/L)	Units	Facility-wide Background	Surface Water FBQ FBQsw-133 FBQSW-133-0299-SW FBQsw-133-0299-SW 11/04/2003 Total Regular samples	Surface Water FBQ FBQsw-134 FBQSW-134-0300-SW FBQsw-134-0300-SW 11/04/2003 Total Regular samples	Surface Water FBQ FBQsw-134 FBQSW-134-0391-SW FBQsw-134-0391-SW 11/04/2003 Total Field Duplicate	Surface Water FBQ FBQsw-134 FBQSW-134-0410-SW FBQsw-134-0410-SW 06/30/2004 Total Regular samples
			Explosives			
2-Amino-4,6-dinitrotoluene	mg/L		0.00026 U	0.00068	0.00053	NA
4-Amino-2,6-dinitrotoluene	mg/L		0.00026 U	0.02	0.018	NA
Nitrocellulose	mg/L		0.18 U	0.51	0.27	NA
			Inorganics			
Aluminum	mg/L	3.37	0.237	0.734	1.22	NA
Antimony	mg/L	0	0.0019 U	0.0019 U	0.0019 U	NA
Arsenic	mg/L	0.0032	0.0049 U	0.0127 B#	0.012 B#	NA
Barium	mg/L	0.0475	0.0333	0.0404	0.0427	NA
Beryllium	mg/L	0	0.00024 B#	0.00011 B#	0.00013 B#	NA
Cadmium	mg/L	0	0.0003 U	0.0003 U	0.0003 U	NA
Calcium	mg/L	41.4	27.3	18.3	18.3	NA
Chromium	mg/L	0	0.0009 B#	0.0018 #	0.0029 #	NA
Chromium, hexavalent	mg/L		0.01 U	0.04 #	0.04 #	NA
Cobalt	mg/L	0	0.0004 U	0.0066 #	0.0069 #	NA
Copper	mg/L	0.0079	0.0023 B	0.0029 B	0.0031 B	NA
Iron	mg/L	2.56	3.32 #	20.4 #	21 #	NA
Lead	mg/L	0	0.0024 B#	0.0037 B#	0.0051 B#	NA
Magnesium	mg/L	10.8	7.05	6.9	7.04	NA
Manganese	mg/L	0.391	0.632 #	1.22 #	1.23 #	NA
Mercury	mg/L	0	0.0001 U	0.0001 U	0.0001 U	NA
Nickel	mg/L	0	0.0011 U	0.0027 B#	0.0026 B#	NA
Potassium	mg/L	3.17	3.96 #	13.9 #	13.9 #	NA
Silver	mg/L	0	0.0007 U	0.0007 U	0.0007 U	NA
Sodium	mg/L	21.3	4.09	1.24	1.08	NA
Vanadium	mg/L	0	0.00076 B#	0.0024 #	0.0035 #	NA
Zinc	mg/L	0.042	0.0144	0.0086 B	0.0097 B	NA
			Miscellaneous			
Perchlorate	mg/L		NA	0.025	0.025	0.001 U/U
			Organic-Semivolatiles			
4-Methylphenol	mg/L		0.011 U	0.17	0.022	NA

Table 4-13. SRCs in Surface Water at the Fuze and Booster Quarry Landfill/Ponds (continued)

Media Location Station Sample ID Customer ID Date Filtered Field Type Analyte (mg/L)	Units	Facility-wide Background	Surface Water FBQ FBQsw-133 FBQSW-133-0299-SW FBQsw-133-0299-SW 11/04/2003 Total Regular samples	Surface Water FBQ FBQsw-134 FBQSW-134-0300-SW FBQsw-134-0300-SW 11/04/2003 Total Regular samples	Surface Water FBQ FBQsw-134 FBQSW-134-0391-SW FBQsw-134-0391-SW 11/04/2003 Total Field Duplicate	Surface Water FBQ FBQsw-134 FBQSW-134-0410-SW FBQsw-134-0410-SW 06/30/2004 Total Regular samples
Bis(2-ethylhexyl)phthalate	mg/L		0.0017 J	0.0028 JB	0.0025 JB	NA
Phenol	mg/L		0.011 U	0.12	0.21	NA
Organic-Volatiles						
2-Butanone	mg/L		0.01 U	0.0034 J	0.0025 J	NA
Acetone	mg/L		0.0089 JB	0.014 B	0.014 B	NA
Carbon Disulfide	mg/L		0.005 U	0.0017 J	0.005 U	NA
Methylene Chloride	mg/L		0.0054 JB	0.0062 JB	0.0067 JB	NA
Styrene	mg/L		0.005 U	0.005 U	0.005 U	NA
Toluene	mg/L		0.0036 J	0.016	0.017	NA

Table 4-13. SRCs in Surface Water at the Fuze and Booster Quarry Landfill/Ponds (continued)

Media Location Station Sample ID Customer ID Date Filtered Field Type Analyte (mg/L)	Units	Facility-wide Background	Surface Water FBQ FBQsw-134 FBQSW-134-0411-SW FBQsw-134-0411-SW 06/30/2004 Total Field Duplicate	Surface Water FBQ FBQsw-135 FBQSW-135-0301-SW FBQsw-135-0301-SW 11/04/2003 Total Regular samples	Surface Water FBQ FBQsw-135 FBQSW-135-0392-SW FBQsw-135-0392-SW 11/04/2003 Total Field Duplicate	Surface Water FBQ FBQsw-136 FBQSW-136-0302-SW FBQsw-136-0302-SW 11/04/2003 Total Regular samples
			Explosives			
2-Amino-4,6-dinitrotoluene	mg/L		NA	0.00026 U	0.00026 U	0.00026 U
4-Amino-2,6-dinitrotoluene	mg/L		NA	0.00026 U	0.00026 U	0.00026 U
Nitrocellulose	mg/L		NA	0.26	0.18 U	0.18 U
			Inorganics			
Aluminum	mg/L	3.37	NA	0.709	0.65	0.174
Antimony	mg/L	0	NA	0.0019 U	0.0019 U	0.0019 U
Arsenic	mg/L	0.0032	NA	0.0049 U	0.0049 B#	0.008 B#
Barium	mg/L	0.0475	NA	0.0307	0.0319	0.0468
Beryllium	mg/L	0	NA	0.00036 B#	0.00017 B#	0.00019 B#
Cadmium	mg/L	0	NA	0.0003 U	0.0003 U	0.0003 U
Calcium	mg/L	41.4	NA	6.13	6.18	28.4
Chromium	mg/L	0	NA	0.0023 #	0.0018 #	0.00069 B#
Chromium, hexavalent	mg/L		NA	0.05 #	0.04 #	0.01 U
Cobalt	mg/L	0	NA	0.0046 #	0.0039 #	0.0092 #
Copper	mg/L	0.0079	NA	0.0073	0.0062	0.00081 B
Iron	mg/L	2.56	NA	5.11 #	5.07 #	15.7 #
Lead	mg/L	0	NA	0.0056 B#	0.0044 B#	0.0022 B#
Magnesium	mg/L	10.8	NA	2.29	2.29	9.22
Manganese	mg/L	0.391	NA	0.652 #	0.637 #	4.4 #
Mercury	mg/L	0	NA	0.0001 U	0.0001 U	0.0001 U
Nickel	mg/L	0	NA	0.0025 B#	0.0021 B#	0.0011 U
Potassium	mg/L	3.17	NA	6.54 #	7.26 #	3.07
Silver	mg/L	0	NA	0.0007 U	0.0007 U	0.0007 U
Sodium	mg/L	21.3	NA	1.14	2.16	3.67
Vanadium	mg/L	0	NA	0.0018 B#	0.0019 B#	0.00082 B#
Zinc	mg/L	0.042	NA	0.0186	0.0235	0.0066 B
			Miscellaneous			
Perchlorate	mg/L		0.001 U/U	NA	NA	NA
			Organic-Semivolatiles			
4-Methylphenol	mg/L		NA	0.011 U	0.011 U	0.011 U

Table 4-13. SRCs in Surface Water at the Fuze and Booster Quarry Landfill/Ponds (continued)

Media Location Station Sample ID Customer ID Date Filtered Field Type Analyte (mg/L)	Units	Facility-wide Background	Surface Water FBQ FBQsw-134 FBQSW-134-0411-SW FBQsw-134-0411-SW 06/30/2004 Total Field Duplicate	Surface Water FBQ FBQsw-135 FBQSW-135-0301-SW FBQsw-135-0301-SW 11/04/2003 Total Regular samples	Surface Water FBQ FBQsw-135 FBQSW-135-0392-SW FBQsw-135-0392-SW 11/04/2003 Total Field Duplicate	Surface Water FBQ FBQsw-136 FBQSW-136-0302-SW FBQsw-136-0302-SW 11/04/2003 Total Regular samples
Bis(2-ethylhexyl)phthalate	mg/L		NA	0.0015 J	0.002 JB	0.0014 J
Phenol	mg/L		NA	0.011 U	0.011 U	0.011 U
Organic-Volatiles						
2-Butanone	mg/L		NA	0.01 U	0.01 U	0.01 U
Acetone	mg/L		NA	0.0071 JB	0.0049 JB	0.01 JB
Carbon Disulfide	mg/L		NA	0.005 U	0.005 U	0.005 U
Methylene Chloride	mg/L		NA	0.0076 JB	0.0057 JB	0.008 JB
Styrene	mg/L		NA	0.005 U	0.005 U	0.005 U
Toluene	mg/L		NA	0.0036 J	0.0039 J	0.0022 J

Table 4-13. SRCs in Surface Water at the Fuze and Booster Quarry Landfill/Ponds (continued)

Media Location Station Sample ID Customer ID Date Filtered Field Type Analyte (mg/L)	Units	Facility-wide Background	Surface Water FBQ FBQsw-137 FBQSW-137-0303-SW FBQsw-137-0303-SW 11/04/2003 Total Regular samples	Surface Water FBQ FBQsw-138 FBQSW-138-0304-SW FBQsw-138-0304-SW 11/04/2003 Total Regular samples	Surface Water FBQ FBQsw-139 FBQSW-139-0305-SW FBQsw-139-0305-SW 11/04/2003 Total Regular samples	Surface Water FBQ FBQsw-141 FBQSW-141-0298-SW FBQsw-141-0298-SW 11/04/2003 Total Regular samples
Explosives						
2-Amino-4,6-dinitrotoluene	mg/L		0.00026 U	0.00026 U	0.00026 U	0.00026 U
4-Amino-2,6-dinitrotoluene	mg/L		0.00026 U	0.00026 U	0.00026 U	0.00026 U
Nitrocellulose	mg/L		0.75	0.26	0.42	0.61
Inorganics						
Aluminum	mg/L	3.37	0.231	0.343	0.518	2.27
Antimony	mg/L	0	0.0019 U	0.0019 U	0.0019 U	0.0019 U
Arsenic	mg/L	0.0032	0.017 B#	0.0082 B#	0.0074 B#	0.009 B#
Barium	mg/L	0.0475	0.019	0.0594 #	0.0987 #	1.03 #
Beryllium	mg/L	0	0.00016 B#	0.00034 B#	0.00036 B#	0.00032 B#
Cadmium	mg/L	0	0.0003 U	0.0003 U	0.0003 U	0.0003 U
Calcium	mg/L	41.4	9.27	8.04	12.6	37.8
Chromium	mg/L	0	0.001 B#	0.0011 B#	0.0013 B#	0.0037 #
Chromium, hexavalent	mg/L		0.03 #	0.02 #	0.01 #	0.01 U
Cobalt	mg/L	0	0.0075 #	0.0092 #	0.005 #	0.0021 #
Copper	mg/L	0.0079	0.0015 B	0.0032 B	0.0036	0.0042
Iron	mg/L	2.56	24.5 #	11 #	12.3 #	18.6 #
Lead	mg/L	0	0.0022 U	0.0033 B#	0.0025 B#	0.0044 B#
Magnesium	mg/L	10.8	4.02	3.1	4.79	7.29
Manganese	mg/L	0.391	1.38 #	1.17 #	0.91 #	11 #
Mercury	mg/L	0	0.0001 U	0.0001 U	0.0001 U	0.0001 U
Nickel	mg/L	0	0.0011 U	0.0018 B#	0.0017 B#	0.0032 B#
Potassium	mg/L	3.17	3.77 #	3.56 #	9.91 #	2.57
Silver	mg/L	0	0.0007 U	0.0007 U	0.0007 U	0.0007 U
Sodium	mg/L	21.3	0.945	1.93	1.05	3.66
Vanadium	mg/L	0	0.0023 #	0.002 #	0.0016 B#	0.0043 #
Zinc	mg/L	0.042	0.0047 B	0.0071 B	0.0087 B	0.036
Miscellaneous						
Perchlorate	mg/L		NA	NA	0.001 U	NA
Organic-Semivolatiles						
4-Methylphenol	mg/L		0.011 U	0.011 U	0.011 U	0.012 U

Table 4-13. SRCs in Surface Water at the Fuze and Booster Quarry Landfill/Ponds (continued)

Media Location Station Sample ID Customer ID Date Filtered Field Type Analyte (mg/L)	Units	Facility-wide Background	Surface Water FBQ FBQsw-137 FBQSW-137-0303-SW FBQsw-137-0303-SW 11/04/2003 Total Regular samples	Surface Water FBQ FBQsw-138 FBQSW-138-0304-SW FBQsw-138-0304-SW 11/04/2003 Total Regular samples	Surface Water FBQ FBQsw-139 FBQSW-139-0305-SW FBQsw-139-0305-SW 11/04/2003 Total Regular samples	Surface Water FBQ FBQsw-141 FBQSW-141-0298-SW FBQsw-141-0298-SW 11/04/2003 Total Regular samples
Bis(2-ethylhexyl)phthalate	mg/L		0.0022 J	0.0015 J	0.011 J	0.0017 J
Phenol	mg/L		0.011 U	0.011 U	0.011 U	0.012 U
Organic-Volatiles						
2-Butanone	mg/L		0.01 U	0.01 U	0.01 U	0.01 U
Acetone	mg/L		0.012 B	0.0083 JB	0.013 B	0.0054 JB
Carbon Disulfide	mg/L		0.005 U	0.005 U	0.00094 J	0.0018 J
Methylene Chloride	mg/L		0.0046 JB	0.0066 JB	0.0076 JB	0.0044 JB
Styrene	mg/L		0.005 U	0.005 U	0.005 U	0.005 U
Toluene	mg/L		0.011	0.0049 J	0.016	0.005 U

Table 4-13. SRCs in Surface Water at the Fuze and Booster Quarry Landfill/Ponds (continued)

Media Location Station Sample ID Customer ID Date Filtered Field Type Analyte (mg/L)	Units	Facility-wide Background	Surface Water FBQ FBQsw-145 FBQSW-145-0291-SW FBQsw-145-0291-SW 10/21/2003 Total Regular samples	Surface Water FBQ FBQsw-147 FBQSW-147-0292-SW FBQsw-147-0292-SW 10/21/2003 Total Regular samples	Surface Water FBQ FBQsw-153 FBQSW-153-0294-SW FBQsw-153-0294-SW 11/03/2003 Total Regular samples	Surface Water FBQ FBQsw-154 FBQSW-154-0293-SW FBQsw-154-0293-SW 11/03/2003 Total Regular samples
Explosives						
2-Amino-4,6-dinitrotoluene	mg/L		0.00026 U	0.00026 U	0.00026 U	0.00026 U
4-Amino-2,6-dinitrotoluene	mg/L		0.00026 U	0.00026 U	0.00026 U	0.00026 U
Nitrocellulose	mg/L		1.1	0.37	1	0.48
Inorganics						
Aluminum	mg/L	3.37	0.0177 UN	0.0236 BN	0.059 B	0.0177 U
Antimony	mg/L	0	0.0042 B#	0.0037 B#	0.0036 B#	0.0088 B#
Arsenic	mg/L	0.0032	0.0048 U	0.0048 U	0.0048 U	0.0048 U
Barium	mg/L	0.0475	0.0482 #	0.0495 #	0.0308	0.0678 #
Beryllium	mg/L	0	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Cadmium	mg/L	0	0.0003 U	0.0003 U	0.0003 U	0.0003 U
Calcium	mg/L	41.4	10.5	10.8	18	44.6 #
Chromium	mg/L	0	0.0009 B#	0.00086 B#	0.0008 U	0.00097 B#
Chromium, hexavalent	mg/L		0.01 U	0.01 U	0.01 U	0.01 U
Cobalt	mg/L	0	0.0009 U	0.0009 U	0.0009 U	0.0011 B#
Copper	mg/L	0.0079	0.0053	0.0062	0.0017 B	0.0011 B
Iron	mg/L	2.56	0.13	0.171	0.107 E	0.204 E
Lead	mg/L	0	0.0008 U	0.0008 U	0.0027 B#	0.0008 U
Magnesium	mg/L	10.8	2.64	2.68	3.73	3.9
Manganese	mg/L	0.391	0.0127	0.0155	0.0117	0.0151
Mercury	mg/L	0	0.0001 U	0.0001 U	0.0001 U	0.0001 U
Nickel	mg/L	0	0.0011 U	0.0011 U	0.0011 U	0.0011 U
Potassium	mg/L	3.17	1.15	1.17	1.82	2.49
Silver	mg/L	0	0.00092 B#	0.00074 B#	0.0007 U*	0.0007 U*
Sodium	mg/L	21.3	1.81	1.84	2.24	2.1
Vanadium	mg/L	0	0.001 U	0.001 U	0.001 U	0.0017 B#
Zinc	mg/L	0.042	0.0236	0.0251	0.0038 B	0.0033 U
Miscellaneous						
Perchlorate	mg/L		0.001 U	0.001 U	0.001 U	0.001 U
Organic-Semivolatiles						
4-Methylphenol	mg/L		0.011 U	0.011 U	0.01 U	0.011 U

Table 4-13. SRCs in Surface Water at the Fuze and Booster Quarry Landfill/Ponds (continued)

Media Location Station Sample ID Customer ID Date Filtered Field Type Analyte (mg/L)	Units	Facility-wide Background	Surface Water FBQ FBQsw-145 FBQSW-145-0291-SW FBQsw-145-0291-SW 10/21/2003 Total Regular samples	Surface Water FBQ FBQsw-147 FBQSW-147-0292-SW FBQsw-147-0292-SW 10/21/2003 Total Regular samples	Surface Water FBQ FBQsw-153 FBQSW-153-0294-SW FBQsw-153-0294-SW 11/03/2003 Total Regular samples	Surface Water FBQ FBQsw-154 FBQSW-154-0293-SW FBQsw-154-0293-SW 11/03/2003 Total Regular samples
Bis(2-ethylhexyl)phthalate	mg/L		0.0029 J	0.011 U	0.0014 JB	0.0029 JB
Phenol	mg/L		0.011 U	0.011 U	0.01 U	0.011 U
Organic-Volatiles						
2-Butanone	mg/L		0.01 U	0.01 U	0.01 U	0.01 U
Acetone	mg/L		0.011 B	0.009 JB	0.0084 JB	0.0071 JB
Carbon disulfide	mg/L		0.005 U	0.005 U	0.005 U	0.005 U
Methylene chloride	mg/L		0.0045 J	0.0047 J	0.0066 JB	0.0078 JB
Styrene	mg/L		0.005 U	0.005 U	0.005 U	0.005 U
Toluene	mg/L		0.005 U	0.005 U	0.005 U	0.005 U

Note: Data qualifiers are presented as laboratory qualifiers/validation qualifiers.
B for inorganics = Result is less than the contract-required detection limit but greater than the instrument detection limit.
B for organics = Compound is detected in the blank as well as the sample.
E = Result estimated because of the presence of interference.
J = Estimated value is less than the reporting limits.
N = Matrix spike recovery is outside the control limits.
P = Greater than 25% difference between the two GC columns.
R = Data are rejected.
U = Not detected.
# = Value is above the facility-wide background.
* = Duplicate analysis is outside the control limits.
"=" = Analyte present and concentration accurate.
Facility-wide background is determined for the Winklepeck Burning Ground Phase II Remedial Investigation (USACE 2001b).
NA = Not applicable.
PCB = Polychlorinated biphenyl.
SRC = Site-related contaminant.

Table 4-14. Summary Statistics and Determination of SRCs in Unconsolidated Groundwater Samples at the Fuze and Booster Quarry Landfill/Ponds

Analyte	Units	Results >Detection Limit	Average Result	Minimum Detect	Maximum Detect	Background Criteria	Site Related?	Justification
Dissolved Metals								
Barium	mg/L	6/ 6	0.0422	0.0196	0.0624	0.0821	No	Below Background
Cadmium	mg/L	1/ 6	0.000342	0.0013	0.0013	0	Yes	Above Background
Calcium	mg/L	6/ 6	44.8	10.3	97.4	115	No	Essential Element
Cobalt	mg/L	2/ 6	0.00415	0.0073	0.0137	0	Yes	Above Background
Copper	mg/L	1/ 6	0.00208	0.0059	0.0059	0	Yes	Above Background
Iron	mg/L	3/ 6	4.3	0.122	16.4	0.279	No	Essential Element
Magnesium	mg/L	6/ 6	15.6	3.36	32.2	43.3	No	Essential Element
Manganese	mg/L	6/ 6	2.1	0.0324	6.77	1.02	Yes	Above Background
Nickel	mg/L	3/ 6	0.00543	0.0046	0.0178	0	Yes	Above Background
Potassium	mg/L	6/ 6	1.96	0.925	2.87	2.89	No	Essential Element
Sodium	mg/L	6/ 6	13.7	3.22	34.6	45.7	No	Essential Element
Zinc	mg/L	2/ 6	0.00653	0.0129	0.0156	0.0609	No	Below Background
Organics-Explosives								
2-Amino-4,6-dinitrotoluene	mg/L	1/ 6	0.000147	0.00023	0.00023		Yes	No Background Data Available
4-Amino-2,6-dinitrotoluene	mg/L	1/ 6	0.000163	0.00033	0.00033		Yes	No Background Data Available
Nitrocellulose	mg/L	5/ 6	0.232	0.23	0.35		Yes	No Background Data Available
Organics-Semivolatile								
Bis(2-ethylhexyl)phthalate	mg/L	3/ 6	0.00153	0.0014	0.0022		Yes	No Background Data Available
Caprolactam	mg/L	3/ 6	0.017	0.014	0.036		Yes	No Background Data Available
Organics-Volatile								
1,1,1-Trichloroethane	mg/L	1/ 6	0.00305	0.0058	0.0058		Yes	No Background Data Available
1,1-Dichloroethene	mg/L	2/ 6	0.00278	0.0025	0.0042		Yes	No Background Data Available
Acetone	mg/L	1/ 4	0.0053	0.0062	0.0062		Yes	No Background Data Available
Carbon Disulfide	mg/L	1/ 6	0.00225	0.00097	0.00097		Yes	No Background Data Available

SRC = Site-related contaminant.

Table 4-15. Summary Statistics and Determination of SRCs in Bedrock Groundwater Samples at the Fuze and Booster Quarry Landfill/Ponds

Analyte	Units	Results >Detection Limit	Average Result	Minimum Detect	Maximum Detect	Background Criteria	Site Related?	Justification
Miscellaneous								
Chromium, hexavalent	mg/L	1/ 6	0.00583	0.01	0.01		Yes	No Background Data Available
Dissolved Metals								
Aluminum	mg/L	1/ 6	0.0266	0.0678	0.0678		Yes	No Background Data Available
Barium	mg/L	6/ 6	0.04	0.0201	0.0867	0.256	No	Below Background
Calcium	mg/L	6/ 6	27.6	8.93	87.2	53.1	No	Essential Element
Cobalt	mg/L	3/ 6	0.00319	0.0038	0.0093	0	Yes	Above Background
Iron	mg/L	2/ 6	1.59	3.87	5.56	1.43	No	Essential Element
Magnesium	mg/L	6/ 6	10.9	3.07	38.9	15	No	Essential Element
Manganese	mg/L	6/ 6	1	0.015	4.15	1.34	Yes	Above Background
Nickel	mg/L	2/ 6	0.0498	0.0377	0.255	0.0834	Yes	Above Background
Potassium	mg/L	6/ 6	1.38	1.04	1.88	5.77	No	Essential Element
Sodium	mg/L	6/ 6	6.54	1.54	22.3	51.4	No	Essential Element
Zinc	mg/L	4/ 6	0.0111	0.0124	0.0206	0.0523	No	Below Background
Organics-Explosives								
2,4,6-Trinitrotoluene	mg/L	2/ 6	0.0034	0.0019	0.018		Yes	No Background Data Available
2,4-Dinitrotoluene	mg/L	1/ 6	0.00016	0.00031	0.00031		Yes	No Background Data Available
2-Amino-4,6-dinitrotoluene	mg/L	2/ 6	0.00524	0.0029	0.028		Yes	No Background Data Available
4-Amino-2,6-dinitrotoluene	mg/L	2/ 6	0.0052	0.0027	0.028		Yes	No Background Data Available
Nitrobenzene	mg/L	1/ 6	0.000137	0.00017	0.00017		Yes	No Background Data Available
Nitrocellulose	mg/L	5/ 6	0.245	0.18	0.32		Yes	No Background Data Available
Organics-Semivolatile								
Bis(2-ethylhexyl)phthalate	mg/L	1/ 6	0.00155	0.0024	0.0024		Yes	No Background Data Available
Butyl benzyl phthalate	mg/L	2/ 6	0.00633	0.0025	0.014		Yes	No Background Data Available
Caprolactam	mg/L	6/ 6	0.108	0.031	0.39		Yes	No Background Data Available
Di-n-butyl phthalate	mg/L	1/ 1	0.0023	0.0023	0.0023		Yes	No Background Data Available
Organics-Volatile								
Acetone	mg/L	2/ 3	0.0057	0.0059	0.0062		Yes	No Background Data Available
Trichloroethene	mg/L	2/ 6	0.00485	0.0071	0.012		Yes	No Background Data Available

SRC = Site-related contaminant.

Table 4-16. SRCs in Unconsolidated Groundwater at the Fuze and Booster Quarry Landfill/Ponds

Media Location Station Sample ID Sample ID (Metals) Date Filtered Field Type Analyte (mg/L)	Units	Facility-wide Background	Groundwater FBQ FBQmw-166 FBQmw-166-0306-GW FBQmw-166-0307-GF 11/20/2003 Total Regular samples	Groundwater FBQ FBQmw-167 FBQmw-167-0407-GW FBQmw-167-0407-GW 11/18/2003 Total Field Duplicate	Groundwater FBQ FBQmw-167 FBQmw-167-0308-GW FBQmw-167-0309-GF 11/18/2003 Total Regular samples	Groundwater FBQ FBQmw-168 FBQmw-168-0310-GW FBQmw-168-0311-GF 11/19/2003 Total Regular samples
Explosives						
2-Amino-4,6-dinitrotoluene	mg/L		0.00026 U	0.00026 U/U	0.00026 U/U	0.00023 J/J
4-Amino-2,6-dinitrotoluene	mg/L		0.00026 U	0.00026 U/U	0.00026 U/U	0.00033 /J
Nitrocellulose	mg/L		0.18 U	0.23 /=	0.23 /=	0.25 /=
Inorganics						
Aluminum	mg/L		0.0414 B#	0.0222 B/UJ	0.0177 U/U	0.0204 B/UJ
Barium	mg/L	0.0821	0.0362	0.0608 E/=	0.0624 E/=	0.0388 /=
Cadmium	mg/L	0	0.0003 U	0.0003 U/U	0.0003 U/U	0.0003 U/U
Calcium	mg/L	115	97.4	36 E/=	37.1 E/=	41.3 /=
Cobalt	mg/L	0	0.0009 U	0.0069 /=#	0.0073 /=#	0.0034 B/UJ
Copper	mg/L	0	0.0059 #	0.0031 B/UJ	0.0027 B/UJ	0.0035 B/UJ
Iron	mg/L	0.279	0.0252 U	16.4 /=#	16.4 /=#	0.122 /=
Lead	mg/L	0	0.0015 B#	0.0015 B/UJ	0.0017 B/UJ	0.0013 B/UJ
Magnesium	mg/L	43.3	32.2	14.3 E/=	14.6 E/=	8.42 /=
Manganese	mg/L	1.02	0.0324	2.14 E/=#	2.21 E/=#	0.615 /=
Nickel	mg/L	0	0.0011 U	0.0087 /=#	0.0085 /=#	0.0046 /=#
Potassium	mg/L	2.89	0.925	2.3 /=	2.28 /=	1.79 /=
Silver	mg/L	0	0.0007 U	0.0007 U/U	0.0007 U/U	0.0007 U/U
Sodium	mg/L	45.7	14.4	34.1 /=	34.6 /=	3.22 /=
Zinc	mg/L	0.0609	0.0087 B	0.0152 /=	0.0129 /=	0.0033 U/U
Organic-Semivolatiles						
Bis(2-ethylhexyl)phthalate	mg/L		0.0035 JB	0.0026 J/J	0.0023 JB/UJ	0.0013 JB/UJ
Caprolactam	mg/L		0.036	0.014 /=	0.035 /=	0.014 /=
Organic-Volatiles						
1,1,1-Trichloroethane	mg/L		0.005 U	0.005 U/U	0.0058 /=	0.005 U/U
1,1-Dichloroethene	mg/L		0.005 U	0.005 U/U	0.0042 J/J	0.005 U/U
Acetone	mg/L		0.01 U	0.0048 JB/R	0.0056 JB/R	0.0062 J/J
Carbon Disulfide	mg/L		0.005 U	0.005 U/U	0.005 U/U	0.005 U/U
Methylene Chloride	mg/L		0.0054 JB	0.0061 JB/R	0.0066 JB/R	0.0058 JB/R

Table 4-16. SRCs in Unconsolidated Groundwater at the Fuze and Booster Quarry Landfill/Ponds (continued)

Media Location Station Sample ID Sample ID (Metals) Date Filtered Field Type Analyte (mg/L)	Units	Facility-wide Background	Groundwater FBQ FBQmw-169 FBQmw-169-0312-GW FBQmw-169-0313-GF 11/18/2003 Total Regular samples	Groundwater FBQ FBQmw-176 FBQmw-176-0326-GW FBQmw-176-0327-GF 11/10/2003 Total Regular samples	Groundwater FBQ FBQmw-177 FBQmw-177-0328-GW FBQmw-177-0329-GF 11/10/2003 Total Regular samples
Explosives					
2-Amino-4,6-dinitrotoluene	mg/L		0.00026 U/U	0.00026 U	0.00026 U
4-Amino-2,6-dinitrotoluene	mg/L		0.00026 U/U	0.00026 U	0.00026 U
Nitrocellulose	mg/L		0.24 /=	0.35	0.23
Inorganics					
Aluminum	mg/L		0.0427 B/UJ	0.0177 U	0.0177 U
Barium	mg/L	0.0821	0.0538 E/=	0.0423	0.0196
Cadmium	mg/L	0	0.0013 /=#	0.0003 U	0.0003 U
Calcium	mg/L	115	36.9 E/=	10.3	45.8
Cobalt	mg/L	0	0.0137 /=#	0.0026 B#	0.0009 U
Copper	mg/L	0	0.0027 B/UJ	0.0025 B#	0.0018 B#
Iron	mg/L	0.279	0.1 B/UJ	9.23 #	0.0252 U
Lead	mg/L	0	0.0026 B/UJ	0.0012 B#	0.0015 B#
Magnesium	mg/L	43.3	22.7 E/=	3.36	12.6
Manganese	mg/L	1.02	6.77 E/=#	1.54 #	1.46 #
Nickel	mg/L	0	0.0178 /=#	0.0011 U	0.0011 U
Potassium	mg/L	2.89	2.87 /=	1.59	2.28
Silver	mg/L	0	0.0011 B/UJ	0.0011 B#	0.0007 U
Sodium	mg/L	45.7	22.1 /=	3.47	4.57
Zinc	mg/L	0.0609	0.0156 /=	0.0061 B	0.0033 U
Organic-Semivolatiles					
Bis(2-ethylhexyl)phthalate	mg/L		0.002 J/J	0.0014 J	0.0022 J
Caprolactam	mg/L		0.011 U/U	0.012 U	0.011 U
Organic-Volatiles					
1,1,1-Trichloroethane	mg/L		0.005 U/U	0.005 U	0.005 U
1,1-Dichloroethene	mg/L		0.0025 J/J	0.005 U	0.005 U
Acetone	mg/L		0.006 JB/R	0.01 U	0.01 U
Carbon Disulfide	mg/L		0.005 U/U	0.005 U	0.00097 J
Methylene Chloride	mg/L		0.0057 JB/R	0.005 JB	0.0053 JB

Table 4-16. SRCs in Unconsolidated Groundwater at the Fuze and Booster Quarry Ponds/Landfill (continued)

Note: Data qualifiers are presented as laboratory qualifiers/validation qualifiers.
B for inorganics = Result is less than the contract-required detection limit but greater than the instrument detection limit.
B for organics = Compound is detected in the blank as well as the sample.
E = Result estimated because of the presence of interference.
J = Estimated value is less than the reporting limits.
N = Matrix spike recovery is outside the control limits.
P = Greater than 25% difference between the two GC columns.
R = Data are rejected.
U = Not detected.
# = Value is above the facility-wide background.
* = Duplicate analysis is outside the control limits.
“=” = Analyte present and concentration accurate.
Facility-wide background is determined for the Winklepeck Burning Ground Phase II Remedial Investigation (USACE 2001b).
NA = Not applicable.
PCB = Polychlorinated biphenyl.
SRC = Site-related contaminant.

Table 4-17. SRCs in Bedrock Groundwater at the Fuze and Booster Quarry Landfill/Ponds

Media Location Station Sample ID Sample ID (Metals) Date Filtered Field Type Analyte (mg/L)	Units	Facility-wide Background	Groundwater FBQ FBQmw-170 FBQmw-170-0314-GW FBQmw-170-0315-GF 11/12/2003 Total Regular samples	Groundwater FBQ FBQmw-171 FBQmw-171-0316-GW FBQmw-171-0317-GF 11/12/2003 Total Regular samples	Groundwater FBQ FBQmw-172 FBQmw-172-0408-GW FBQmw-172-0408-GW 11/19/2003 Total Field Duplicate	Groundwater FBQ FBQmw-172 FBQmw-172-0318-GW FBQmw-172-0319-GF 11/19/2003 Total Regular samples
Explosives						
2,4,6-Trinitrotoluene	mg/L		0.00026 U/U	0.00026 U/U	0.00026 U/U	0.00026 U/U
2,4-Dinitrotoluene	mg/L		0.00026 U/U	0.00026 U/U	0.00026 U/U	0.00026 U/U
2-Amino-4,6-dinitrotoluene	mg/L		0.00026 U/U	0.00026 U/U	0.00026 U/U	0.00026 U/U
4-Amino-2,6-dinitrotoluene	mg/L		0.00026 U/U	0.00026 U/U	0.00026 U/U	0.00026 U/U
Nitrobenzene	mg/L		0.00026 U/U	0.00026 U/U	0.00026 U/U	0.00026 U/U
Nitrocellulose	mg/L		0.29 /=	0.31 /=	0.18 U/U	0.18 U/U
Inorganics						
Aluminum	mg/L		0.0678 /=#	0.0597 B/UJ	0.0179 B/UJ	0.0214 B/UJ
Barium	mg/L	0.256	0.0374 /=	0.0337 /=	0.0828 /J	0.0867 /J
Calcium	mg/L	53.1	14.5 /=	18.5 /=	86.2 /J#	87.2 /J#
Chromium, hexavalent	mg/L		0.01 /=#	0.01 U/U	0.01 U/U	0.01 U/U
Cobalt	mg/L	0	0.0004 U/U	0.0004 U/U	0.0033 B/UJ	0.0038 /=#
Copper	mg/L	0	0.0008 U/U	0.0008 U/U	0.0041 /UJ	0.0036 /UJ
Iron	mg/L	1.43	0.115 B/UJ	0.0405 U/U	3.65 /J#	3.87 /J#
Lead	mg/L	0	0.0022 U/U	0.0022 U/U	0.0012 B/UJ	0.0008 U/U
Magnesium	mg/L	15	4.14 /=	6.02 /=	38 /J#	38.9 /J#
Manganese	mg/L	1.34	0.14 /=	0.0596 /=	4.06 /J#	4.15 /J#
Nickel	mg/L	0.0834	0.0033 B/UJ	0.0022 B/UJ	0.0047 /=	0.0039 B/UJ
Potassium	mg/L	5.77	1.66 /=	1.04 /=	1 /J	1.05 /J
Sodium	mg/L	51.4	22.3 /=	1.54 /=	6.21 /J	6.69 /J
Zinc	mg/L	0.0523	0.0126 /=	0.0129 /=	0.0096 B/UJ	0.0069 B/UJ
Organic-Semivolatiles						
Bis(2-ethylhexyl)phthalate	mg/L		0.0026 JB/UJ	0.0014 JB/UJ	0.0032 JB/UJ	0.0042 JB/UJ
Butyl benzyl phthalate	mg/L		0.014 /=	0.0025 J/J	0.012 U/UJ	0.011 U/UJ
Caprolactam	mg/L		0.099 /=	0.042 /=	0.036 /=	0.046 /=
Di-n-butyl phthalate	mg/L		0.0033 J/R	0.0026 J/R	0.012 U/R	0.011 U/R
Organic-Volatiles						
Acetone	mg/L		0.0067 JB/R	0.0053 JB/R	0.0067 J/J	0.0059 J/J
Methylene Chloride	mg/L		0.0051 JB/R	0.0064 JB/R	0.0064 JB/R	0.0075 JB/R
Trichloroethene	mg/L		0.012 /=	0.0071 /=	0.005 U/U	0.005 U/U

Table 4-17. SRCs in Bedrock Groundwater at the Fuze and Booster Quarry Landfill/Ponds (continued)

Media Location Station Sample ID Sample ID (Metals) Date Filtered Field Type Analyte (mg/L)	Units	Facility-wide Background	Groundwater FBQ FBQmw-173 FBQmw-173-0320-GW FBQmw-173-0321-GF 11/20/2003 Total Regular samples	Groundwater FBQ FBQmw-174 FBQmw-174-0322-GW FBQmw-174-0323-GF 11/18/2003 Total Regular samples	Groundwater FBQ FBQmw-175 FBQmw-175-0324-GW FBQmw-175-0325-GF 11/19/2003 Total Regular samples
Explosives					
2,4,6-Trinitrotoluene	mg/L		0.0019	0.018 /=	0.00026 U/U
2,4-Dinitrotoluene	mg/L		0.00026 U	0.00031 /=	0.00026 U/U
2-Amino-4,6-dinitrotoluene	mg/L		0.0029	0.028 /=	0.00026 U/U
4-Amino-2,6-dinitrotoluene	mg/L		0.0027	0.028 /J	0.00026 U/U
Nitrobenzene	mg/L		0.00017 J	0.00026 U/U	0.00026 U/U
Nitrocellulose	mg/L		0.28	0.18 /=	0.32 /=
Inorganics					
Aluminum	mg/L		0.0339 B#	0.0463 B/UJ	0.0227 B/UJ
Barium	mg/L	0.256	0.0377	0.0201 E/=	0.0243 /=
Calcium	mg/L	53.1	20.3	8.93 E/=	16.1 /=
Chromium, hexavalent	mg/L		0.01 U	0.01 U/U	0.01 U/U
Cobalt	mg/L	0	0.0052 #	0.0009 U/U	0.0093 /=#
Copper	mg/L	0	0.0035 B#	0.0026 B/UJ	0.0051 /UJ
Iron	mg/L	1.43	5.56 #	0.0252 U/U	0.0252 U/U
Lead	mg/L	0	0.0018 B#	0.0008 U/U	0.0008 U/U
Magnesium	mg/L	15	6.26	3.07 E/=	6.96 /=
Manganese	mg/L	1.34	1.43 #	0.015 E/=	0.216 /=
Nickel	mg/L	0.0834	0.255 #	0.0029 B/UJ	0.0377 /=
Potassium	mg/L	5.77	1.88	1.23 /=	1.4 /=
Sodium	mg/L	51.4	3.41	2.24 /=	3.07 /=
Zinc	mg/L	0.0523	0.0093 B	0.0206 /=	0.0124 /=
Organic-Semivolatiles					
Bis(2-ethylhexyl)phthalate	mg/L		0.0032 JB	0.0024 J/J	0.0024 JB/UJ
Butyl benzyl phthalate	mg/L		0.011 U	0.01 U/U	0.011 U/UJ
Caprolactam	mg/L		0.041	0.031 /=	0.39 /=
Di-n-butyl phthalate	mg/L		0.0023 J	0.01 U/R	0.011 U/R
Organic-Volatiles					
Acetone	mg/L		0.01 U	0.0068 JB/R	0.0062 J/J
Methylene Chloride	mg/L		0.0058 JB	0.0058 JB/R	0.0066 JB/R
Trichloroethene	mg/L		0.005 U	0.005 U/U	0.005 U/U

Table 4-17. SRCs in Bedrock Groundwater at the Fuze and Booster Quarry Ponds/Landfill (continued)

Note: Data qualifiers are presented as laboratory qualifiers/validation qualifiers.
B for inorganics = Result is less than the contract-required detection limit but greater than the instrument detection limit.
B for organics = Compound is detected in the blank as well as the sample.
E = Result estimated because of the presence of interference.
J = Estimated value is less than the reporting limits.
N = Matrix spike recovery is outside the control limits.
P = Greater than 25% difference between the two GC columns.
R = Data are rejected.
U = Not detected.
# = Value is above the facility-wide background.
* = Duplicate analysis is outside the control limits.
"=" = Analyte present and concentration accurate.
Facility-wide background is determined for the Winklepeck Burning Ground Phase II Remedial Investigation (USACE 2001b).
NA = Not applicable.
PCB = Polychlorinated biphenyl.
SRC = Site-related contaminant.

4.3 SURFACE SOIL

4.3.1 Explosives and Propellants

FBQ

Nine explosive/propellant compounds were detected at least once in surface soil samples collected during the Phase II RI. Table 4-2 presents a statistical summary of analytical results for all detected explosive/propellant compounds in surface soils. Table 4-4 presents the explosive and propellant SRCs detected in surface soil by sample location. Complete laboratory results for explosive/propellant testing in surface soil are presented in Appendix H, Table H-1. Of the detected compounds, nitrocellulose was detected with the most frequency, occurring in 6 of 8 (75%) of the surface soil samples. The remaining explosive/propellant compounds detected were 2,4,6-TNT (11 of 60 samples); nitrobenzene (4 of 60 samples); 2-amino-4,6-dinitrotoluene (DNT) (9 of 60 samples); 4-amino-2,6-DNT (9 of 60 samples); 1,3,5-trinitrobenzene (TNB) (6 of 60 samples); 2,4-DNT (4 of 60 samples); 2,6-DNT (2 of 60 samples); and RDX (1 of 60 samples). The distribution of detected explosives and propellants in surface soil at FBQ is shown in Figure 4-1.

40-mm Firing Range

Seven explosive/propellant compounds were detected at least once in surface soil samples collected during the Phase II RI. Of the detected compounds, nitrocellulose was detected with the most frequency, occurring in 4 of 4 (100%) of the surface soil samples. The remaining explosive/propellant compounds detected were 2,4,6-TNT (1 of 40 samples); nitrobenzene (4 of 40 samples); 2,4-DNT (1 of 40 samples); HMX (1 of 40 samples); 3-nitrotoluene (1 of 40 samples); and tetryl (1 of 30 samples). The distribution of detected explosives and propellants in surface soil at the 40-mm Range is shown in Figure 4-1.

4.3.2 Inorganic Constituents

A total of 23 inorganic compounds were detected at least once in surface soil samples collected during the Phase II RI, 19 of which were identified as SRCs. Five of the detected constituents were eliminated as potential surface soil SRCs because they were considered essential nutrients (calcium, iron, magnesium, sodium, and potassium). The maximum detected concentrations for aluminum, antimony, arsenic, barium, beryllium, chromium, cobalt, copper, lead, manganese, mercury, nickel, selenium, thallium, vanadium, and zinc exceeded their respective background criteria and were retained as SRCs for either FBQ, 40-mm Firing Range, or both. Cadmium, hexavalent chromium, and silver were also retained as SRCs because the background criteria for the constituents were set to zero.

Summary statistics for inorganic SRCs are in Table 4-2 for FBQ and Table 4-3 for the 40-mm Firing Range. A complete listing of the surface soil inorganic SRCs are in Table 4-4 for FBQ and Table 4-5 for the 40-mm Firing Range. Complete laboratory results for inorganics in surface soil is presented in Appendix H, Table H-2. Surface soil sample locations are shown in Figure 3-1 and the distribution of detected inorganics in the surface soil samples is shown in Figure 4-2.

FBQ

Seventeen inorganic compounds were detected above background in surface soil samples collected from the FBQ area. These compounds are listed below, along with how many times the compound was

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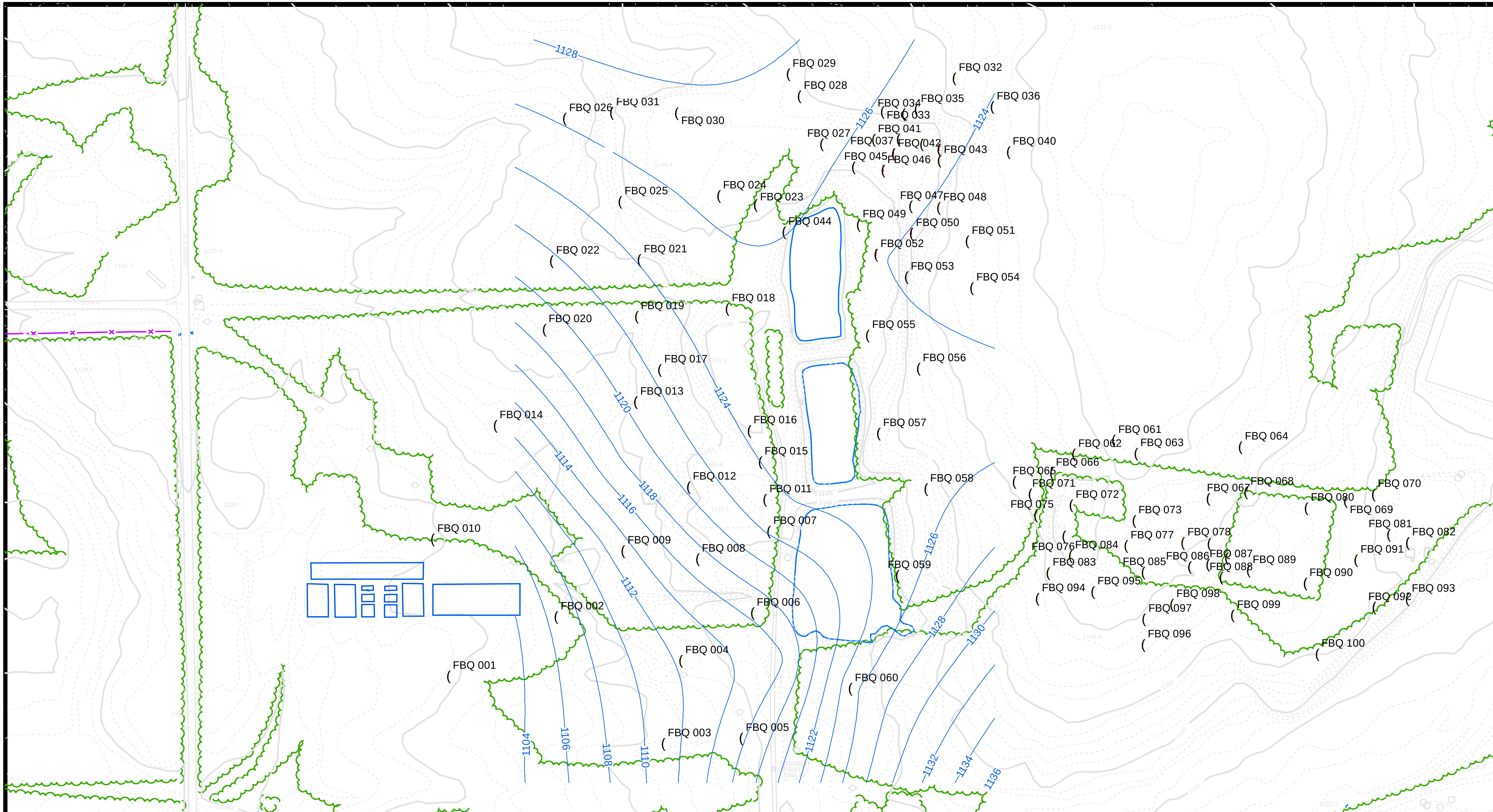

Legend

Road
Vegetation
Water
2 Ft. Contour
10 Ft. Contour
Settling Basins
Telephone Pole

Number Detected of Explosives and Propellants

(0
(1 - 3
(> 3

0 100 200 400 600 800 Feet

An Employee-Owned Company

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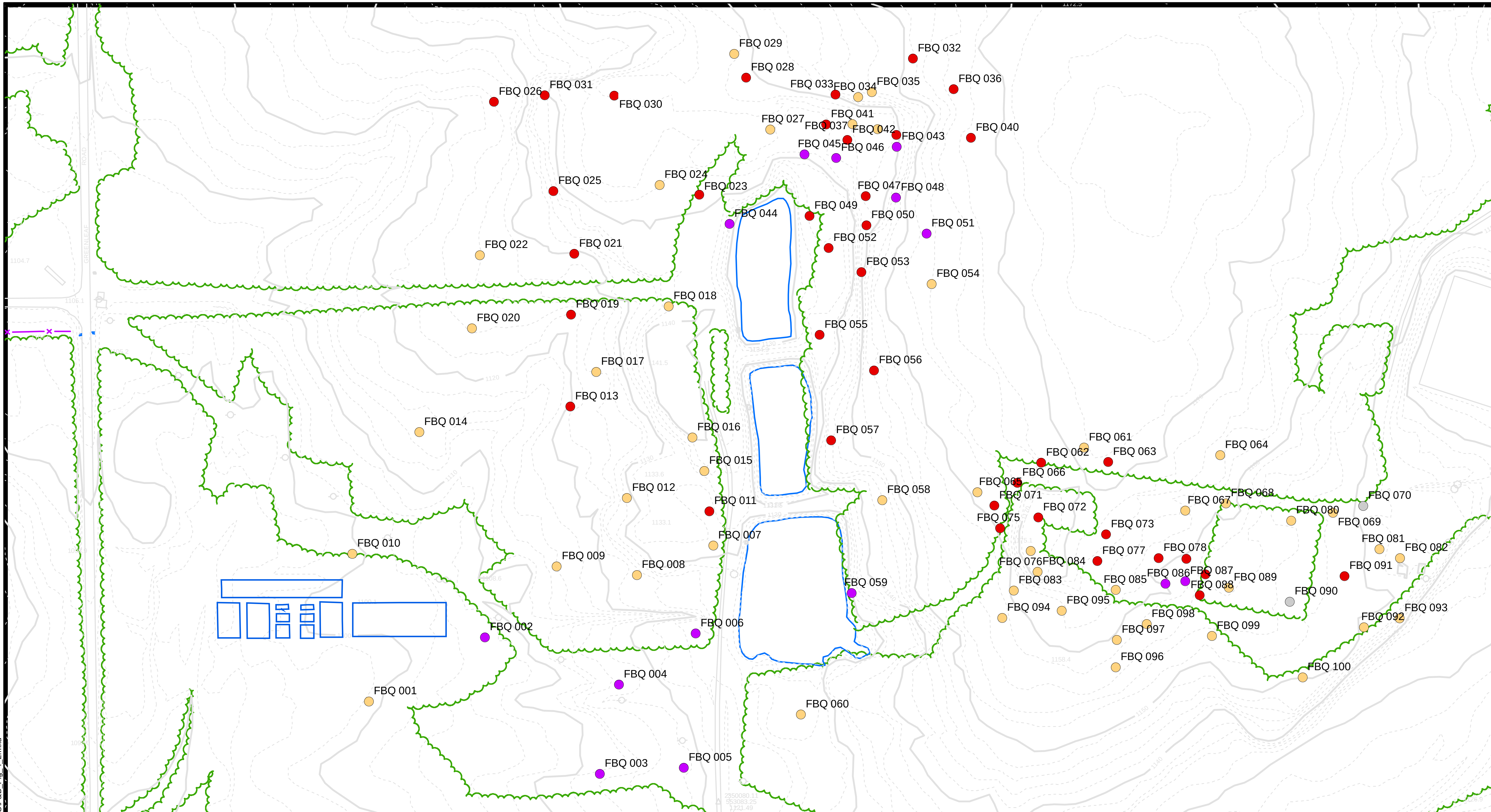
Figure 4-1

Distribution of Detected Explosives and Propellants in Surface Soil Samples

Drawn By: HRA

CAD FILES: R31718/R31617/R21718/R21617

Date: 8/18/05



Legend

- Road
- Vegetation
- Water
- 2 Ft. Contour
- 10 Ft. Contour
- Settling Basins
- Telephone Pole

Inorganic SRCs Above Background Levels

- 0
- 1 - 5
- 6 - 9
- > 10

0 100 200 400 600 800 Feet

An Employee-Owned Company

Distribution of Detected Inorganics Above Background Levels in Surface Soil Samples

Drawn By: HRA

CAD FILES: R31718/R31617/R21718/R21617

Figure 4-2

Date: 8/18/05

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detected above background from the 60 samples collected (except where noted), and the sample location where the highest concentration was measured:

- Antimony – 14 , FBQ-034 (74.4 mg/kg);
- Arsenic – 9, FBQ-044 (27.1 mg/kg);
- Barium – 11, FBQ-044 (1070 mg/kg);
- Beryllium – 8, FBQ-045 (1.5 mg/kg);
- Cadmium – 32, FBQ-044 (4 mg/kg);
- Chromium – 19, FBQ-044 (88.9 mg/kg);
- Hexavalent chromium – 7 out of 8 samples, FBQ-018 (6.8 mg/kg);
- Cobalt – 27, FBQ-044 (36.8 mg/kg);
- Copper – 25, FBQ-044 (559 mg/kg);
- Lead – 20, FBQ-044 (887 mg/kg);
- Mercury – 12, FBQ-059 (1.2 mg/kg);
- Manganese – 2, FBQ-002 (2310 mg/kg);
- Nickel – 8, FBQ-044 (85.4 mg/kg);
- Selenium – 17, FBQ-044 (7.9 mg/kg);
- Silver – 1, FBQ-021 (0.26 mg/kg);
- Vanadium – 1, FBQ-044 (36 mg/kg); and
- Zinc – 35, FBQ-044 (1330 mg/kg).

The following surface soil sample locations at FBQ had 10 or more surface soil inorganic SRCs detected above background: FBQ-044 and 045.

40-mm Firing Range

Thirteen inorganic compounds were detected above background in surface soil samples collected from the 40-mm Firing Range area. These compounds are listed below, along with how many times the compound was detected above background from the 40 samples collected (except where noted), and the sample location where the highest concentration was measured:

- Aluminum – 1, FBQ-087 (21000 mg/kg);
- Arsenic – 6, FBQ-086 (20.5 mg/kg);
- Barium – 9, FBQ-081 (144 mg/kg);
- Beryllium – 3, FBQ-091 (1.0 mg/kg);
- Cadmium – 20, FBQ-072 (0.87 mg/kg);
- Chromium – 18, FBQ-095 (429 mg/kg);
- Cobalt – 12, FBQ-071 (13 mg/kg);
- Copper – 15, FBQ-072 (68.6 mg/kg);
- Lead – 1, FBQ-091 (49.5 mg/kg);
- Nickel – 6, FBQ-078 (28.2 mg/kg);
- Thallium – 6, FBQ-072 (2.6 mg/kg);
- Vanadium – 3, FBQ-087 (34.1 mg/kg); and
- Zinc – 13, FBQ-072 (114 mg/kg).

4.3.3 SVOCs, VOCs, Pesticides, and PCBs

SVOCs

A total of 66 SVOCs were analyzed for in eight surface soil samples collected from FBQ and four surface soil samples collected from the 40-mm Firing Range during the Phase I/II RI. The following SVOCs were detected at FBQ:

- Benzo(*a*)anthracene, benzo(*a*)pyrene, benzo(*b*)fluoranthene, benzo(*k*)fluoranthene, chrysene, and pyrene at FBQ-060.
- Fluoranthene at FBQ-017 and FBQ-060.

Only bis(2-ethylhexyl) phthalate and diethyl phthalate were detected at FBQ-098 in the 40-mm Firing Range area.

Appendix H, Table H-4 lists the laboratory results for SVOCs in surface soil samples. Table 4-2 presents a statistical summary of analytical results for all detected SVOCs in surface soil for FBQ. Table 4-3 presents a statistical summary of analytical results for all detected SVOCs in surface soil for the 40-mm Firing Range. All SVOCs detected in surface soil are presented in Table 4-4 for FBQ and Table 4-5 for the 40-mm Firing Range.

VOCs

A total of 37 VOCs were analyzed for in 12 surface soil samples collected during the Phase I/II RI. Methylene chloride (one of four samples); acetone (one of four samples); trichloroethene (TCE) (two of eight samples); toluene (one of four samples); carbon disulfide (one of eight samples); 1,1,1-trichloethane (one of four samples); and 1,1-dichloroethene (DCE) (one of three samples) were detected. Low levels of methylene chloride and acetone are often seen as common laboratory contaminants. The laboratory refers to them as such, and these low levels are usually discarded as laboratory contamination in the review of data. For this project, acetone was quantified at a reporting limit of 10 μg/kg even though the QAPP only requires a reporting limit of 20 μg/kg. More than 75% of the acetone values reported as lab contamination are less than 20 μg/kg. The laboratory attempted to reach the lowest possible levels of quantification (less than required) and in doing so is identifying low levels of contamination. By stressing the importance of proper receipt and storage of soil samples in the laboratory separate from organic extractions as well as higher-grade reagents, and better cleaning between samples with higher levels and low level soil samples with little or no contamination, the laboratory expects to be able to achieve their standard reporting limit with little or no contamination. Appendix H, Table H-5 lists the laboratory results for VOCs in surface soil samples. Table 4-2 presents a summary of analytical results for all detected VOCs in surface soil for FBQ. Table 4-3 presents a summary of analytical results for all detected VOCs in surface soil for the 40-mm Firing Range.

Pesticides and PCBs

A total of 22 pesticides and 7 PCB compounds (aroclors) were analyzed for in 12 surface soil samples collected from FBQ and 40-mm Firing Range. No PCB compounds were detected in these samples. The following pesticides were detected in this investigation:

- 4,4'-DDE at FBQ-009 and -029 (FBQ), and FBQ-083 (40-mm Firing Range)
- Aldrin, endrin aldehyde, endrin ketone, gamma-BHC (Lindane), and heptachlor at FBQ-083 (40-mm Firing Range).

Appendix H, Table H-3 lists the laboratory results for pesticides and PCBs in surface soil samples. Table 4-2 presents a statistical summary of analytical results for all detected pesticides and PCBs in surface soil at the FBQ. Table 4-3 presents a statistical summary of analytical results for all detected pesticides and PCBs in surface soil at the 40-mm Firing Range.

4.4 SUBSURFACE SOIL

4.4.1 Explosives and Propellants

Subsurface soil samples collected from 37 locations at FBQ and 26 locations at the 40-mm Firing Range were analyzed for explosives and propellants during the FBQ Phase I/II RI. At FBQ, the following explosive/propellant compounds were detected: nitrobenzene at 8 of 37 locations (maximum concentration of 0.1 mg/kg at FBQ-009) and nitrocellulose at 4 of 5 locations (maximum concentration of 110 mg/kg at FBQ-003). At the 40-mm Firing Range area, the following explosive/propellant compounds were detected: 3-nitrotoluene was detected in 1 of 26 samples (FBQ-067, 0.098 mg/kg), nitrobenzene was detected in 3 of 26 samples (maximum concentration of 0.07 mg/kg at FBQ-077), and nitrocellulose was detected in 3 of 3 samples (maximum concentration of 59 mg/kg at FBQ-079). Table 4-6 presents summary statistics for all detected explosive and propellant compounds in subsurface soil for FBQ. Table 4-7 presents summary statistics for all detected explosive and propellant compounds in subsurface soil for the 40-mm Firing Range. Table 4-8 presents the SRCs by sample location for the subsurface soil samples for FBQ. Table 4-9 presents the SRCs by sample location for the subsurface soil samples at the 40-mm Firing Range. Complete laboratory results for explosives and propellants in subsurface soil are presented in Appendix H, Table H-6. The distribution of explosives/propellant compounds in subsurface soil is shown in Figure 4-3.

4.4.2 Inorganic Constituents

Subsurface soil samples collected from 63 stations were analyzed for inorganic elements. In addition, five subsurface soil samples were analyzed for hexavalent chromium. A total of 23 inorganics (including hexavalent chromium) were detected at least once in these samples. Eight of these inorganics were eliminated as potential SRCs because they are normally considered essential nutrients (calcium, iron, magnesium, potassium, and sodium); the frequency of detection was less than 5% (mercury); or there were no detections above the background criteria (manganese and nickel). The remaining 15 inorganic constituents were classified as SRCs; these constituents are further summarized on Table 4-6 for FBQ and Table 4-7 for the 40-mm Firing Range. Complete laboratory results for inorganics in subsurface soil are presented in Appendix H, Table H-7. Subsurface soil sample locations are shown in Figure 3-1 and the distribution of detected inorganics in the subsurface soil samples is shown in Figure 4-4.

FBQ

Thirteen inorganic compounds were detected above background in subsurface soil samples collected from FBQ. These compounds are listed below, along with how many times the compound was detected above background from the 37 samples collected (except where noted), and the sample location where the highest concentration was measured:

- Aluminum – 5, FBQ-021 (20900 mg/kg);
- Antimony – 2, FBQ-059 (1.9 mg/kg);
- Arsenic – 5, FBQ-026 (24.6 mg/kg);
- Barium – 1, FBQ-010 (151 mg/kg); and
- Beryllium – 9, FBQ-021 (1.2 mg/kg).

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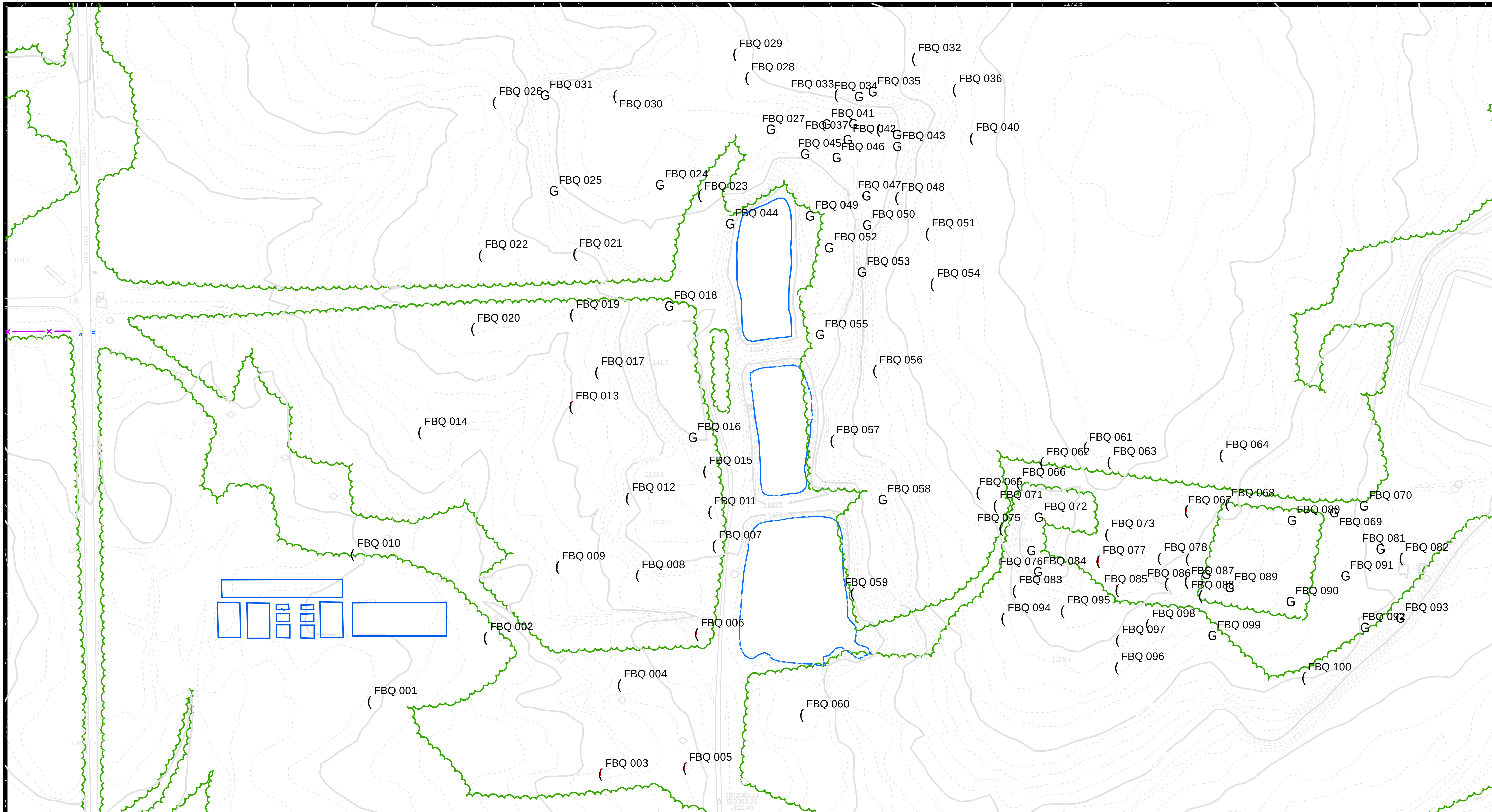


Legend

Road
Vegetation
Water
2 Ft. Contour
10 Ft. Contour
Settling Basins
Telephone Pole

Number of Detected Explosives & Propellants

(0
(=> 1
G Not Sampled (please refer to Table 3.1)

0 100 200 400 600 800 Feet

An Employee-Owned Company

O

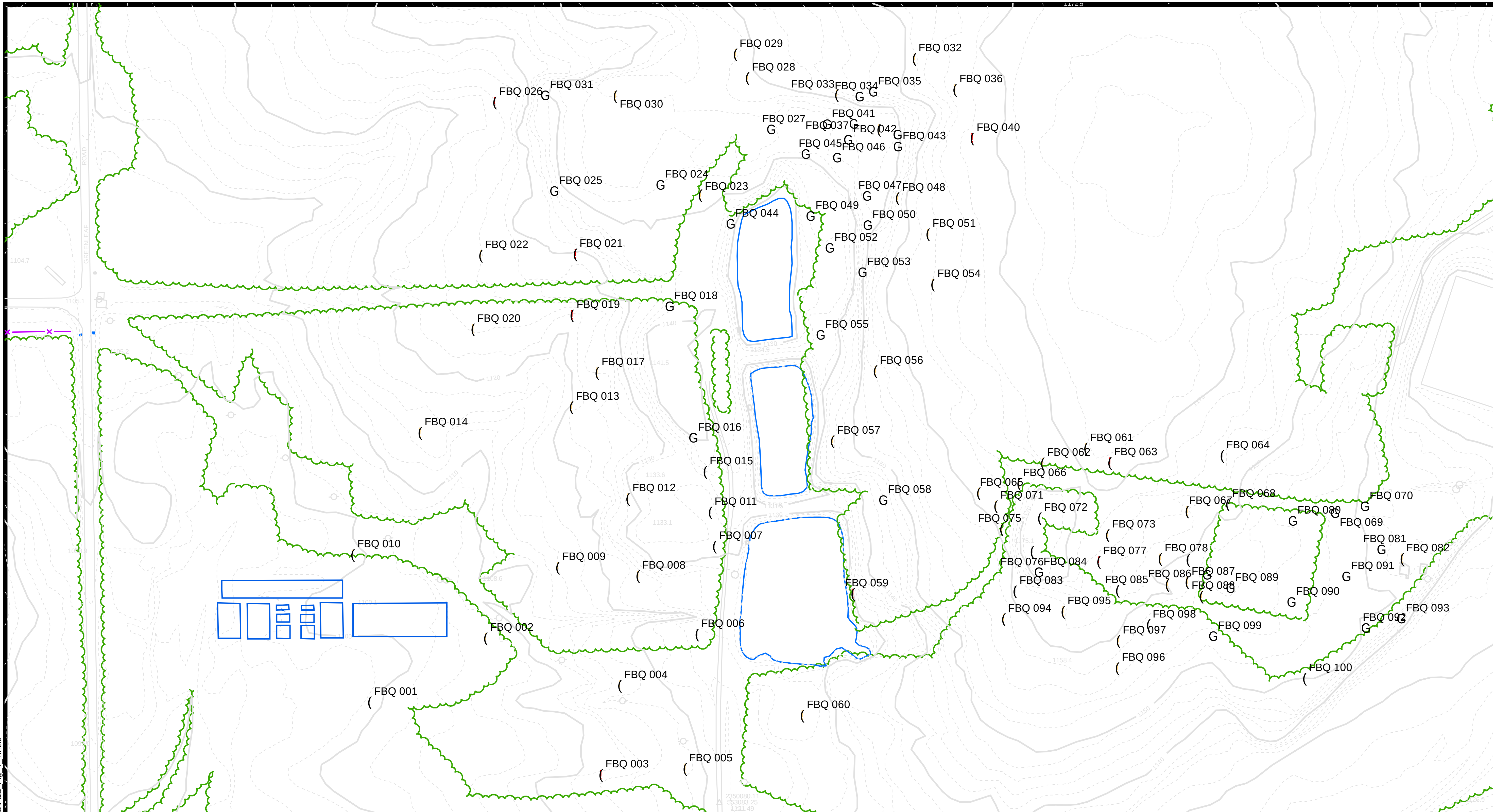
Figure 4-3

Distribution of Detected Explosives and Propellants In Subsurface Soil Samples

Drawn By: HRA

CAD FILES: R31718/R31617/R21718/R21617

Date: 8/18/05



Legend

Road
Vegetation
Water
2 Ft. Contour
10 Ft. Contour
Settling Basins
Telephone Pole

Inorganic SRCs Above Background Levels

(0
(1 - 3
(>= 4
G Not Sampled (please refer to Table 3-1)

0 100 200 400 600 800 Feet

An Employee-Owned Company

O

Distribution of Detected Inorganics Above Background Levels in Subsurface Soil Samples

Drawn By: HRA

CAD FILES: R31718/R31617/R21718/R21617

Figure 4-4

Date: 8/18/05

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- Cadmium – 10, FBQ-059 (0.72 mg/kg);
- Chromium – 3, FBQ-012 (283 mg/kg);
- Hexavalent chromium – 2 out of 5 samples, FBQ-009 (7.9 mg/kg);
- Lead – 5, FBQ-059 (116 mg/kg);
- Mercury – 1, FBQ-059 (0.76 mg/kg);
- Selenium – 8, FBQ-019 (3.1 mg/kg);
- Vanadium – 1, FBQ-021 (40.3 mg/kg); and
- Zinc – 1, FBQ-059 (156 mg/kg).

The following sample locations at FBQ had four or more subsurface soil inorganic SRCs detected above background: FBQ- 019, -021, -040, and -059.

40-mm Firing Range

Nine inorganic compounds were detected above background in subsurface soil samples collected from the 40-mm Firing Range area. These compounds are listed below, along with how many times the compound was detected above background from the 26 samples collected (except where noted), the sample location where the highest concentration was measured:

- Aluminum – 1, FBQ-063 (19600 mg/kg);
- Arsenic – 7, FBQ-077 (30.3 mg/kg);
- Beryllium – 5, FBQ-063 (1.2 mg/kg);
- Cadmium – 3, FBQ-075 (0.22 mg/kg);
- Chromium – 1, FBQ-063 (27.7 mg/kg);
- Cobalt – 1, FBQ-061 (23.8 mg/kg);
- Copper – 1, FBQ-075 (36.5 mg/kg);
- Lead – 1, FBQ-077 (36.1 mg/kg); and
- Thallium – 6, FBQ-062 (2.8 mg/kg).

The following sample locations had 4 or more subsurface soil inorganic SRCs detected above background in the 40-mm Firing Range area: FBQ-062, -063, -077, and -095.

4.4.3 SVOCs, VOCs, Pesticides, and PCBs

SVOCs

A total of 66 SVOCs were analyzed in eight subsurface soil samples during the Phase I/II RI. No SVOCs were detected. Appendix H, Table H-9 lists the laboratory results for SVOCs in subsurface soil samples.

VOCs

A total of 37 VOCs were analyzed in 8 subsurface soil samples for the Phase I/II RI. Methylene chloride was detected at two of three sample locations at FBQ, with a maximum concentration of 0.018 mg/kg. Carbon disulfide was detected at four of eight locations, concentrations ranging from 0.0031 to 0.087 mg/kg; m,p-Xylenes (0.0051 mg/kg); 1,2-dimethylbenzene (0.002 mg/kg); and toluene (0.0036 mg/kg) were detected at FBQ-083. TCE was only detected at FBQ- 003 at 0.0028 mg/kg. Appendix H, Table H-10 lists the laboratory results for VOCs in subsurface soil samples. Table 4-6 presents a summary of analytical results for all detected VOCs in subsurface soil at the FBQ. Table 4-7 presents a summary of analytical results for all detected VOCs in subsurface soil at the 40-mm Firing Range.

Pesticides and PCBs

Seven PCBs (Aroclors) and 22 pesticides were analyzed for in eight subsurface soil samples. No PCB compounds or pesticides were detected in the samples. Appendix H, Table H-8 lists the laboratory results for pesticides and PCBs in subsurface soil samples.

4.5 SEDIMENT

Sediment samples were collected at depths of 0.0 to 0.2 m (0 to 0.5 ft) at 40 locations at FBQ during the Phase I/II RI to determine the nature and extent of contamination (Figures 3-3 and 3-4). The sample locations lie within drainage ditches, the three Quarry Ponds, and the smaller settling basins. Sediment samples were analyzed for explosives, propellants, inorganics, hexavalent chromium, VOCs, SVOCs, PCBs/pesticides, and Total Organic Carbon (TOC). Grain size analysis was not performed.

The complete analytical results for the sediment samples are presented by sample location and analyte in Appendix H. Table 4-10 presents the summary statistics and determination of SRCs in sediment. SRCs in sediment samples are presented in Table 4-11. Complete laboratory analytical results for sediment are presented in Appendix H, Tables H-11 through H-15. The following sections describe major findings from the Phase I/II RI, as well as the distribution of explosives, propellants, inorganic, and organic constituents in sediment at the FBQ AOC.

4.5.1 Total Organic Carbon Results

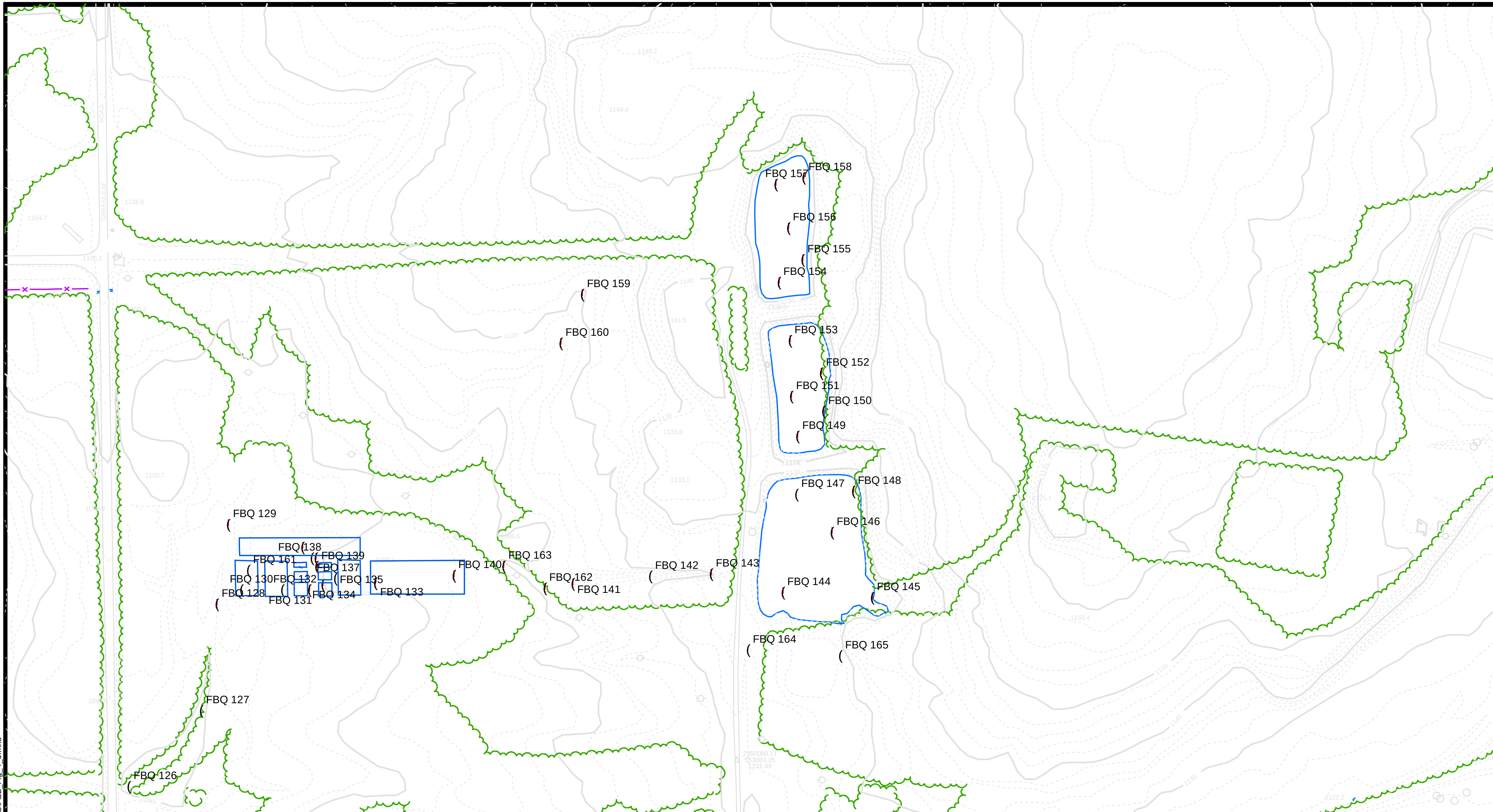
Sediment samples from all 40 locations were analyzed for TOC. All of the sediment samples were disturbed (grab) samples. The TOC results are statistically summarized in Table 4-10 and are presented in Table 4-11 and Appendix H, Table H-15. The highest TOC concentration (120,000 mg/kg) was detected at station FBQ-156.

4.5.2 Explosives and Propellants

Eleven explosive/propellant compounds were detected at least once at 29 of the 40 sediment sample locations during the Phase I/II RI. A summary of the detected explosive/propellant compounds in sediment samples with the number of times the compound was detected and the location of the highest concentration follows:

- 1,3,5-TNB – 1, FBQ-134 (0.098 mg/kg);
- 1,3-Dinitrobenzene (DNB) – 1, FBQ-134 (0.11 mg/kg);
- 2,4,6-TNT – 5, FBQ-146 (0.3 mg/kg);
- 2,6-DNT – 1, FBQ-139 (0.085 mg/kg);
- 2-Amino-4,6-DNT – 1, FBQ-155 (0.073 mg/kg);
- 4-Amino-2,6-DNT – 3, FBQ-146 (0.39 mg/kg);
- HMX – 2, FBQ-146 (0.16 mg/kg);
- 3-Nitrotoluene – 3, FBQ-162 (0.15 mg/kg);
- Nitrobenzene – 7, FBQ-144 (0.11 mg/kg);
- Nitrocellulose – 23, FBQ-129 (110 mg/kg); and
- Nitroglycerine – 1, FBQ-156 (49 mg/kg).

The distribution of detected explosive/propellant compounds in sediment is presented in Figure 4-5.



Legend

- Road
- Vegetation
- Water
- 2 Ft. Contour
- 10 Ft. Contour
- Settling Basins
- Telephone Pole
- (Non-Detected
- (Detected

0 100 200 400 600 800 Feet

An Employee-Owned Company

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Distribution of Detected Explosives and Propellants in Sediment Samples

Drawn By: HRA

CAD FILES: R31718/R31617/R21718/R21617

Figure 4-5

Date: 8/18/05

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4.5.3 Inorganic Constituents

A total of 23 inorganics (including hexavalent chromium) were detected at least once in the 40 sediment samples collected during the Phase II RI. Five of the detected inorganics were eliminated as potential SRCs because they are considered essential elements (calcium, iron, magnesium, potassium, and sodium). Inorganic SRCs detected above background are listed below, along with how many times the chemical was detected above background and the sample location where the highest concentration was measured:

- Aluminum – 22, FBQ-132 (22100 mg/kg);
- Antimony – 16, FBQ-146 (128 mg/kg);
- Arsenic – 4, FBQ-143 (33.3 mg/kg);
- Barium – 16, FBQ-155 (976 mg/kg);
- Beryllium – 38, FBQ-130 (1.2 mg/kg);
- Cadmium – 32, FBQ-148 (18.9 mg/kg);
- Chromium – 29, FBQ-126 (1140 mg/kg);
- Hexavalent chromium – 23, FBQ-148 (33 mg/kg);
- Cobalt – 24, FBQ-155 (18 mg/kg);
- Copper – 14, FBQ-155 (660 mg/kg);
- Lead – 29, FBQ-148 (1490 mg/kg);
- Manganese – 3, FBQ-141 (4100 mg/kg);
- Mercury – 31, FBQ-146 (35 mg/kg);
- Nickel – 32, FBQ-158 (80.5 mg/kg);
- Selenium – 6, FBQ-155 (8.2 mg/kg);
- Silver – 7, FBQ-146 (12.4 mg/kg);
- Vanadium – 16, FBQ-140 (42 mg/kg); and
- Zinc – 6, FBQ-148 (3620 mg/kg).

The sediment sample locations at FBQ that had 14 or more inorganic SRCs above background are FBQ-126, -127, -142, -148, and -155. The distribution of detected inorganics above background in sediment is shown in Figure 4-6. Appendix H, Table H-12 presents analytical results for inorganic compounds in sediment.

4.5.4 SVOCs, VOCs, Pesticides, and PCBs

SVOCs

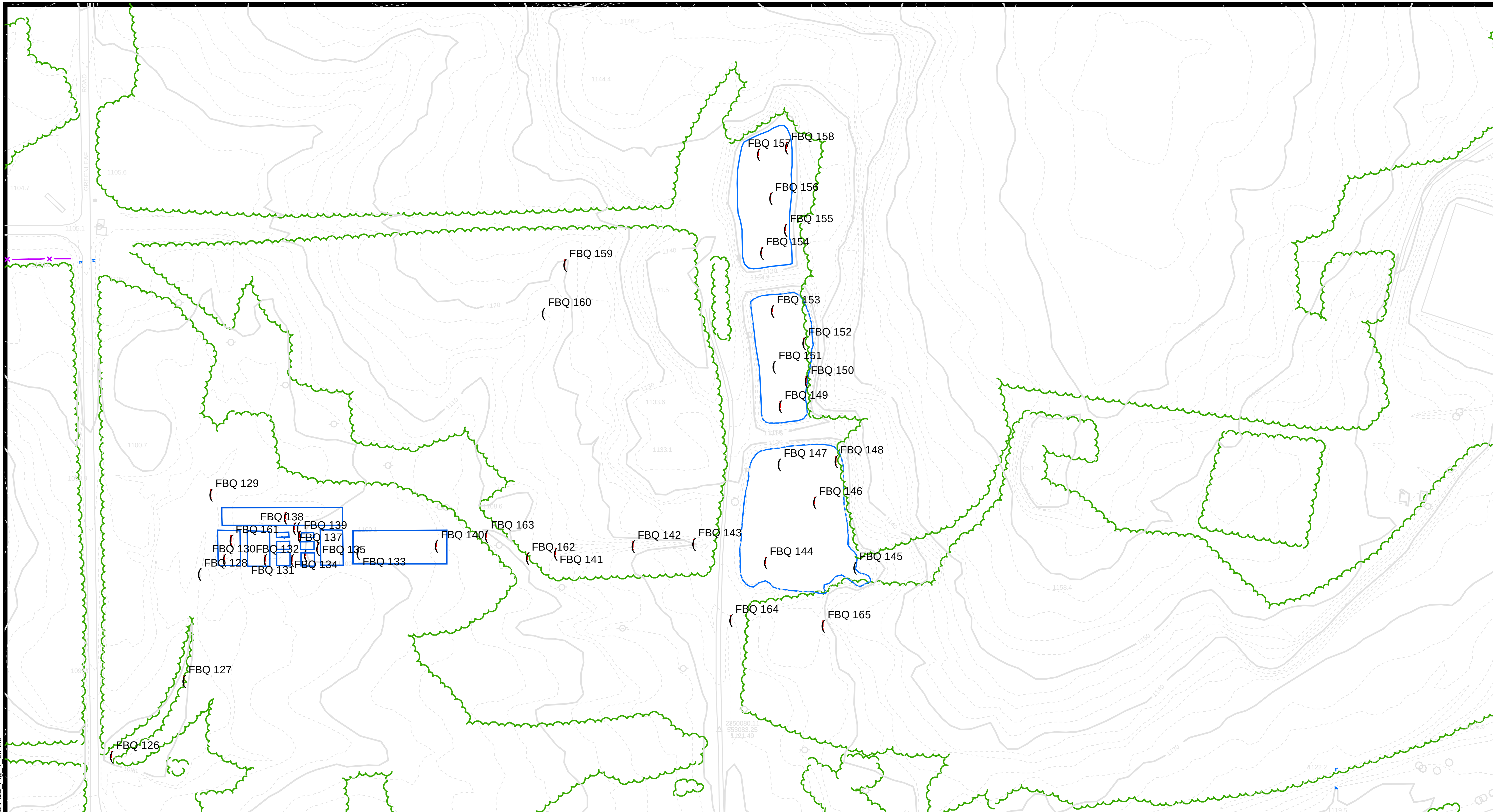
A total of 66 SVOCs were analyzed in 40 sediment samples during the Phase I/II RI. Nineteen SVOCs were detected. 4-Methylphenol, anthracene, carbazole, dibenzofuran, acenaphthylene, and fluorene were eliminated as SRCs because they were detected in 5% or less of the samples. The SVOC SRCs in sediment are as follows:

- 2-methylnaphthalene was detected at 5 of the 40 sample locations. The highest concentration detected was 1.6 mg/kg at FBQ-141.

- Anthracene was detected at FBQ-148 (0.23 mg/kg) and FBQ-163 (0.46 mg/kg).

- Benzo(*a*)anthracene was detected at 12 of the 40 sample locations. The highest concentration detected was 2.1 mg/kg at FBQ-148.

- Benzo(*a*)pyrene was detected at 16 of the 40 sample locations. The highest concentration detected was 2.0 mg/kg at FBQ-148.



Legend

- Road
- Vegetation
- Water
- 2 Ft. Contour
- 10 Ft. Contour
- Settling Basins
- Telephone Pole

Number of SRCs Exceeding Background Levels

(< 9

(>= 9

0 100 200 400 600 800 Feet

O

Distribution of Detected Inorganics Above Background Levels in Sediment Samples

Drawn By: HRA

CAD FILES: R31718/R31617/R21718/R21617

Figure 4-6

Date: 8/18/05

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- Benzo(*b*)fluoranthene was detected at 16 of the 40 sample locations. The highest concentration detected was 2.3 mg/kg at FBQ-148.

- Benzo(*ghi*)perylene was detected at 4 of the 40 sample locations. The highest concentration detected was 1.2 mg/kg at FBQ-148.

- Benzo(*k*)fluoranthene was detected at 3 of the 40 sample locations. The highest concentration detected was 0.95 mg/kg at FBQ-148.

- Bis(2-ethylhexyl) phthalate was detected at 4 of the 40 sediment sample locations. The highest concentration measured was 0.1 mg/kg at FBQ-156.

- Carbazole was detected at FBQ-163 (0.23 mg/kg) and FBQ-148 (0.11 mg/kg).

- Chrysene was detected at 15 of 40 sample locations. The highest concentration measured was 1.3 mg/kg at FBQ-148.

- Dibenzofuran was detected at FBQ-141 (0.43 mg/kg) and FBQ-163 (0.11 mg/kg).

- Fluoranthene was detected at 18 of 40 locations sampled. The highest concentration measured was 3.2 mg/kg at FBQ-148.

- Ideno(1,2,3-*cd*)pyrene was detected at 6 of 40 sample locations. The highest concentration detected was 1.0 mg/kg at FBQ-148.

- Naphthalene was detected in 4 of 40 samples. The highest concentration measured was 0.97 mg/kg at FBQ-141.

- Phenanthrene was detected in 11 of 40 samples. The highest concentration measured was 1.7 mg/kg at FBQ-163.

- Pyrene was detected in 14 of 40 sediment samples. The highest concentration measured was 2.3 mg/kg at FBQ-148.

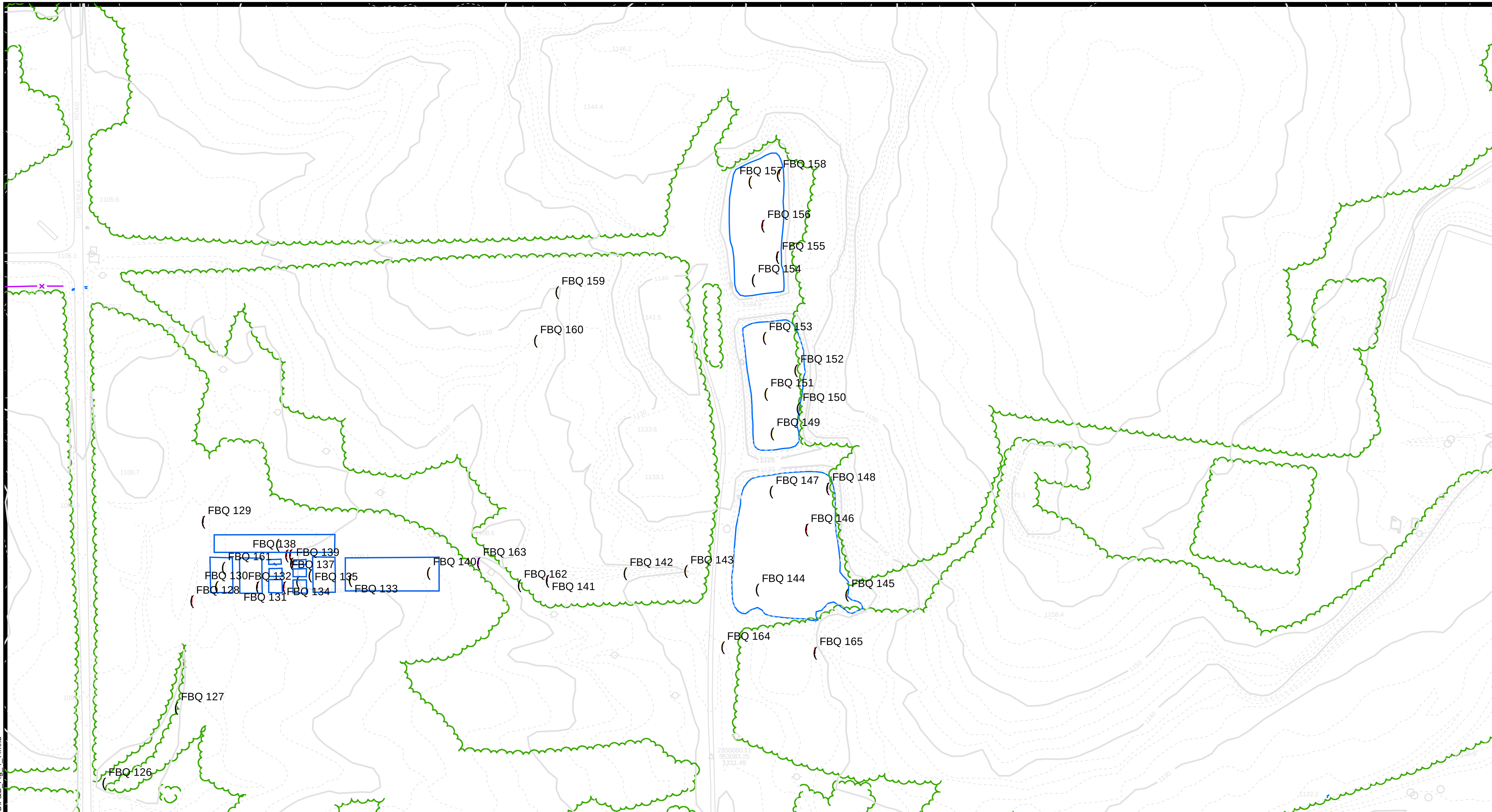
Summary statistics and the determination of SRCs for sediment samples are presented in Table 4-10. A listing of SRCs by sediment sample number is presented in Table 4-11. Appendix H, Table H-14 lists all laboratory results for SVOCs in sediment samples. The distribution of detected SVOCs, VOCs, PCBs, and pesticides in sediment samples is shown in Figure 4-7.

VOCs

A total of 37 VOCs were analyzed in 40 sediment samples for the Phase I/II RI. Six VOCs were detected. TCE was eliminated as an SRC because it was detected in only 1 of 40 samples (<5%). The VOC SRCs in sediment are as follows:

- 2-Butanone was detected in 11 of 40 samples. The highest concentration measured was 0.043 mg/kg at FBQ-156.

- Acetone was detected in 5 of 40 samples. The highest concentration measured was 0.064 mg/kg at FBQ-144.



Legend

Road
Vegetation
Water
2 Ft. Contour
10 Ft. Contour
Settling Basins
Telephone Pole

Number of Detected SVOC, VOC, PCB/Pest

0
1 - 5
6 - 14
15 - 20

0 100 200 400 600 800 Feet

An Employee-Owned Company

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Distribution of Detected SVOCs, VOCs, PCBs, and Pesticides in Sediment Samples

Drawn By: HRA

CAD FILES: R31718/R31617/R21718/R21617

Figure 4-7

Date: 8/18/05

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- Carbon disulfide was detected at FBQ-142 (0.0023 mg/kg), FBQ-143 (0.0036 mg/kg) and FBQ-156 (0.0029 mg/kg).

- Methylene chloride was detected in 6 of 40 sediment samples. The highest concentration measured was 0.037 mg/kg at FBQ-145.

- Toluene was detected in 6 of 40 samples. The highest concentration measured was 0.09 mg/kg at FBQ-133.

In June 2004, eight sediment contingency samples were collected from several of the smaller retention basins and analyzed for perchlorate. These sediment samples were collected in response to detections of perchlorate in two of ten surface water samples collected in 2003. In June 2004 additional surface water and sediment samples were collected and analyzed for perchlorate to confirm the presence of perchlorate in the smaller retention ponds and to determine if perchlorate is a SRC. Perchlorate was not detected in the 2004 sediment samples or surface water samples.

Appendix H, Table H-15 lists the laboratory results for VOCs in surface soil samples. Table 4-10 presents a statistical summary of analytical results for all detected VOCs in sediment. VOC SRC results for sediment are presented in Table 4-11.

Pesticides/PCBs

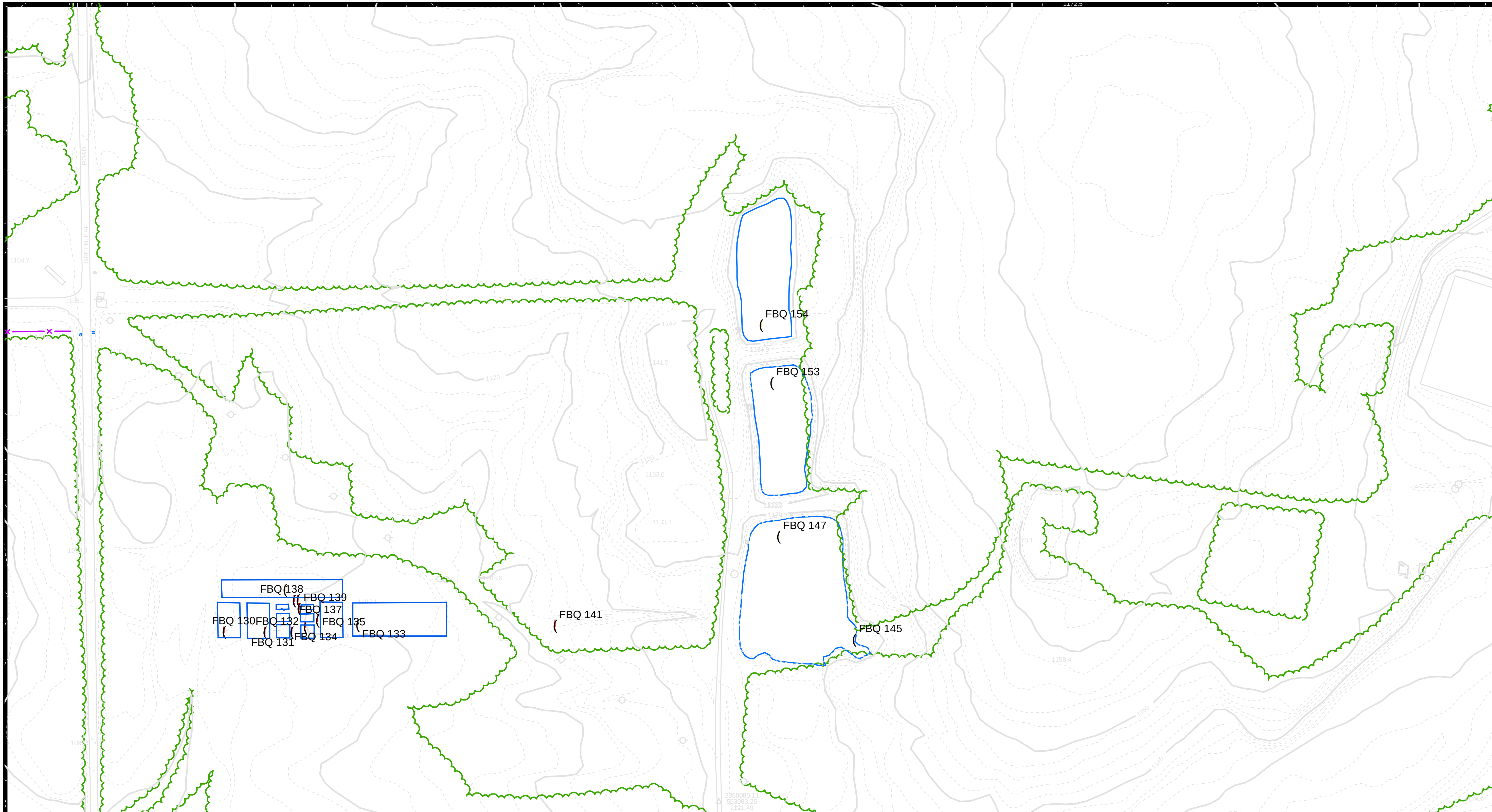
Seven PCBs (Aroclors) and 22 pesticides were analyzed for in 40 sediment samples. No PCB compounds were detected in the sediment samples. Eleven pesticides were detected in the sediment samples. Endosulfan I, gamma BHC (Lindane), beta BHC, and heptachlor epoxide (all detected at FBQ-139), 4,4'-DDT (detected at FBQ-132), and endrin (detected at FBQ-139 and FBQ-153) were retained as SRCs even though they were only detected at 5% or less of the sample locations. Endrin aldehyde was also retained as an SRC even though it was found at only one sample location (FBQ-165) because other pesticides were detected there as well. 4,4'-DDD was detected at 5 of 40 sample locations, the highest concentration was 0.013 mg/kg at FBQ-143. 4,4'-DDE was detected at 6 of 40 sample locations, the highest concentration was 0.0015 mg/kg at FBQ-160. Methoxychlor was detected at 4 of 40 sample locations, the highest concentration was measured at 0.003 mg/kg (FBQ-148). Summary statistics for pesticides and PCBs in sediment are presented in Table 4-10. Pesticide SRCs for sediment are presented in Table 4-11. Appendix H, Table H-13 lists the laboratory results for pesticides and PCBs sediment samples.

4.6 SURFACE WATER

Surface water samples were collected from 15 locations at FBQ for the Phase I and II RI to determine nature and extent of contamination (Figures 3-3 and 3-4). All surface water samples were co-located with sediment samples.

All surface water sample collection and analysis for the Phase I/II RI was conducted in accordance with the *Work Plan and Sampling and Analysis Plan Addenda for the Phase I/Phase II RI at the Fuze & Booster Quarry Landfill/Ponds at the Ravenna Army Ammunition Plant, Ravenna, Ohio* (2003), as described in Chapter 3.0 of this report. Surface water samples were analyzed for explosives, inorganics, VOCs, SVOCs, and PCBs/pesticides. Two samples (FBQsw-132-0414-sw and FBQsw-134-0411-sw) were collected from the smaller settling basins in June 2004 and analyzed for perchlorate.

The complete analytical results for surface water samples collected at the FBQ AOC are presented by sample location and analyte in Appendix H, Tables H-16 through H-20. Table 4-12 presents the summary



Legend

- Road
- Vegetation
- Water
- 2 Ft. Contour
- 10 Ft. Contour
- Settling Basins
- Telephone Pole

Number of SRCs

- (< 6
- (6 - 10
- (> 10

SAIC
An Employee-Owned Company

0 100 200 400 600 800 Feet

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Figure 4-8

Distribution of Site-Related Contaminants in Suface Water Samples

Drawn By: HRA

CAD FILES: R31718/R31617/R21718/R21617

Date: 8/18/05

statistics and determination of SRCs in surface water. Table 4-13 presents the SRC detected in surface water for each sample location. Figure 4-8 shows the distribution of SRCs in surface water samples. The following sections describe the distribution of explosives, propellants, inorganic, and organic constituents as determined in the Phase I/II RI

4.6.1 Explosives and Propellants

2-Amino-4,6-DNT (0.00068 mg/L) and 4-amino-2,6-DNT (0.02 mg/L) were detected in FBQ-134. No other explosive compounds were detected in surface water samples collected during the Phase I and II RI. The only propellant compound detected was nitrocellulose, which was detected at 12 of the 15 locations, the highest concentration measured was 1.1 mg/L at FBQ-145.

4.6.2 Inorganic Constituents

A total of 17 Inorganics and hexavalent chromium were detected at least once in surface water during the Phase I/II RI. Five of the detected inorganics were eliminated as potential SRCs because they are considered essential elements (calcium, iron, potassium, magnesium, and sodium). A summary of the Inorganics detected above facility-wide background in surface water are as follows:

- Aluminum was detected above background at one sample location, FBQ-130 (7.01 mg/L).
- Arsenic was detected above background at 1 of 15 sample locations. The highest concentration measured was 0.0197 mg/L at FBQ-130.
- Barium was detected above background at 8 of 15 locations. FBQ-141 had the highest concentration detected (1.03 mg/L).
- Beryllium was detected above background at one sample location, FBQ-130 (0.00077 mg/L).
- Chromium was detected above background at 4 of 15 sample locations. The highest concentration measured was 0.0122 mg/L at FBQ-130.
- Hexavalent chromium was detected above background at 5 of 15 sample locations. The highest concentration measured was 0.05 mg/L at FBQ-135.
- Cobalt was detected above background at 9 of 15 sample locations. The highest concentration was 0.0173 mg/L at FBQ-130.
- Copper was detected above background at one sample location, FBQ-130 (0.0418 mg/L).
- Lead was detected above background at 3 of 15 sample locations. The highest concentration measured was 0.0249 mg/L at FBQ-130.
- Manganese was detected above background at 11 of 15 sample locations. The highest concentration measured was 11 mg/L at FBQ-141.
- Nickel was detected above background at one location, FBQ-130 (0.0259 mg/L).
- Vanadium was detected above background at 5 of 15 locations. The highest concentration measured was 0.0191 mg/L at FBQ-130.
- Zinc was detected above background at one location, FBQ-130 (0.107 mg/L).

Overall, the highest concentrations and greatest number of inorganic SRCs above site background occurred in surface water at station FBQ-130, which was collected from the southwestern-most settling basin. The settling basins generally have more inorganic SRCs at higher concentrations than the Quarry Ponds.

4.6.3 SVOCs, VOCs, and Pesticides/PCBs

SVOCs

The following SVOCs were detected in 15 surface water samples for the Phase I/II RI:

- 4-methlphenol was detected at 4 of 15 sample locations. The highest concentration measured was 0.17 mg/L at FBQ-134.
- Bis(2-ethylhexyl) phthalate was detected at 11 of 15 sample locations. The highest concentration measured was 0.011 mg/L at FBQ-139.
- Phenol was detected at three sample locations. The highest concentration was 0.12 mg/L at FBQ-134.

VOCs

The following VOCs were detected in 15 surface water samples for the Phase I/II RI:

- 2-Butanone was detected at three locations: FBQ-131 (0.0051 mg/L), FBQ-132 (0.005 mg/L), and FBQ-134 (0.0034 mg/L).
- Carbon disulfide was detected at three locations: FBQ-134 (0.0017 mg/L), FBQ-139 (0.0094 mg/L), and FBQ-141 (1.8 μg/L).
- Methylene chloride was detected at two sample locations: FBQ-145 (0.0045 mg/L) and FBQ-147 (0.0047 mg/L).
- Perchlorate was detected at two of nine original sample locations: 0.0075 mg/L at FBQ-132 and 0.025 mg/L at FBQ-134. In June 2004, surface water samples were recollected at these locations and analyzed for perchlorate to confirm the detections. Perchlorate was not detected in July 2004.
- Styrene was only detected at FBQ-132 (0.0011 mg/L).
- Toluene was detected at ten sample locations. The highest concentration measured was 0.02 mg/L at FBQ-131.

Perchlorate was detected at two of ten0 surface water sampling locations: 7.5 μg/L at FBQ-132 and 25 μg/L at FBQ-134. In June 2004, surface water samples were collected at these same locations and analyzed for perchlorate to confirm previous detections. Perchlorate was not detected in the surface water samples collected in July 2004. In response to the detections of perchlorate in two of the ten surface water samples, additional surface water and sediment samples were collected and analyzed for perchlorate in June 2004. The surface water samples were collected at the same locations of the perchlorate detections in 2003. EPA Method 314.0 was used to analyze both the November 2003 and June 2004 surface water samples. EPA Method 314.0 is an EPA-approved test method for perchlorate in finished drinking water. Both EPA and DoD officials have expressed concerns regarding the use of this method for media other than finished drinking water, such as groundwater, surface water, soil, and sediment. Sediment and dissolved ions commonly found in groundwater and surface water can yield false positive results. Numerous documented cases demonstrate use of Method 314.0 has resulted in the reporting of false positives: (http://www.epa.gov/safewater/ccl/perchlorate/pdf/okamoto.pdf, http://www.dtic.mil/ndia/2004Chemistry/Chapman_AFCEE_Perchlorate.pdf, and http://www.ime.org/files/Guidelines/ Perclhorstatemt.pdf).

The retention basins where the 2003 detections of perchlorate were reported were resampled to confirm the presence of perchlorate. Perchlorate was not detected in 2004 in either the surface water or the sediment samples. Perchlorate detected in surface water in 2003 is considered likely false positive results, and perchlorate is not considered an SRC. However, perchlorate was carried forward into the risk assessment for further evaluation.

Pesticides/PCBs

No pesticides or PCBs were detected in the surface water samples. Laboratory analytical data for SVOCs, VOCs, pesticides and PCBs for surface water samples are presented in Appendix H, Tables H-18, H-19, and H-20, respectively.

4.7 GROUNDWATER

Groundwater samples were collected from 12 monitoring wells during the Phase I/II RI (see Figure 3-2). Six monitoring wells were screened in unconsolidated materials (FBQ-166 through -169, -176, and -177). These monitoring wells are generally located in the lower site elevations on the west and south sides of the site. Monitoring wells FBQ-170 through -175 were screened in sandstone bedrock, and are located in the higher site elevations adjacent to the Quarry Ponds to the east and north.

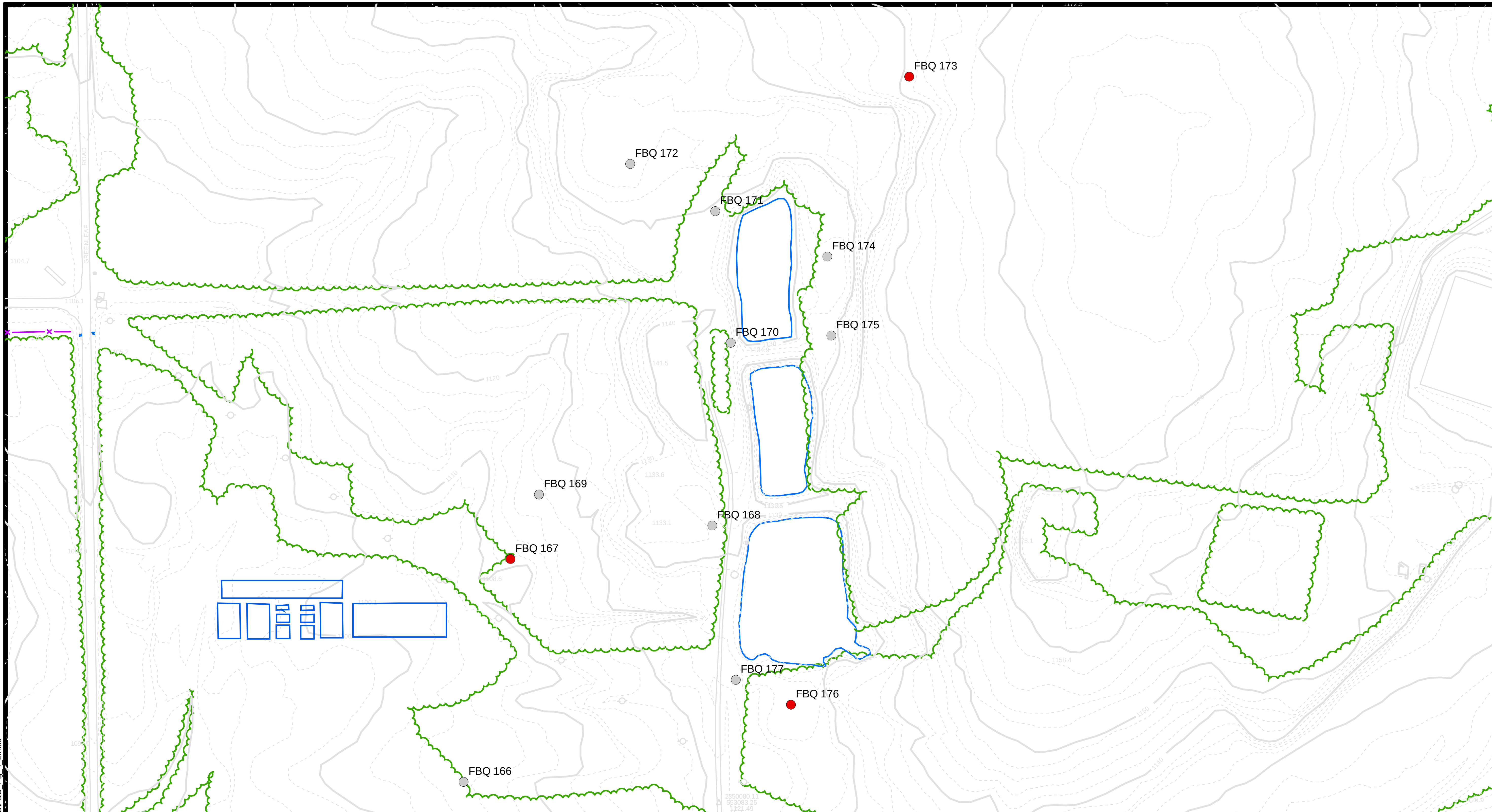
Groundwater flow patterns have been approximated from water level measurements in the wells (Figure 2-5). In general, groundwater flows from potentiometric highs in the north and east towards the unnamed creek to the southwest of the site. The potentiometric gradient appears to be relatively low across the site.

Unfiltered groundwater samples from each well were analyzed for explosives, propellants, VOCs, SVOCs, PCB/pesticides and hexavalent chromium. Metals were analyzed for in filtered groundwater samples. The complete analytical results are provided for groundwater by analyte and station in Appendix H, Tables H-21 through 25. Table 4-14 provides the summary statistics and determination of SRCs for unconsolidated groundwater at the AOC. Table 4-15 provides the summary statistics and determination of SRCs for bedrock groundwater at the AOC. Table 4-16 presents the SRC detected in unconsolidated groundwater for each sample location. Table 4-17 presents the SRC detected in bedrock groundwater for each sample location. The groundwater results are separated into two aggregates, those from wells screened in unconsolidated materials and those from wells screened in sandstone bedrock. Results of selected compounds detected in groundwater samples collected for the Phase II RI are presented in Figure 4-9.

4.7.1 Explosives and Propellants

Wells Screened in Unconsolidated Materials

Three explosive/propellant compounds were detected in monitoring wells screened in unconsolidated materials. 2-Amino-4,6-DNT (0.00023 mg/L) and 4-amino-2,6-DNT (0.00033 mg/L) were detected in FBQ-168. Nitrocellulose was detected in five of the six wells screened in unconsolidated materials, the highest concentration measured was at FBQ-176 (0.35 mg/L).



Legend

Road

Vegetation

Water

2 Ft. Contour

10 Ft. Contour

Settling Basins

Telephone Pole

Number of SRCs

4 - 7

8 - 14

An Employee-Owned Company

0 100 200 400 600 800 Feet

Distribution of Site-Related Contaminants in Groundwater Samples

Drawn By: HRA

CAD FILES: R31718/R31617/R21718/R21617

Figure 4-9

Date: 8/18/05

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Wells Screened in Sandstone Bedrock

Six explosive/propellant compounds were detected in the monitoring wells screened in bedrock. These compounds are as follows:

- 2,4,6-TNT was detected at FBQ-173 (0.0019 mg/L) and FBQ-174 (0.018 mg/L).
- 2,4-DNT was detected in FBQ-174 (0.00031 mg/L).
- 2-Amino-4,6-DNT was detected at FBQ-173 (0.0029 mg/L) and FBQ-174 (0.028 mg/L).
- 4-Amino-2,6-DNT was detected at FBQ-173 (0.0027 mg/L) and FBQ-174 (0.028 mg/L).
- Nitrobenzene was detected at FBQ-173 (0.00017 mg/L).
- Nitrocellulose was detected in five of the six wells screened in bedrock, the highest concentration measured was at FBQ-175 (0.32 mg/L).

4.7.2 Inorganics

All groundwater samples were analyzed for Inorganics. Facility-wide background for inorganics was established prior to the Phase I and II efforts and only detections above background are discussed below. Facility-wide background for certain compounds are different for filtered samples collected from monitoring wells screened in unconsolidated materials and those screened in bedrock.

Wells Screened in Unconsolidated Materials

Twelve inorganics were detected in at least one of the monitoring wells screened in unconsolidated materials. Five of the detected inorganics (calcium, iron, magnesium, potassium, and sodium) were eliminated as potential SRCs because they are considered essential elements. The inorganic SRCs detected in all six unconsolidated monitoring wells were barium and manganese. Nickel was detected in three samples, zinc and cobalt in two samples, and copper and cadmium in one sample. FBQ-169 had the most inorganic SRCs at the maximum concentration detected in groundwater sampled from the unconsolidated materials.

Wells Screened in Bedrock

Twelve inorganics (including hexavalent chromium) were detected in at least one of the monitoring wells screened in bedrock. Five of the detected inorganics (calcium, iron, magnesium, potassium, and sodium) were eliminated as potential SRCs because they are considered essential elements. Barium and manganese were detected in all six bedrock-screened monitoring wells. Zinc was detected in four of the samples, cobalt in three of the samples, nickel in two of the samples, and aluminum and hexavalent chromium in one of the samples. FBQ-173 had the most inorganic SRCs detected (aluminum, cobalt, copper, lead, manganese, and nickel).

4.7.3 SVOCs, VOCs, and PCBs

Wells Screened in Unconsolidated Materials

The SVOCs caprolactum (three of six samples) and bis(2-ethylhexyl) phthalate (three of six samples) were detected in the monitoring well samples.

The following VOCs were detected in groundwater samples collected from the unconsolidated materials:

- 1,1,1-Trichloethane was detected at FBQ-167 (0.0058 mg/L).
- 1,1-Dichlorethene was detected at FBQ-167 (0.00042 mg/L) and FBQ-169 (0.0025 mg/L).
- Acetone was detected at 1 of the 4 samples, the highest being measured at 0.0062 mg/L (FBQ-168).
- Carbon disulfide was detected at FBQ-177 (0.00097 mg/L).

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

Wells Screened in Bedrock

The SVOCs caprolactum (six of six samples), bis(2-ethylhexyl) phthalate (one of six samples), benzyl butyl phthalate (two of six samples), and di-n-butyl phthalate (one of one sample) were detected in the bedrock monitoring well samples. The following VOCs were detected in groundwater samples collected from the bedrock:

- Acetone was detected in two of three samples, the highest concentration measured was at FBQ-175 (0.0062 mg/L).

- TCE was detected at FBQ-170 (0.012 mg/L) and FBQ-171 (0.0071 mg/L).

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

4.8 ORDNANCE AND EXPLOSIVES AVOIDANCE SURVEY SUMMARY

UXO technicians provided OE avoidance training and support during all field operations. The OE avoidance crew cleared all soil, surface water/sediment, and drilling locations. No UXO, propellants, or explosives were discovered during field reconnaissance and magnetometer surveys of access routes and proposed sampling or drilling locations. Various debris and metal scrap were encountered throughout the AOC during visual and magnetometer surveys. In several instances, subsurface magnetic anomalies resulted in the decision to move pre-planned sampling and well locations to points where no anomalies were observed.

4.9 SUMMARY OF CONTAMINANT NATURE AND EXTENT

During the Phase I and II RI at FBQ, 184 environmental samples were collected as follows: 100 surface soil samples, 67 subsurface soil samples, 48 sediment samples, 14 surface water samples, and 12 groundwater samples. The following text summarizes the results of the investigation at FBQ and the 40-mm Firing Range.

4.9.1 Surface Soil

FBQ

Nine explosive/propellant compounds were detected at least once in surface soil samples collected during the Phase II RI. The following compounds were detected: nitrocellulose (6 of 8 samples); 2,4,6-TNT (11 of 60 samples); nitrobenzene (4 of 60 samples); 2-amino-4,6-DNT (9 of 60 samples); 4-amino-2,6-DNT (9 of 60 samples); 1,3,5-TNB (6 of 60 samples); 2,4-DNT (4 of 60 samples); 2,6-DNT (2 of 60 samples); and RDX (1 of 60 samples). The sample locations with the most detected explosive/propellant compounds (FBQ-039, -042, -046, -050, and -052) are located in the higher elevations northeast of the Quarry Ponds.

Seventeen inorganics were detected above background in surface soil samples collected from FBQ. These compounds are: antimony, arsenic, barium, beryllium, cadmium, chromium, hexavalent chromium, cobalt, copper, lead, mercury, manganese, nickel, selenium, silver, vanadium, and zinc.

The following surface soil sample locations had ten or more surface soil inorganic SRCs above background: FBQ-002, -044, and -045. 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.

The following SVOCs were detected at FBQ:

- Benzo(*a*)anthracene, benzo(*a*)pyrene, benzo(*b*)fluoranthrene, benzo(*k*)fluoranthrene, and chrysene were detected only at FBQ-060.

- Fluoranthene at FBQ-017 and -060.

- Pyrene at FBQ-060.

40-mm Firing Range

Seven explosive/propellant compounds were detected at least once in surface soil samples collected during the Phase II RI. The following compounds were detected: nitrocellulose (4 of 4 samples); 2,4,6-TNT (1 of 40 samples); nitrobenzene (4 of 40 samples); 2-amino-4,6-DNT (2 of 40 samples); 4-amino-2,6-DNT (2 of 40 samples); 1,3,5-TNB (1 of 40 samples); 2,4-DNT (1 of 40 samples); tetryl (1 of 30 samples); and HMX and 3-nitrotoluene (each at 1 of 40 samples). FBQ-98 had the greatest number (six) of detected explosive/propellant compounds in surface soil samples at the 40-mm Firing Range area.

Thirteen inorganics were detected above background in surface soil samples collected from the 40-mm Firing Range area. These compounds are: aluminum, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, lead, nickel, thallium, vanadium, and zinc.

FBQ-066, -078, -079, -086, -087, and -091 had the greatest number of surface soil inorganic SRCs above background in the 40-mm Firing Range area. These sample locations are located throughout the central portion of the 40-mm Firing Range area.

The only SVOCs detected in the 40-mm Firing Range area were detected at FBQ-098 (bis(2-ethylhexyl) phthalate and diethyl phthalate).

VOCs

A total of 37 VOCs were analyzed for in 12 surface soil samples collected during the Phase I and II RI. Methylene chloride and acetone were detected in one of four samples. TCE (two of eight samples); toluene (one of four samples); carbon disulfide (one of eight samples); 1,1,1-trichloethane (one of four samples); and 1,1-DCE (one of three samples) were also detected.

Pesticides and PCBs

A total of 22 pesticides and 7 PCB compounds (aroclors) were analyzed for in 12 surface soil samples collected at FBQ and 40-mm Firing Range. No PCB compounds were detected in these samples.

The following pesticides were detected for this investigation:

- 4,4-DDE at FBQ-009 and -029 (FBQ), and FBQ-083 (40-mm Firing Range)
- Aldrin endrin, endrin aldehyde, endrin ketone, gamma-BHC (Lindane), and heptachlor at FBQ-083 (40-mm Firing Range area).

4.9.2 Subsurface Soil

Subsurface soil samples were collected from 37 locations at FBQ and 26 locations at the 40-mm Firing Range and analyzed for explosives and propellants during the FBQ Phase I/II RI

FBQ

At FBQ, two explosive/propellant compounds (nitrobenzene and nitrocellulose) were detected at three locations (FBQ-003, -009, and -019).

Thirteen inorganic compounds were detected above background in subsurface soil samples collected at FBQ. These compounds are: aluminum, antimony, arsenic, barium, beryllium, cadmium, chromium, hexavalent chromium, lead, mercury, selenium, vanadium, and zinc. The following sample locations had four or more subsurface soil inorganic SRCs above background: FBQ- 017, -019, -021, -026, -028, -040, and -059.

The following VOCs were detected in subsurface soil samples collected from FBQ: methylene chloride (FBQ-017, -018, -019, -051, and -060); carbon disulfide (FBQ-019); m,p-Xylenes; 1,2-dimethylbenzene; and toluene (all at FBQ-083) and TCE (FBQ-003).

40-mm Firing Range

At the 40-mm Firing Range area, either 3-nitrotoluene (1 of 26 samples), nitrobenzene (3 of 26 samples), or nitrocellulose (3 of 3 samples) was detected at least once at five sample locations (FBQ-067, -079, -082, -083, and -086).

Nine inorganics were detected above background in subsurface soil samples collected from the 40-mm Firing Range area. These compounds are: aluminum, arsenic, beryllium, cadmium, chromium, cobalt, copper, lead, and thallium. The following sample locations had four or more subsurface soil inorganic SRCs above background in the 40-mm Firing Range area: FBQ- 062, -063, -077, and -095.

Two sample locations from the 40-mm Firing Range were analyzed for VOCs. The VOCs detected at these locations are:

- FBQ-083 – acetone; carbon disulfide; m,p-xylenes; o-xylene; and toluene.
- FBQ-086 – 2-butanone and acetone.

No SVOCs, PCBs, or pesticides were detected in the subsurface soil samples collected from either FBQ or the 40 mm Firing Range area.

4.9.3 Sediment

Eleven explosive/propellant compounds were detected at least once at 29 of the 40 sediment sample locations during the Phase I/II RI. A summary of the detected explosive/propellant compounds in sediment samples with the number of times the compound was detected and the location of the highest concentration is as follows:

- 1,3,5-TNB – 1, FBQ-134 (98 μg/kg);
- 1,3-DNB – 1, FBQ-134 (110 μg/kg);
- 2,4,6-TNT – 5, FBQ-146 (300 μg/kg);
- 2,6-DNT – 1, FBQ-139 (85 μg/kg);
- 2-Amino-4,6-DNT – 1, FBQ-155 (73 μg/kg);
- 4-Amino-2,6-DNT – 3, FBQ-146 (390 μg/kg);
- HMX – 2, FBQ-146 (160 μg/kg);
- 3-nitrotoluene – 3, FBQ-162 (150 μg/kg);
- Nitrobenzene – 7, FBQ-144 (110 μg/kg);
- Nitrocellulose – 23, FBQ-129 (110 μg/kg); and
- Nitroglycerine – 1, FBQ-156 (459000 μg/kg.

Explosive/propellant compounds were detected in every sediment sample collected from the Quarry Ponds, with the exception of FBQ-147. 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 SRCs were detected in every sediment sample collected. FBQ-126, which was collected from sediment located in the southwestern-most corner of the AOC, had the highest number of inorganic SRCs detected (15). The highest concentrations of inorganic SRCs above background are found at the following locations:

- Aluminum – 22100 mg/kg at FBQ-132;
- Antimony – 128 mg/kg at FBQ-146;
- Arsenic – 33.3 mg/kg at FBQ-143;
- Barium – 976 mg/kg at FBQ-155;
- Beryllium – 1.2 mg/kg at FBQ-130;
- Cadmium – 18.9 mg/kg at FBQ-148;
- Chromium – 1140 mg/kg at FBQ-126;
- Hexavalent chromium – 33 mg/kg at FBQ-148;
- Cobalt – 18 mg/kg at FBQ-155;
- Copper – 660 mg/kg atFBQ-091;
- Lead – 31.3 mg/kg at FBQ-097;
- Manganese -4100 mg/kg at FBQ-141;
- Mercury – 35 mg/kg at FBQ-146;
- Nickel – 80.5 mg/kg at FBQ-158;
- Selenium – 8.2 mg/kg at FBQ-155;
- Silver – 12.4 mg/kg at FBQ-146;
- Vanadium – 42 mg/kg at FBQ-140; and
- Zinc – 3620 mg/kg at FBQ-148.

The sediment sample locations that had 14 or more inorganic SRCs above background are FBQ-126, -127, -142, -148, and -155.

SVOCs

The SVOC SRCs in sediment are as follows:

- 2-Methylnaphthalene was detected at 5 of the 40 sample locations. The highest concentration detected was 1,600 μg/kg at FBQ-141.
- Anthracene was detected at FBQ-145 (102 μg/kg), FBQ-148 (230 μg/kg), and FBQ-163 (460 μg/kg).
- Benzo(*a*)anthracene was detected at 12 of the 40 sample locations. The highest concentration detected was 2,100 μg/kg at FBQ-148.
- Benzo(*a*)pyrene was detected at 16 of the 40 sample locations. The highest concentration detected was 2,000 μg/kg at FBQ-148.
- Benzo(*b*)fluoranthene was detected at 16 of the 40 sample locations. The highest concentration detected was 2,300 μg/kg at FBQ-148.
- Benzo(*ghi*)perylene was detected at 4 of the 40 sample locations. The highest concentration detected was 1,200 μg/kg at FBQ-148.
- Benzo(*k*)fluoranthene was detected at 3 of the 40 sample locations. The highest concentration detected was 950 μg/kg at FBQ-148.
- Bis(2-ethylhexyl) phthalate was detected at 4 of the 40 sediment sample locations. The highest concentration measured was 100 μg/kg at FBQ-156.
- Carbazole was detected at FBQ-163 (230 μg/kg), FBQ-145 (129 μg/kg), FBQ-148 (110 μg/kg).
- Chrysene was detected at 15 of 40 sample locations. The highest concentration measured was 1,300 μg/kg at FBQ-148.
- Dibenzofuran was detected at FBQ-141 (430 μg/kg) and FBQ-163 (110 μg/kg).
- Fluoranthene was detected at 18 of 40 locations sampled. The highest concentration measured was 3,200 μg/kg at FBQ-148.
- Ideno(1,2,3-*cd*)pyrene was detected at 6 of 40 sample locations. The highest concentration detected was 1,000 μg/kg at FBQ-148.
- Naphthalene was detected in 4 of 40 samples. The highest concentration measured was 970 μg/kg at FBQ-141.
- Phenanthrene was detected in 11 of 40 samples. The highest concentration measured was 1,700 μg/kg at FBQ-141.
- Pyrene was detected in 14 of 40 sediment samples. The highest concentration was measured at FBQ-148 (2,300 μg/kg).

The VOC SRCs in sediment are as follows:

- 2-Butanone was detected in 11 of 40 samples. The highest concentration measured was 43 μg/kg at FBQ-156.
- Acetone was detected in 5 of 40 samples. The highest concentration measured was 180 μg/kg at FBQ-156.
- Carbon disulfide was detected at FBQ-142 (2.3 μg/kg), FBQ-143 (3.6 μg/kg), and FBQ-156 (2.9 μg/kg).
- Methylene chloride was detected in 6 of 40 sediment samples. The highest concentration measured was 37 μg/kg at FBQ-145.
- Toluene was detected in 6 of 40 samples. The highest concentration measured was 90 μg/kg at FBQ-133.

In July 2004, eight sediment contingency samples were collected from several of the smaller settling basins and analyzed for perchlorate. Perchlorate was not detected in these samples.

No PCB compounds were detected in the sediment samples. Eleven pesticides were detected in the sediment samples. Endosulfan I, beta-BHC, gamma BHC (Lindane), and heptachlor epoxide (all detected at FBQ-139), 4-4'-DDT (detected at FBQ-132), and endrin (detected at FBQ-139 and FBQ-153) 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 (FBQ-165) because other pesticides were detected there as well. 4,4-DDD was detected at 5 of 40 sample locations, the highest concentration was 13 μg/kg at FBQ-143. Endrin was detected at FBQ-139 (0.55 μg/kg) and FBQ-153 (0.71 μg/kg). 4,4-DDE was detected at 6 of 40 sample locations, the highest concentration was 1.5 μg/kg at FBQ-150. Methoxychlor was detected at 4 of 40 sample locations, the highest concentration was measured was 3 μg/kg at FBQ-148.

The greatest number of SVOC, VOC, and pesticide SRCs detected in surface water were collected from FBQ-145, -148, and -156 (quarry ponds), and FBQ-141 and -163, collected from a drainage channel west of the southern-most Quarry Pond.

4.9.4 Surface Water

The following explosives/propellants were detected in surface water samples:

- 2-Amino-4,6-DNT and 4-amino-2,6-DNT was detected only at FBQ-134, obtained from one of the smaller settling basins.
- Nitrocellulose, which was detected at 12 of 15 stations. The highest concentration measured was 1.1 μg/L at FBQ-145.

The following Inorganics were detected above facility-wide 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 site background occurred in surface water at station FBQ-130, which was 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 surface water samples for the Phase I/II RI: 4-methlphenol, bis(2-ethylhexyl) phthalate and phenol. The following VOCs were detected in 15 surface water samples collected for the Phase I/II RI:

- 2-Butanone was detected at three locations: FBQ-131 (5.1 μg/L), FBQ-132 (5 μg/L), and FBQ-134 (3.4 μg/L).
- Carbon disulfide was detected at three locations: FBQ-134 (1.7 μg/L), FBQ-139 (0.94 μg/L), and FBQ-141 (1.8 μg/L).
- Methylene chloride was detected at two sample locations: FBQ-145 (4.5 μg/kg) and FBQ-147 (4.7 μg/kg).
- Perchlorate was detected at two of nine original sample locations: 7.5 μg/L at FBQ-132 and 25 μg/L at FBQ-134; however, these locations were resampled in June 2004 and perchlorate was not detected in subsequent samples.
- Styrene was only detected at FBQ-132 (1.1 μg/L).
- Toluene was detected at ten sample locations. The highest concentration measured was 20 μg/L at FBQ-131.

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 site generally have a greater number of SRCs than the surface water sampled from the upgradient Quarry Ponds located to the east.

4.9.5 Groundwater

Wells Screened in Unconsolidated Materials

Explosives/propellants were detected in five of the six monitoring wells screed in the unconsolidated materials. The following explosives/propellants were detected:

- 2-amino-4,6-DNT – detected in FBQ-168.
- 4-amino-2,6-DNT – detected in FBQ-168.
- Nitrocellulose was detected in FBQ-167, -168, -169, -176, and -177.

Inorganic SRCs detected above background in all six unconsolidated monitoring wells were barium and manganese. Aluminum and nickel in were detected in three, zinc and cobalt in two, and copper and cadmium in one. FBQ-169 had the most inorganic SRCs at the maximum concentration detected in groundwater sampled from the unconsolidated materials.

The SVOCs caprolactum (three of six samples) and bis(2-ethylhexyl) phthalate (three of six samples) were detected in the monitoring well samples.

The following VOCs were detected in groundwater samples collected from the unconsolidated materials:

- 1,1,1-Trichloethane was detected at FBQ-167.
- 1,1-Dichlorethene was detected at FBQ-167 and -169.

- Acetone was detected at FBQ-167, -168, and -169.
- Carbon disulfide was detected at FBQ-177

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

Wells Screened in Sandstone Bedrock

Six explosive/propellant compounds were detected in the monitoring wells screened in bedrock. These compounds are as follows:

- 2,4,6-TNT was detected at FBQ-173 and -174.
- 2,4-DNT was detected in FBQ-174.
- 2-Amino-4,6-DNT was detected at FBQ-173 and -174.
- 4-Amino-2,6-DNT was detected at FBQ-173 and -174.
- Nitrobenzene was detected at FBQ-173.
- Nitrocellulose was detected in five of the six wells screened in bedrock; the highest concentration measured was at FBQ-175 (0.32 μg/L). Nitrocellulose was not detected in FBQ-166.

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 samples, nickel in two of the samples, and aluminum and hexavalent chromium in one of the samples. FBQ-173 had the most inorganic SRCs detected (aluminum, cobalt, copper, lead, manganese, and nickel).

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. The following VOCs were detected in groundwater samples collected from bedrock:

- Acetone was detected in two of three samples. The highest concentration measured was 6.2 μg/L at FBQ-175.
- TCE was detected at FBQ-170 (12 μg/L) and FBQ-171 (7.1 μg/L).

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, FBQ-173. The monitoring wells with the lowest number of SRCs are the downgradient wells, FBQ-166, -177, and -176.

5.0 CONTAMINANT FATE AND TRANSPORT

5.1 INTRODUCTION

This chapter describes the potential migration pathways and mechanisms for transport of chemical substances found in surface soils, subsurface soils, and groundwater at FBQ and the 40-mm Firing Range at RVAAP. Computer-based contaminant fate and transport analyses were performed to predict the rate of contaminant migration in the identified primary transport media and to project likely future contaminant concentrations at receptor locations through these media. The ultimate objectives of these analyses are to evaluate potential future impacts to human health and the environment and to provide a basis for evaluating the effectiveness of the future remedial alternatives.

Fate and transport modeling was used to simulate vertical transport of contaminants from principal source areas in soil to groundwater, as well as horizontal transport within the groundwater system from the source areas to receptor locations. A summary of the principles of contaminant fate and transport is presented in this chapter along with the results of modeling activities. Section 5.2 describes the physical and chemical properties of the SRCs (including metals, organic compounds, and explosives found at FBQ and the 40-mm Firing Range). Section 5.3 presents a conceptual model for contaminant fate and transport at FBQ and the 40-mm Firing Range that considers site topography, hydrogeology, contaminant sources, and release mechanisms through the transport media. Section 5.4 presents a soil leachability analysis to identify contaminant migration contaminant of potential concerns (CMCOPCs). Sections 5.5 describes the fate and transport modeling. The summary and conclusions of the fate and transport analysis are presented in Section 5.6.

5.2 PHYSICAL AND CHEMICAL PROPERTIES OF SITE-RELATED CONTAMINANTS

Inorganic and organic constituents in soil and groundwater are in continuous chemical and physical interaction with ambient surface and subsurface environments. The observed distributions of chemical concentrations in the environment are the result of these interactions. These interactions also determine the chemical fate of these materials in the transport media. Chemicals released into the environment are susceptible to several degradation pathways including hydrolysis, oxidation, reduction, isomerization, photolysis, photo-oxidation, biotransformation, and biodegradation. Transformation products resulting from these processes will behave distinctively in the environment.

The migration of chemical constituents through the transport media is governed by the physical and chemical properties of the constituents and the surface and subsurface media through which the chemicals are transferred. In a general way, chemical constituents and structures with similar physical and chemical characteristics will show similar patterns of transformation, transport, or attenuation in the environment. Solubility, vapor pressure data, chemical partitioning coefficients, degradation rates, and Henry's Law Constant provide information that can be used to evaluate contaminant mobility in the environment. Partitioning coefficients are used to assess the relative affinities of compounds for solution or solid phase adsorption. However, the synergistic effects of multiple migrating compounds and the complexity of soil/water interactions, including pH and oxidation-reduction potential (Eh), grain size, and clay mineral variability, are typically unknown.

The physical properties of the chemical constituents that were detected in the transport media at FBQ and the 40-mm Firing Range are summarized in Tables L-1, L-2, and L-3 of Appendix L. The properties are used to assess the anticipated behavior of each compound under environmental conditions.

5.2.1 Chemical Factors Affecting Fate and Transport

The water solubility of a compound is a measure of the saturated concentration of the compound in water at a given temperature and pressure. The tendency for a compound to be transported by groundwater is directly related to its solubility and inversely related to both its tendencies to adsorb to soil and to volatilize from water (OGE 1988). Compounds with high water solubilities tend to desorb from soils, are less likely to volatilize from water, and are susceptible to biodegradation. The water solubility of a compound varies with temperature, pH, and the presence of other dissolved constituents (including organic carbon and humic acids).

The octanol-water partition coefficient (Kow) can be used to estimate the tendency for a chemical to partition between environmental phases of different polarity. The Kow is a laboratory-determined ratio of the concentration of a chemical in the n-octanol phase of a two-phase system to the concentration in the water phase. Compounds with log Kow values less than 1 are highly hydrophilic, while compounds with log Kow values greater than 4 will partition to soil particles (Lyman, Reehl, and Rosenblatt 1990).

The water/organic carbon partition coefficient (Koc) is a measure of the tendency of a compound to partition between soil and water. The Koc is defined as the ratio of the absorbed compound per unit weight of organic carbon to the aqueous solute concentration. This coefficient can be used to estimate the degree to which a compound will adsorb to soil and, thus, not migrate with groundwater. The higher the Koc value, the greater is the tendency of the compound to partition into soil (OGE 1988). The sorption coefficient (Kd) is calculated by multiplying the Koc value by the fraction of organic carbon in the soil.

Vapor pressure is a measure of the pressure at which a compound and its vapor are in equilibrium. The value can be used to determine the extent to which a compound would travel in air, as well as the rate of volatilization from soils and solution (OGE 1988). In general, compounds with vapor pressures lower than 10^{-7} mm mercury will not be present in the atmosphere or air spaces in soil in significant amounts, while compounds with vapor pressures higher than 10-2 mm mercury will exist primarily in the air (Dragun 1988).

The Henry's Law Constant value (KH) for a compound is a measure of the ratio of the compound's vapor pressure to its aqueous solubility. The KH value can be used to make general predictions about the compound's tendency to volatilize from water. Substances with KH values less than 10^{-7} atm-m^3/mol will generally volatilize slowly, while compounds with a KH greater than 10^{-3} atm-m^3/mol will volatilize rapidly (Lyman, Reehl, and Rosenblatt 1990).

5.2.2 Biodegradation

Organic chemicals with differing chemical structures will biodegrade at different rates. Primary biodegradation consists of any biologically induced structural change in an organic chemical, while complete biodegradation is the biologically mediated degradation of an organic compound into carbon dioxide, water, oxygen, and other metabolic inorganic products (Dragun 1988). The first order biodegradation rate of an organic chemical is proportional to the concentration:

$$-dC/dt = kC, \qquad \textbf{(5-1)}$$

where

C = concentration,
t = time,
k = biodegradation rate constant = ln 2 / t1/2,
$t_{1/2}$ = biodegradation half-life.

The biodegradation half-life is the time necessary for half of the chemical to react. The biodegradation rate of an organic chemical is generally dependent on the presence and population size of soil microorganisms that are capable of degrading the chemical.

5.2.3 Inorganic Compounds

Inorganic constituents detected in soil samples at FBQ and the 40-mm Firing Range are associated with both the aqueous phase and with leachable metal ions on soil particles. The transport of these materials from unsaturated soils to the underlying groundwater is controlled by the physical processes of precipitation, infiltration, chemical interaction with the soil, and downward transport of removed metal ions by continued infiltration. The chemistry of inorganic interaction with percolating precipitation and varying soil conditions is complex and includes numerous chemical transformations that may result in altered oxidation states, ion exchange, adsorption, precipitation, or complexation. The chemical reactions, which are affected by environmental conditions including pH, oxidation/reduction conditions, and the type and amount of organic matter, clay, and the presence of hydrous oxides, may act to enhance or reduce the mobility and toxicity of the metal ions. In general, these reactions are reversible and add to the variability commonly observed in distributions of inorganics in soil.

The chemical form of an inorganic constituent determines its solubility and mobility in the environment; however, chemical speciation is complex and difficult to delineate in routine laboratory analysis. Metals in soil are commonly found in several forms, including dissolved concentrations in soil pore water, metal ions occupying exchange sites on inorganic soil constituents, specifically adsorbed metal ions on inorganic soil constituents, metal ions associated with insoluble organic matter, precipitated inorganic compounds as pure or mixed solids, and metal ions present in the structure of primary or secondary minerals (Shuman 1991).

The dissolved (aqueous) fraction and its equilibrium fraction are of primary importance when considering the migration potential of metals associated with soil. Of the inorganic compounds that are likely to form, chlorides, nitrates, and nitrites are commonly the most soluble. Sulfate, carbonate, and hydroxides generally have low to moderate solubility. Soluble compounds are transported in aqueous form subject to attenuation, whereas less soluble compounds remain as a precipitate and limit the overall dissolution of the metal ions. The solubility of the metal ions also is regulated by ambient chemical conditions, including pH and oxidation/reduction.

The attenuation of metal ions in the environment can be estimated numerically using the retardation factor (R_d). The extent to which the velocity of the contaminant is slowed is largely derived from the soil/water partitioning coefficient (K_d). The retardation factor is calculated using the following equation:

$$R_d = 1 + (K_d \, \rho_b)/\phi_w, \qquad \textbf{(5-2)}$$

where

ρb = the soil bulk dry density, (g/cm^3),
ϕw = soil moisture content, (dimensionless).

Metal ion concentrations in the environment do not attenuate by natural or biological degradation because of low volatility and solubility of the ions. Metals concentrations may be biotransformed or bioconcentrated through microbial activity.

5.2.4 Organic Compounds

Organic compounds, such as SVOCs or VOCs, detected in soil, sediment, or water at FBQ and the 40-mm Firing Range may be transformed or degraded in the environment by various processes, including hydrolysis, oxidation/reduction, photolysis, volatilization, biodegradation, or biotransformation. The half-life of organic compounds in the transport media can vary from minutes to years, depending on environmental conditions and the chemical structures of the compounds. Some types of organic compounds are very stable, and degradation rates can be very slow. Organic degradation may either enhance (through the production of more toxic byproducts) or reduce (through concentration reduction) the toxicity of a chemical in the environment.

5.2.5 Explosives – Related Compounds

Explosive compounds were detected in soil and sediment at FBQ and the 40-mm Firing Range. With regard to these compounds, microbiological and photochemical transformation may affect the fate and distribution of this class of constituents in the environment as well. For example, based on the results of culture studies involving the removal of TNT by activated sludge microorganisms, it has been concluded that TNT undergoes biotransformation, but not biodegradation (Burrows et al. 1989). It has been found (Funk et al. 1993) that the anaerobic metabolism occurs in two stages. The first stage is the reductive stage in which TNT is reduced to its amino derivatives. In the second stage, degradation to non-aromatic products begins after the reduction of the third nitro group.

The biotransformation pathway for TNT in simulated composting systems is shown on Figure 5-1 (Kaplan and Kaplan 1990). The biotransformation of 2,4-DNT has been systematically studied in laboratory cell cultures (McCormick et al. 1978). The pathway proposal for this biotransformation is shown in Figure 5-2. The reduction products include the amino and azoxy derivatives as observed with TNT biotransformation. As with TNT and DNT, the principal mode of microbial transformation of the nitroaromatic compounds TNB and 1,3-DNB is reduction of nitro groups to form amino groups.

Limited information exists regarding biotransformation or biodegradation of RDX. One pilot study being conducted by USACE (USACE 2004) that evaluates treatment of pink water wastes using an anaerobic fluidized-bed granular activated carbon bioreactor indicated RDX biodegradation in the presence of ethanol. Such data may be useful for evaluating potential use of enhanced bioremediation as a remedial option. Biodegradation studies were also conducted by ANRCP (Shull et al. 1999) on vadose zone soils obtained from a depth of 55 to 60 ft at location beneath the Pantext Plant. They were able to determine the impact of electron acceptor availability and nutrient addition on RDX biodegradation, the extent of RDX mineralization (i.e., conversion to inorganic carbon) during biodegradation and estimated the kinetics of RDX biodegradation to provide information for mathematical modeling of fate and transport. They had concluded that biodegradation rates RDX were very slow under aerobic conditions as compared to anaerobic conditions. The aerobic biodegradation half-life was determined to be as high as 1,390 days.

5.3 CONCEPTUAL MODEL FOR FATE AND TRANSPORT

To effectively represent site-specific conditions in numerical modeling applications, the CSM is relied upon to provide inputs on site conditions that serve as the framework for quantitative modeling. Site conditions described by the CSM, which is outlined in Chapter 2.0 and refined in Chapter 8.0, include contaminant source information, the surrounding geologic and hydrologic conditions, and the magnitude of SRCs and their current spatial distribution. This information is used to identify chemical migration pathways at FBQ and the 40-mm Firing Range for fate and transport analysis. The predictive function of the CSM, which is of primary importance to contaminant fate and transport analysis, relies on known

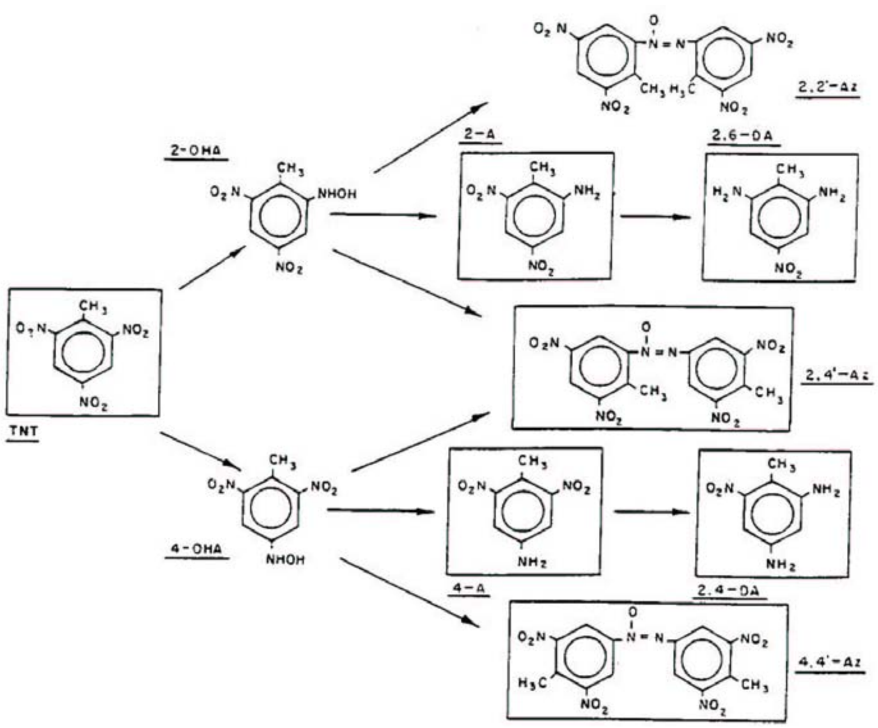


Figure 5-1. 2,4,6-TNT Biotransformation Pathway (Kaplan and Kaplan 1990)

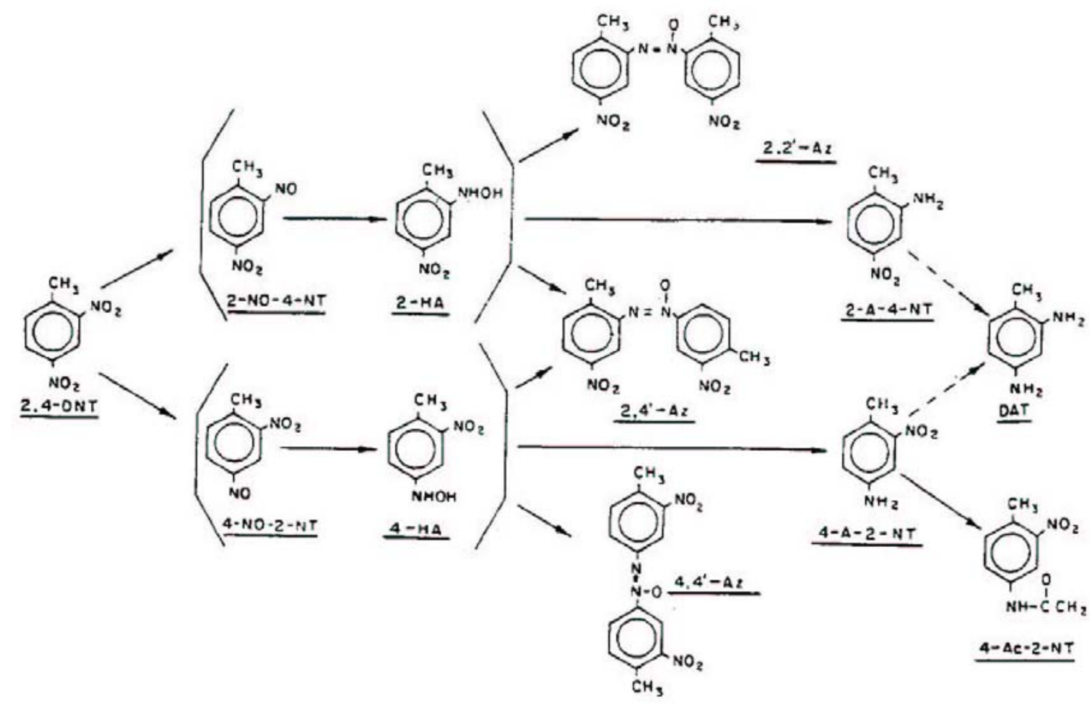


Figure 5-2. 2,4-DNT Biotransformation Pathway (McCormick et al. 1978)

information and informed assumptions about the site. Assumptions contained in the CSM are reiterated throughout this section. The better the information and the greater the accuracy of the assumptions, the more accurately the CSM describes the AOC and, therefore, the more reliable the numerical modeling predictions can be. Below, a summary of the salient elements of the CSM that apply to fate and transport modeling is given.

5.3.1 Contaminant Sources

Based on the analysis of the field data, the following contaminant sources have been identified.

- Metals and explosive residues are present primarily in the surface soil below the footprint of FBQ and the 40-mm Firing Range. Numerous inorganic SRCs are identified in these areas; aluminum, antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, iron, lead, manganese, nickel, selenium, silver, thallium, vanadium, and zinc were most pervasive. Organic SRCs identified are benzo(*a*)anthracene; benzo(*a*)pyrene; benzo(*b*)fluoranthene; benzo(*k*)fluoranthene; bis(2-ethylhexyl)phthalate; chrysene; diethyl phthalate; di-n-butyl phthalate; fluoranthene; pyrene; 1,1,1-trichloroethane (TCA); 1,1-DCE; acetone; carbon disulfide; methylene chloride; toluene; TCE; o-xylene; and m+p-xylene. Explosive SRCs identified are 1,3-DNB; 1,3,5-TNB; 2,4,6-TNT; 2,4-DNT; 2,6-DNT; 2-amino-4,6-DNT; 4-amino-2,6-DNT; 3-nitrotoluene; HMX; nitrobenzene; nitrocellulose; RDX; and tetryl.

- Metals and organic residues are present in the groundwater below FBQ. Metal SRCs identified in the groundwater are aluminum, barium, cobalt, copper, iron, manganese, nickel, and zinc. Organic SRCs identified are bis(2-ethylhexyl)phthalate; butylbenzyl phthalate; caprolactum; di-n-butyl phthalate; 1,1,1-TCA; 1,1-DCE; acetone; carbon disulfide; and TCE. Explosive SRCs identified were 2,4,6-TNT; 2,4-DNT; 2-amino-4,6-DNT; 4-amino-2,6-DNT; nitrobenzene; and nitrocellulose.

5.3.2 Hydrogeology

A complete description of the site geology and hydrology for FBQ and the 40-mm Firing Range is provided in Chapter 2.0 and is summarized below.

- Elevations vary from approximately 335 m in the eastern portion of this area, to 353 m (1,088 to 1,160 ft) AMSL on the western portion of this area. The area is characterized by gently sloping to relatively flat-lying topography on a weathered sandstone bedrock surface

- Soil at RVAAP is generally derived from the silty clay glacial till that overlies bedrock. At these sites, soils of the Mitiwanga series in the eastern portion, and soils of Mahoning in the central and western part of the area, are prevalent. Trumbull series soils are common adjacent to the unnamed tributary in the western part of FBQ. The Mitiwanga series soils are typically moderately deep, well drained soils formed in glacial till overlying sandstone bedrock. The Mahoning series soils are typified by poorly drained soil formed in silty clay loam or clay loam glacial till where bedrock is generally greater than 1.8 m (6 ft). Runoff is typically medium to rapid, and the soil is seasonally wet. Permeabilities typically range from 1.52 to 5.08 cm (0.6 to 2.0 in.) per hour. Trumbull series soils are generally deep, poorly drained, nearly level soils formed in silty clay loam, clay loam, or silty clay glacial till (USDA 1978). FBQ is situated within a band of glacial outwash deposits.

- On the northern, western, and northeastern portions of FBQ, surface water generally drains from east to west towards the unnamed creek in the western portion of FBQ. Surface water generally flows to the south from the southeastern section of FBQ. The three larger ponds in the eastern part of FBQ intersect surface water flow from the east and northeast. Based on the groundwater elevations in surrounding monitoring wells, the ponds are hydraulically connected to the groundwater table. Groundwater flow at the site is generally towards the unnamed creek at the western portion of FBQ. The elevation of the groundwater table varies from 1105 to 1125 ft AMSL at FBQ.

- Contaminant concentrations are highest within a discrete zone [0- to 1-m (0- to 3-ft) surface soil interval]. Contaminant leaching pathways from soil to the water table are through the soil cover.

5.3.3 Contaminant Release Mechanisms and Migration Pathways

Based on the information presented above, the following contaminant release mechanisms and migration pathways have been identified.

Water infiltrating through contaminated surface soils may leach contaminants into the groundwater. The factors that affect the leaching rate include a contaminant's solubility, K_d, and the amount of infiltration. Insoluble compounds will precipitate out of solution in the subsurface or remain in their insoluble forms with little leaching. For the contaminants detected at FBQ and the 40-mm Firing Range, sorption processes and the K_d generally will have the greatest effect on leaching. Another factor that affects whether a contaminant will reach the water table through infiltration of rainwater is the contaminant's rate of decay. Most of the organic and explosives compounds decay at characteristic rates that are described by the substance's half-life. For a given percolation rate, those contaminants with long half-lives have a greater potential for contaminating groundwater than those with shorter half-lives. Explosives were not detected in groundwater samples; therefore, chemical decay and attenuation rates exceed leaching rates.

Surface water and sediment transport are considered minor future pathways and were not evaluated in fate and transport modeling although this pathway may have been more significant in the past when the sites were active. Current impacted surface soils are limited in extent (e.g., few detects of explosives/propellants, SVOCs, and VOCs; highest detects of inorganics limited to few sample locations). A broader range of constituents were detected in the quarry pond sediment than in surface soils, which may be attributable to past operational activity and use of the quarry ponds. Currently, vegetation limits sediment transport in the vicinity of the quarry ponds. The southernmost quarry pond has an overflow pipe that discharges water to the west – presumably the nearby ditch. This overflow pipe is controlled by a shut-off valve that is currently closed. The other two quarry ponds do not have overflow drainage points. Streams at FBQ are ephemeral and only limited surface water was available for sample collection – stream just west of quarry ponds was sampled but unnamed tributary near Greenleaf Road was not. The settling basins by design limit sediment transport. In addition, the western portion of the site where these are located is relatively flat further limiting significant sediment transport. Vegetation also limits sediment transport in the vicinity of the unnamed tributary near Greenleaf Road.

Release by gaseous emissions and airborne particulates is not significant at FBQ or the 40-mm Firing Range. VOCs were not found at significant concentrations in surface soil, as they had already volatilized; therefore, there is likely little to no gaseous emission, and contaminant levels in the air pathway are minor to nonexistent.

5.3.4 Water Balance

The potential for contaminant transport begins with precipitation. Infiltration is the driving mechanism for leaching of soil contaminants to groundwater. The actual amount of rainwater available for flow and infiltration to groundwater is highly variable and dependent upon soil type and climatic conditions. A water balance calculation can be used as a tool to quantitatively account for all the components of the hydrologic cycle at FBQ and the 40-mm Firing Range. The quantified elements of the water balance are used for inputs to the soil leaching and groundwater transport models discussed later. The components of a simple steady-state water balance model include precipitation (P), evapotranspiration (ET), surface runoff (Sr), and groundwater recharge or percolation (Gr). These terms are defined as follows:

$$P = ET + Sr + Gr, \qquad \textbf{(5-3)}$$

or

$$\text{Rainwater available for flow} = Sr + Gr = P - ET. \qquad \textbf{(5-4)}$$

A relatively moderate amount of runoff occurs from the site. It is expected that loss of runoff occur in the form of evaporation. The remaining water after runoff is infiltration, which includes loss to the atmosphere by evapotranspiration. The water balance estimations were developed using the Hydrologic Evaluation of Landfill Performance (HELP) model (Schroeder et al. 1994) calculations for FBQ and the 40-mm Firing Range site conditions using precipitation and temperature data for a 100-year period generated synthetically in HELP using coefficients for Cleveland, Ohio.

The annual average water balance estimates indicate an evapotranspiration of 28% [0.26 m (10.3 in.)] of total precipitation [0.94 m (37 in.)]. The remaining 72% [0.68 m (27 in.)] of rainwater is available for surface water runoff and infiltration to groundwater. Of the 0.68 m (27 in.) of rainwater available for runoff or infiltration, groundwater recharge (infiltration) accounts for 10% [0.095 m (3.7 in.)], and surface runoff accounts for the remaining 62% [0.60 m (23. in.)].

5.3.5 Natural Attenuation of Contaminants

Natural attenuation accounting for advection, dispersion, sorption, volatilization, and decay effects can effectively reduce contaminant toxicity, mobility, or volume (mass) to levels that are protective of human health and the ecosystem within an acceptable, site-specific time period. Therefore, natural attenuation as a remedial alternative has become a cost-effective approach to site remediation. The overburden materials at FBQ and the 40-mm Firing Range generally have sufficient organic carbon content to cause retardation of organic constituents. In addition, the clay mineralogy results in significant cation retardation of inorganic constituents by adsorption reactions. Attenuation through adsorption occurs in the vadose zone because of higher organic carbon and clay content in the overburden materials. However, the available data collected to date do not allow quantification of natural attenuation. A focused investigation would be required to quantify natural attenuation at this site and to determine if it would be a viable potential remedial approach.

5.4 SOIL LEACHABILITY ANALYSIS

Soil leachability analysis is a screening analysis performed to define CMCOPCs. The CMCOPCs are defined as the constituents that may pose the greatest problem if they are migrating from a specified source.

5.4.1 Soil Screening Analysis

The first step of the soil screening analysis is the development of SRCs, as discussed in Chapter 4.0. The chemical data in soils were grouped into two aggregate areas (Figure 1-4) and screened using frequency of detection and RVAAP facility-wide background criteria to identify SRCs. The sediment data were grouped into a separate aggregate from the soils at FBQ. The aggregates are as follows:

- FBQ Soils
- 40-mm Firing Range
- Sediment Aggregate at FBQ

The second step of the soil screening analysis is development of the source-specific soil exposure concentrations. The soil exposure concentration of a contaminant in an aggregate represents the 95% upper confidence limit (UCL_{95}) developed using results of all the soil samples within the aggregate, or the maximum value if the UCL_{95} exceeds the maximum.

In the third step of the soil screening analysis, the soil exposure concentrations of all identified SRCs are compared with EPA generic soil screening levels (GSSLs). The GSSLs are set for Superfund sites for the migration to groundwater pathway (EPA 1996b). A dilution attenuation factor (DAF) of 1.3 was estimated following EPA guidelines (1996b) and applied to the GSSLs 40-mm Firing Range soil aggregate. The DAFs were estimated to be 1.14 for the FBQ soil aggregate, and 1.91 for the sediment aggregate. As described in the EPA Soil Screening Guidance documentation (EPA 1996b), contaminant dilution in groundwater is estimated at each unit from a unit-specific dilution attenuation factor (DAF). The DAF, which is defined as the ratio of soil leachate concentration to receptor point concentration, is minimally equal to 1. Dilution in groundwater is derived from a simple mixing zone equation (Equation 5-5) and relies upon estimation of the mixing zone depth (Equation 5-6).

$$\mathrm{DAF} = 1 + \frac{(\mathrm{K} \times i \times \mathrm{d})}{(\mathrm{I} \times \mathrm{L})} \qquad \textbf{(5-5)}$$

where

DAF	=	dilution attenuation factor,
K	=	aquifer hydraulic conductivity (m/year) (see Table 5.1),
i	=	horizontal hydraulic gradient (m/m),
I	=	infiltration rate (m/year),
L	=	source length parallel to groundwater flow (m),
d	=	mixing zone depth (m), which is defined below.

$$\mathrm{d} = \sqrt{0.0112 \times \mathrm{L}^2} + \mathrm{d_a} \times \left[1 - \exp\left(\frac{-\mathrm{L} \times \mathrm{I}}{\mathrm{K} \times i \times \mathrm{d_a}}\right)\right] \qquad \textbf{(5-6)}$$

where

d_a	=	aquifer thickness (m),
d	≤	d_a.

Table 5-1. Unit-specific Parameters Used in SESOIL and AT123D Modeling for FBQ and the 40-mm Firing Range[a]

Parameters	Symbol	Units	Value	Source for Value
		SESOIL		
Percolation rate (recharge rate)	q	m/year	9.50E-02	0.1 * SESOIL precipitation
Horizontal area of aggregate	A_p	sq. m	60,000	Estimated from soil aggregate[b]
Intrinsic permeability - clayey sand	p	cm^2	8.9E-11	Calibrated SESOIL model
Disconnectedness index	c	unitless	10	Calibrated from SESOIL model
Freundlich equation exponent	n	unitless	1	SESOIL default
Fraction organic carbon	f_{oc}	unitless	4.95E-03[h]	Site-specific average data[c]
Bulk density	ρ_b	kg/L	1.77	Site-specific average geotechnical data[c]
Porosity - total	n_T	unitless	0.35	Site-specific average geotechnical data[c]
Vadose zone thickness	Vz	m	4.2	Average based on depth to water table data
Leaching zone thickness	Th	m	3[i]	Based on soil contamination and water level data
		AT123D		
Aquifer thickness	h	m	5	Average site-specific[d]
Hydraulic conductivity in saturated zone	K_S	cm/s	1.6E-04	Site-specific slug test data[e]
Hydraulic gradient in saturated zone	I_S	m/m	1.80E-02	Groundwater potentiometric surface map
Effective porosity	n_e	unitless	0.2	Assumed for silt[f]
Distance to the compliance point	X	m	0	Beneath the source
Dispersivity, longitudinal	α_L	m	10	Assumed[g]
Dispersivity, transverse	α_T	m	3.3	0.3 α_L
Dispersivity, vertical	α_V	m	1	0.1 α_L
Retardation factor	R_d	unitless	chemical-specific	See Table L-15

[a] All the parameters used by SESOIL and AT123D for the three source areas are the same except the area.
[b] An area 300 x 200 m = 60,000 m^2 (approximately) was considered for FBQ and an area of 165 x 450 m =72,000 m2 was considered for the 40-mm Firing Range.
[c] See Table 4-1 for information on the depths and locations of geotechnical samples
[d] The aquifer thickness was based on the average observed in the well logs for monitoring wells FBQ-166 through FBQ-177.
[e] The hydraulic conductivity was based on the geomean of the slug test values (slug in and slug out) for monitoring wells FBQ-166 through FBQ-177.
[f] The hydraulic conductivity was estimated as1.55E-4 cm/sec. This value suggests the subsurface to be silt/sand (Mills et al., 1985). The subsurface was assumed to be silt.
[g] Longitudinal dispersivity is assumed by using 10% of the mean travel distance (0.1 x 100m) = 10 (Gelhar and Axness 1981) (Gelhar et al. 1985)
[h] The average f_{oc} for sediment aggregate was estimated to be 0.0421.
[i] The average leaching zone thickness for sediment aggregate was estimated to be 4.0 m.
AT123D = Analytical Transient 1-,2-,3-Dimensional model.
FBQ = Fuze and Booster Quarry Landfill/Ponds.
HELP = Hydrologic Evaluation of Landfill Performance model.
NA = Not applicable - parameter not used.
SESOIL = Seasonal Soil Compartment model.

As stated above, if the aquifer thickness is less than the calculated mixing zone depth, then the aquifer thickness is used for "d" in the DAF calculation. The GSSL is defined as the concentration of a contaminant in soil that represents a level of contamination below which there is no concern under CERCLA, provided conditions associated with GSSLs are met. Generally, if contaminant concentrations in soil fall below the GSSL, and there are no significant ecological receptors of concern, then no further study or action is warranted for that area. However, it should be noted that the purpose of this screen is not to identify the contaminants that may pose risk at downgradient locations, but to target those contaminants that may pose the greatest problem if they are migrating from the site. When the GSSL for an SRC was not available from EPA (1996b), a calculated GSSL was developed using the following equation (EPA 1996b):

$$C_s = C_w \left\{ K_d + \frac{\theta_w + \theta_a K_H}{\rho_b} \right\} \quad \textbf{(5-7)}$$

where

C_w = target groundwater concentration (mg/L),
C_s = calculated soil screening level (GSSL) (mg/kg),
K_d = soil adsorption coefficient (L/Kg),
K_H = Henry's Law Constant (unitless),
ρ_b = dry soil bulk density (kg/L),
θ_w = water-filled soil porosity (volume percent),
θ_a = air-filled soil porosity (volume percent).

Default values, as used by EPA (1996b) to develop the GSSLs, were used in the calculations. Non-zero maximum contaminant levels (MCLs) or risk-based concentrations (RBCs) for groundwater were used for target groundwater concentrations. Based on this screening, only those constituents that exceeded their published or calculated GSSL multiplied by the DAF were identified as the initial (preliminary) CMCOPCs, based on leaching to groundwater. These initial CMCOPCs, illustrated on Table L-5 in Appendix L, include metals, explosive compounds, and VOCs.

In the fourth step, the initial CMCOPCs from FBQ and the 40-mm Firing Range were further evaluated using fate and transport models provided in Section 5.5.

5.4.2 Limitations and Assumptions of Soil Screening Analysis

It is important to recognize that acceptable soil concentrations for individual chemicals are highly site-specific. The GSSLs used in this screening are based on a number of default assumptions chosen to be protective of human health for most site conditions (EPA 1996b). These GSSLs are expected to be more conservative than site-specific screening levels based on site geotechnical conditions. The conservative assumptions included in this analysis are: (1) no adsorption in the unsaturated zone or in the aquifer, (2) no biological or chemical degradation in the soil or in the aquifer, and (3) contamination is uniformly distributed throughout the source. However, the GSSL does not incorporate the existence of contamination already present in the aquifer. In any case, to evaluate the contaminant migration potential from the source areas, a GSSL screen can be used as an effective tool.

5.5 FATE AND TRANSPORT MODELING

Contaminant fate and transport modeling is based on the conceptual model for FBQ and the 40-mm Firing Range, as was discussed in Section 5.3. Seasonal Soil Compartment (SESOIL) modeling was performed for constituents identified as the initial CMCOPCs from the source (see Section 5.5.2). The modeling was performed to predict concentrations of a constituent in the leachate immediately beneath the selected source area just above the water table. If the predicted leachate concentration of a CMCOPC exceeded its MCL or RBC, then lateral migration using the Analytical Transient 1-,2-,3-Dimensional (AT123D) model (see Section 5.5.2) was performed to predict the groundwater concentrations at designated receptor locations. The receptor location identified for the source area is (1) the water table immediately below the source. Noted, the receptor is below the source, and the AT123D model is used to predict the concentration in groundwater after dilution due to hydrodynamic dispersion and mixing.

5.5.1 Modeling Approach

Contaminant transport in the vadose zone includes the movement of water and dissolved materials from the source area at FBQ and the 40-mm Firing Range to groundwater. This occurs as rainwater infiltrates from the surface and percolates through the area of contamination, and its surrounding soil, into the saturated zone. The downward movement of water, driven by gravitational potential, capillary pressure, and other components of total fluid potential, mobilizes the contaminants and carries them through the vadose zone. Lateral transport is controlled by the regional groundwater gradient. Vertical transport down through the vadose zone to the water table and the horizontal transport through the glacial deposits to the downgradient locations are illustrated in Figure 5-3.

The output of the contaminant fate and transport modeling is presented as the expected maximum concentration of modeled contaminants at the selected receptor locations. For SESOIL, the receptor location was the groundwater table beneath the source area. For lateral transport using AT123D modeling, the receptor location is the water table below the source area. The modeling results allow prediction of the approximate locations of future maximum concentrations resulting from the integration of the contributions from multiple sources and different pathways.

The SESOIL model was calibrated to match the percolation rate developed by the HELP model simulation. If the concentration in the groundwater was observed to be higher than the leachate concentration predicted by SESOIL, the AT123D was calibrated to match the observed groundwater concentration.

Once the leachate modeling for the source area was completed using the SESOIL model, the predicted maximum groundwater concentrations beneath the source area were determined using the AT123D model, and the concentrations were compared against the existing groundwater concentrations at the source area. The greater of the predicted or observed concentration in the groundwater was compared against the respective MCLs or RBCs. If the predicted or measured maximum groundwater concentrations were higher than the MCLs or RBCs, groundwater modeling was performed using the higher concentration as the source term concentration. If the predicted and actual concentrations were less than the MCLs or RBCs, the contaminant was eliminated from the list of CMCOPCs, and no further evaluations were performed.

5.5.2 Model Applications

The SESOIL model (GSC 1998) used for leachate modeling, when applicable, estimates pollutant concentrations in the soil profile following introduction via direct application and/or interaction with transport media. The AT123D model (Yeh 1992) is an analytical groundwater pollutant fate and transport model. It computes the spatial-temporal concentration distribution of wastes in the aquifer system and predicts the transient spread of a contaminant plume through a groundwater aquifer. The application of both of these models is discussed in the following subsections.

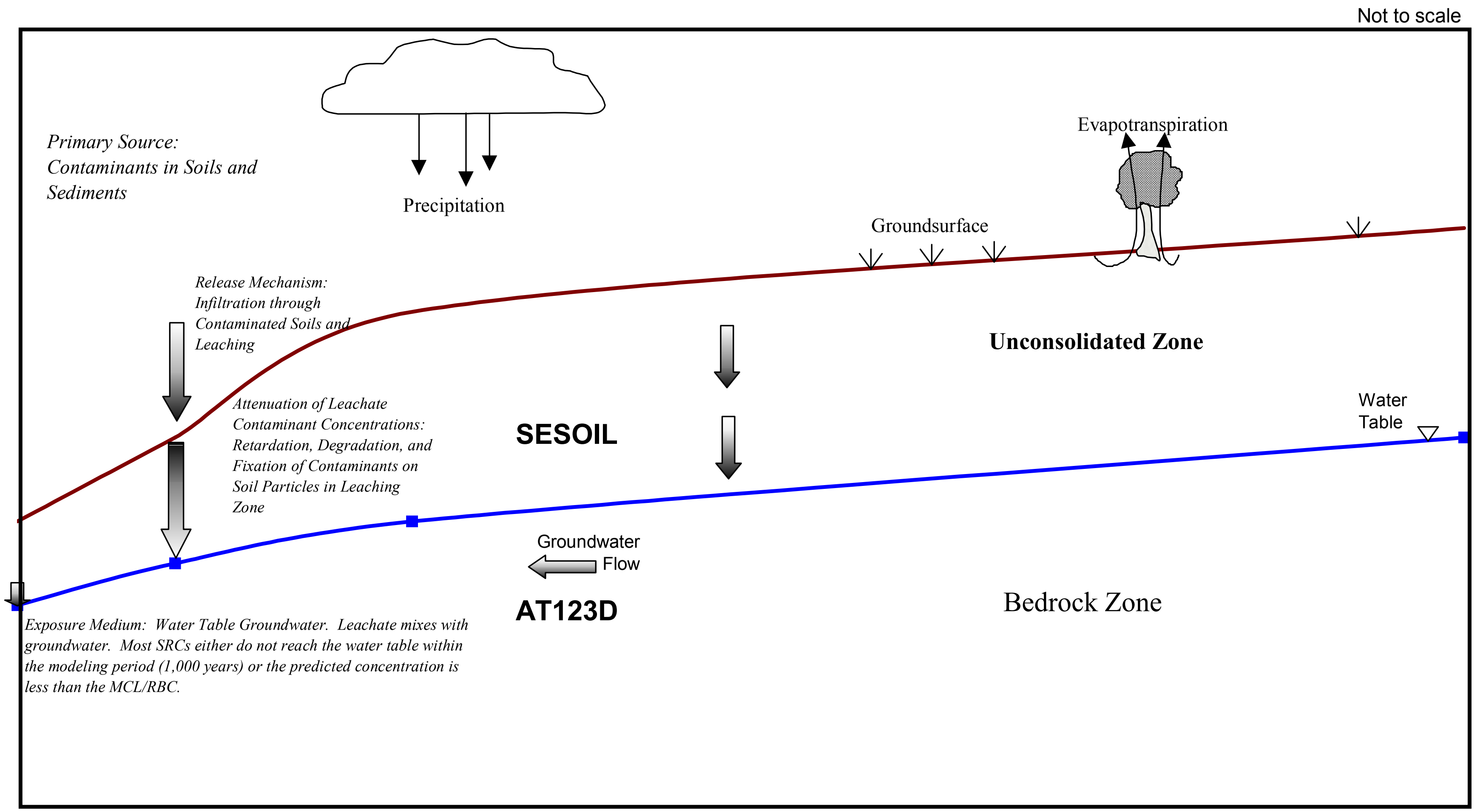


Figure 5-3. Contaminant Migration Conceptual Model

5.5.2.1 SESOIL modeling

The SESOIL model defines the soil compartment as a soil column extending from the ground surface through the unsaturated zone and to the upper level of the saturated soil zone. Processes simulated in SESOIL are categorized in three cycles – the hydrologic cycle, sediment cycle, and pollutant cycle. Each cycle is a separate submodule in the SESOIL code. The hydrologic cycle includes rainfall, surface runoff, infiltration, soil-water content, evapotranspiration, and groundwater recharge. The pollutant cycle includes convective transport, volatilization, adsorption/desorption, and degradation/decay. A contaminant in SESOIL can partition in up to four phases (liquid, adsorbed, air, and pure). The sediment washload cycle includes erosion and sediment transport.

Data requirements for SESOIL are not extensive, utilizing a minimum of site-specific soil and chemical parameters and monthly or seasonal meteorological values as input. Output of the SESOIL model includes pollutant concentrations at various soil depths and pollutant loss from the unsaturated soil zone in terms of surface runoff, percolation to groundwater, volatilization, and degradation. The mathematical representations in SESOIL generally consider the rate at which the modeled processes occur, the interaction of different processes with each other, and the initial conditions of both the waste area and the surrounding subsurface matrix material.

SESOIL simulation for a contaminant was performed over a 1,000-year period. The period was selected considering the voluminous output and the lengthy time required to complete a simulation for a longer period of time. Also, EPA suggests a screening value of 1,000 years to be used due to the high uncertainty associated with predicting conditions beyond that time frame. Therefore, the initial CMCOPCs at the selected source were screened against a travel time of greater than 1000, and to be conservative, the travel time selected for screening was 1,500 years. The travel time is the time required by a contaminant to travel from the base of its contamination to the water table. The estimated travel time for each initial CMCOPC to reach the water table is determined using the following equation:

$$T_r = \frac{T_h \times R_d}{V_p} \qquad \textbf{(5-8)}$$

where

T_r = leachate travel time (year),
T_h = thickness of attenuation zone (ft),
R_d = retardation factor (dimensionless) (Equation 5-2),
V_p = pore water velocity (ft/year).

and

$$V_p = \frac{I}{\theta} \qquad \textbf{(5-9)}$$

where

I = infiltration rate (ft/year),
θ = fraction of total porosity that is filled by water.

If the source depth for a constituent is equal to the thickness of the vadose zone, the constituent is determined to have a travel time equal to zero using the above equations (i.e., no leaching zone). The estimated travel time is then compared to a screening value. If the travel time for a constituent from a source area exceeded 1,500 years, then the constituent was eliminated from the list of CMCOPCs. Initial CMCOPCs with travel times less than 1,500 years are considered to be COPCs and are selected for further analysis.

Details of the model layers utilized in this modeling are presented in Tables L-9 and L-10 of Appendix L. The SESOIL model was calibrated against the percolation rate by varying the intrinsic permeability and by keeping all other site-specific geotechnical parameters fixed. The final site-specific hydrogeologic parameter values used in this modeling are shown in Table 5-1. Fraction organic carbon, bulk density, and porosity were determined based on site-specific geotechnical data collected (See Table 4-1). The hydraulic conductivity value represents the geometric mean from the slug test analysis (slug in and slug out) conducted from monitoring wells FBQ-166 through FBQ-177. Longitudinal dispersivity is assumed to be 10 based on Gelhar and Axness (1981) suggestion of using 10% of the mean travel distance for estimating. Gelhar et al. (1985)indicates that no definite conclusion can be reached greater than 100m distance. Therefore 0.1 x 100m, or 10 is used as the longitudinal dispersivity. The loading soil concentrations used in the model represent the exposure concentration (i.e., smaller of the maximum detected concentration or the 95% UCL).

The intrinsic permeability was derived during calibration of the model to a percolation rate of 0.09 m/year. The chemical-specific parameters are presented in Appendix L (Table L-8). The distribution coefficients (K_ds) for metals were obtained from EPA's Soil Screening Guidance Document (EPA 1996b) unless stated otherwise. The K_ds for organic compounds were estimated from organic carbon-based water partition coefficients (K_{oc}) using the relationship $K_d = (f_{oc})(K_{oc})$, where f_{oc} = soil organic carbon content as mass fraction obtained from site-specific measurements and K_{oc} values were obtained from EPA's Soil Screening Guidance Document (EPA 1996b), unless stated otherwise. Biodegradation rates are not applicable for the inorganic CMCOPCs. Most conservative values found in the literature (Howard et al. 1991) were used for organic CMCOPCs, however, biodegradation values could not be found in literature for 1,3-trinitrobenzene, 3-nitrotoluene, and RDX (Table L-8). The constituents selected for SESOIL modeling are listed in Table 5-2.

5.5.2.2 AT123D modeling in the saturated zone

The fate and transport processes accounted for in the AT123D model include advection, dispersion, adsorption/retardation, and decay. This model can be used as a tool for estimating the dissolved concentration of a chemical in three dimensions in the groundwater resulting from a mass release over a source area (point, line, area, or volume source). The model can handle instantaneous, as well as continuous, source loadings of chemicals of interest at the site. AT123D is frequently used by the scientific and technical community to perform quick and conservative estimates of groundwater plume movement in space and time. SESOIL and AT123D are linked in a software package (RISKPRO) so that mass loading to the groundwater predicted by SESOIL can be directly transferred to AT123D. Therefore, AT123D was chosen to predict the future receptor concentrations for the contaminants.

Table 5-2. Summary of Leachate Modeling Results for FBQ and the 40-mm Firing Range

Initial CMCOPC	RME 0-3 ft[1] (mg/kg)	Predicted $C_{leachate,max}$ Beneath the Source (mg/L)	Predicted Tmax (years)	Predicted $C_{gw,max}$ At the Source[2] (mg/L)	Observed $C_{gw,max}$ Downgradient of Source (mg/L)	MCL/RBC (mg/L)	Final CM COPC[3]
FBQ							
Explosives							
2,4-Dinitrotoluene	6.15E-02	6.40E-08	20	5.61E-08	3.10E-04	7.30E-02	
2,6-Dinitrotoluene	8.45E-02	2.20E-06	16	1.93E-06	ND	3.60E-02	
Nitrobenzene	5.31E-02	1.00E-10	22	8.77E-11	1.70E-04	6.10E-02	
RDX	1.06E-01	1.30E-01	7	1.14E-01	ND	6.10E-04	Yes
Metals							
Chromium	2.59E+01	8.16E-01	720	7.16E-01	1.00E-02	1.00E-01	Yes
Selenium	1.37E+00	1.63E-01	195	1.43E-01		5.00E-02	Yes
Organics-Volatile							
Methylene chloride	2.69E-02	1.00E-09	10	2.28E-07	ND	5.00E-03	
Sediment Aggregate at FBQ							
Explosives							
1,3-Dinitrobenzene	0.0578	1.00E-10	90	5.24E-11		3.65E-03	
1,3,5-Trinitrobenzene	0.0562	0.003985	20	2.09E-03		1.09E+00	
2,6-Dinitrotoluene	0.0545	1.00E-10	90	5.24E-11	ND	3.60E-02	
3-Nitrotoluene	0.106	3.75E-04	370	1.96E-04		6.10E-02	
Nitrobenzene	0.0526	1.00E-10	150	5.24E-11	1.70E-04	3.40E-03	
Metals							
Selenium	8.19E-01	6.40E-03	175	3.35E-03		5.00E-02	

Table 5-2. Summary of Leachate Modeling Results for FBQ and the 40-mm Firing Range (continued)

Initial CMCOPC	RME 0-3 ft[1] (mg/kg)	Predicted $C_{leachate,max}$ Beneath the Source (mg/L)	Predicted $C_{leachate,max}$ Predicted Tmax (years)	Predicted $C_{gw,max}$ At the Source[2] (mg/L)	Observed $C_{gw,max}$ Downgradient of Source (mg/L)	MCL/RBC (mg/L)	Final CM COPC[3]
40-mm Firing Range							
Explosives							
2,4-Dinitrotoluene	5.19E-02	2.40E-08	20	1.85E-08	3.10E-04	7.30E-02	
3-Nitrotoluene	1.00E-01	2.35E-02	40	1.81E-02	ND	6.10E-02	
Nitrobenzene	4.98E-02	0.00E+00	NA	NA	1.70E-04	3.40E-03	
Pesticide							
Lindane	9.30E-04	0.00E+00	NA	NA	ND	7.30E-02	
Metals							
Chromium	3.36E+01	1.04E+00	720	7.99E-01	ND	1.00E-01	Yes
Organics-Volatile							
1,1-Dichloroethene	5.84E-03	2.80E-06	17	2.15E-06	4.20E-03	5.00E-03	

[a] The concentration was calculated using a dilution attenuation factor (DAF) = 1.14 for FBQ, 1.91 for the sediment aggregate at FBQ, and a DAF = 1.3 for the 40-mm Firing Range.
[b] The final contaminant migration constituent of potential concern (CMCOPC) was identified by comparing the predicted/observed concentration in groundwater to the maximum contaminant level/risk-based concentration (MCL/RBC). A constituent is a final CMCOPC if its predicted/observed concentration in groundwater exceeds its MCL/RBC within 1,000 years.
ND = Not detected.
RBQ = Fuze and Booster Quarry Landfill/Ponds.
RME = Reasonable maximum exposure.
RVAAP = Ravenna Army Ammunition Plant.

The hydrogeologic parameter values used in this modeling are shown in Table 5-1. The chemical-specific parameters are presented in Appendix L (Table L-15). A discussion of model assumptions and limitations is presented in Section 5.5.4. The constituents selected for this modeling are listed in Table 5-3, along with the results of the modeling. The CMCOPCs in this table represent all of the constituents that were identified as final CMCOPCs based on leachate modeling (SESOIL) plus any additional constituents currently observed in groundwater exceeding their respective MCL or RBC. Constituents for which the predicted maximum groundwater concentration exceeded the MCL or RBC at a receptor location were identified as the constituent migration constituents of concern (CMCOCs).

5.5.3 Modeling Results

SESOIL modeling was performed for initial CMCOPCs that are expected to reach the water table within 1500 years (Table 5-2). The modeling was performed for 2,4-DNT, 2,6-DNT, nitrobenzene, and RDX among the explosive compounds; chromium and selenium among the metals; and methylene chloride among the VOCs from FBQ. From the 40-mm Firing Range 2,4-DNT; 3-nitrotoluene; nitrobenzene; lindane; and 1,1-DCE among the organic compounds; and chromium among the metals were selected for SESOIL modeling. For the sediment aggregate at FBQ, 1,3-dinitrobenzene, 1,3,5-trinitrobenzene, 2,6-DNT; 3-nitrotoluene; and nitrobenzene among the organic compounds; and selenium among the metals were selected for SESOIL modeling Table 5-2 presents the predicted peak leachate and groundwater concentrations beneath the source area and the corresponding time for peak leachate concentrations. The predicted groundwater concentrations were developed by dividing the predicted peak leachate concentration by the site-specific DAF (see Section 5.4). In addition, this table presents, for comparison, the current maximum observed concentrations in the groundwater downgradient of the source and drinking water MCLs or RBCs (if no MCL is available). Due to the variable groundwater gradient at the site, all wells were considered downgradient from the source so that the highest groundwater concentration measured was taken as the downgradient groundwater concentration. The table shows that RDX, chromium, and selenium were predicted to exceed MCLs or RBCs beneath the source area at FBQ, and only chromium was predicted to exceed its MCL beneath the source area at the 40-mm Firing Range. Therefore, these two constituents were selected as the final CMCOPCs for lateral migration. However, because none of the initial CMCOPCs from the sediment aggregate at FBQ were predicted to exceed groundwater MCL or RBC beneath the source area, there were no final CMCOPCs and lateral migration modeling was not necessary for this aggregate.

Table 5-3 shows the final CMCOPCs selected for lateral migration using AT123D. As can be seen in Table 5-3, along with the CMCOPCs from SESOIL modeling, TCE; 2,4,6-TNT; manganese; and iron are added to the list of CMCOPC for lateral migration modeling based on comparison of observed groundwater data to their respective MCL/RBC values. Table 5-3 presents the predicted groundwater concentration at the selected receptor locations. 2,4,6-TNT, RDX, chromium, iron, and manganese are predicted to exceed their respective MCLs and are identified as CMCOCs from FBQ. Only chromium is identified as a CMCOC from the 40-mm Firing Range.

Table 5-3. Summary of Fate and Transport Modeling Results for the Fuze and Booster Quarry Landfill/Ponds

Initial CMCOPC	Predicted/Observed $C_{gw,max}$ At the Source[a] (mg/L)	Predicted $C_{gw,max}$ at Receptors Locations: at Source Boundary (mg/L)	Predicted $C_{gw,max}$ at Receptors Locations: at the unnamed Creek (mg/L)	Observed $C_{gw,max}$ Downgradient of Source (mg/L)	MCL/RBC (mg/L)	Final CMCOPC[b]	Comment
FBQ							
Explosives							
2,4,6-Trinitrotoluene[c]	1.80E-02	0.00E+00	0.00E+00	1.80E-02	2.24E-03	Yes	*d*
RDX	1.10E-01	1.93E-02	5.88E-05	ND	6.10E-04	Yes	*e*
Metals							
Chromium	7.16E-01	1.65E-01	0.00E+00	1.00E-02	1.00E-01	Yes	*e*
Iron[c]	1.64E+01	0.00E+00	0.00E+00	1.64E+01	1.10E+01	Yes	*d*
Manganese[c]	6.77E+00	0.00E+00	0.00E+00	6.77E+00	8.80E-01	Yes	*d*
Selenium	1.43E-01	4.80E-02	0.00E+00	ND	5.00E-02		
Organics-Volatile							
Trichloroethene	1.20E-02	8.00E-09	0.00E+00	1.20E-02	5.00E-03	Yes	*d*
40-mm Firing Range							
Metals							
Chromium	7.99E-01	2.04E-01	0.00E+00	1.00E-02	1.00E-01	Yes	*e*

[a] The concentration was calculated using dilution attenuation factor (DAF) = 1.14 for FBQ and a DAF = 1.3 for the 40-mm Firing Range.
[b] The final contaminant migration constituent of potential concern (CMCOPC) was identified comparing the predicted/observed concentration in groundwater at the receptor locations to its maximum contaminant level (MCL) or risk-based concentration (RBC). A constituent is a final CMCOPC if its predicted/observed concentration in groundwater at any of the receptor locations exceeds its MCL/RBC within 1,000 years.
[c] The constituent was not identified as a CMCOPC based on leachability analysis; however, it was selected for lateral migration modeling based on the detected concentration in groundwater exceeding its RBC.
d The constituent is a contaminant migration constituent of concern (CMCOC) because the maximum observed groundwater exceeds its MCL/RBC.
e The constituent is a CMCOC because the maximum predicted groundwater concentration at the source boundary exceeds its MCL/RBC.
ND = Not detected.
FBQ = Fuze and Booster Quarry Landfill/Ponds.
RVAAP = Ravenna Army Ammunition Plant.

5.5.4 Limitations/Assumptions

A conservative modeling approach was used, which may overestimate the contaminant concentration in the leachate for migration from observed soil concentrations. Listed below are important assumptions used in this analysis.

- The use of K_d and R_d to describe the reaction term of the transport equation assumes that an equilibrium relationship exists between the solid- and solution-phase concentrations and that the relationship is linear and reversible.
- The K_d-values used in this analysis for all the CMCOPCs represent literature or calculated values and may not represent the site conditions.
- Flow and transport in the vadose zone is one-dimensional (i.e., only in the vertical direction).Initial condition is disregarded in the vadose zone modeling.
- Flow and transport are not affected by density variations.
- A realistic distribution of soil contamination is not considered.
- No seasonal variation in the groundwater flow direction was considered.
- Contaminant migration from the source to the compliance point is along the shortest line.

The inherent uncertainties associated with using these assumptions must be recognized. K_d values are highly sensitive to changes in the major chemistry of the solution phase. Therefore, it is important that the values be measured or estimated under conditions that will represent as closely as possible those of the contaminant plume. It is also important to note that the contaminant plume will change over time and will be affected by multiple solutes that are present at the site. Projected organic concentrations in the aquifer are uncertain because of the lack of site-specific data on constituent decay in the vadose zone, as well as in the saturated zone. Use of literature values (particularly partition coefficients) may produce either over- or underestimation of constituent concentrations in the aquifer. In this sense, the modeling may not be conservative. Deviations of actual site-specific parameter values from assumed literature values may significantly affect contaminant fate predictions.

The effects of heterogeneity, anisotropy, and spatial distribution of fractures are not addressed in these simulations. The present modeling study using SESOIL and AT123D does not address the effects of flow and contaminant transport across interfaces in rapidly varying heterogeneous media.

Conceptually, the water-table depth was assumed to be 14 ft BGS (SESOIL modeling depth). Therefore, the saturated groundwater flow was assumed to occur below soil cover (Figure 2-4). Given AT123D limitation, the hydraulic conductivity field for the saturated zone was assumed homogeneous, and its geometric mean value of 1.55E-4 cm/sec based on the slug-test results (Table 2-1) was used in this modeling. Noting the conductivity to range from 8.0E-06 to 3.3E-03 cm/sec, the predicted concentrations appear to represent a mean condition within a range of expected concentrations. The range appears to be orders of magnitude, suggesting the associated uncertainty to be significant.

For AT123D modeling, the key input parameters are hydraulic conductivity (K_s), hydraulic gradient (I_s), effective porosity (n_e), and K_d. The K_s, I_s, and n_e work as a lumped parameter controlling the seepage velocity $V_s = K_s*I_s/n_e$. The impact (sensitivity) of K_d is discussed above. The hydraulic gradient is noted to vary over a relatively narrow range below the facility (Figure 2-5). Therefore, the impact of hydraulic gradient is expected to be relatively less than that of K_s. In addition, a change in groundwater flow direction will affect the travel distance from the source to the compliance point. Here, groundwater was assumed to flow from the source to the compliance point along the shortest line. This assumption is expected to produce conservative results. The impact of n_e can be significant given the presence of fractures in the Sharon Group (Chapter 2).

5.6 SUMMARY AND CONCLUSIONS

Based on site characterization and monitoring data, metals, organics, and explosives-related compounds exist in surface soil, subsurface soil, and groundwater at FBQ and the 40-mm Firing Range. Based on site 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 MCLs/RBCs. Fate and transport modeling indicate 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 for the three source areas are as follows.

Fuze and Booster Quarry Landfill/Ponds

- 2,4-DNT; 2,6-DNT; nitrobenzene; RDX; methylene chloride; chromium; and selenium were identified as initial CMCOPCs for from 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 SESOIL modeling.
- RDX and chromium were identified as CMCOCs based on 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. Although the maximum groundwater concentrations of these constituents were predicted or observed to exceed MCLs/RBCs within the site boundary, none of these constituents were predicted to reach the downgradient receptor location (i.e., unnamed creek) at concentrations exceeding their respective MCL/RBC.

40-mm Firing Range

- 2,4-DNT; 3-nitrotoluene; nitrobenzene; lindane; 1,1-DCE; and chromium were identified as initial CMCOPCs for the 40-mm Firing Range based on soil screening analysis.
- Only chromium was identified as final CMCOPCs for the 40-mm Firing Range based on source loading predicted by the SESOIL modeling.
- Chromium was also identified as CMCOCs based on AT123D modeling. The maximum groundwater concentration of chromium was predicted to exceed its MCL below the source as well as at the downgradient source boundary. However, it was not predicted to reach the downgradient receptor location (i.e., unnamed creek) within 1,000 years of simulation time.

Sediment Aggregate at FBQ

- 1,3-Dinitrobenzene, 1,3,5-trinitrobenzene, 2,6-DNT; 3-nitrotoluene; nitrobenzene; and selenium were identified as initial CMCOPCs for from the sediments based on soil screening analysis.

- None of the initial CMCOPCs were identified as final CMCOPCs for this source area based on source loading predicted by the SESOIL modeling. Therefore, contaminated sediments from this site are not predicted to impact groundwater in the future.

6.0 HUMAN HEALTH RISK ASSESSMENT

6.1 INTRODUCTION

This HHRA documents the potential health risks to humans resulting from exposure to contamination within FBQ. This HHRA is based on the methods from the *RVAAP's Facility-wide Human Health Risk Assessor Manual* (FWHHRAM) (USACE 2004b). The objective of this HHRA is to evaluate and document the potential risks to human health associated with current and potential future exposures to contaminants if no remedial action is taken. Thus, this assessment represents the risks for the "no-action" alternative in a FS.

The methodology presented in the FWHHRAM is based on *Risk Assessment Guidance for Superfund* (RAGS) (EPA 1989a and 1991a) and additional methodology taken from *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment)* (EPA 2004a); *Exposure Factors Handbook* (EPA 1997a); Integrated Risk Information System (IRIS) (EPA 2005, updated approximately monthly); and Health Effects Assessment Summary Tables (HEAST) (EPA 1997b). The inorganic and organic COPCs identified in this HHRA are quantitatively analyzed (when possible) to characterize the potential risks to human health from exposure to these contaminants. The results of the HHRA are used to (1) document and evaluate risks to human health; (2) determine the need, if any, for remedial action; and (3) identify COCs that may require the development of chemical-specific remediation levels.

This risk assessment is organized into six major sections. The screening process used to identify COPCs is discussed in Section 6.2. The exposure assessment, which is performed to identify the exposure pathways by which receptors may be exposed to contaminants and calculate potential intakes, is presented in Section 6.3. The toxicity assessment for the FBQ COPCs is presented in Section 6.4. The results of the risk characterization are presented in Section 6.5 and the uncertainty analysis is presented in Section 6.6. Remedial goal options (RGOs) are presented in Section 6.7, and the conclusions of the HHRA are summarized in Section 6.8.

6.2 DATA EVALUATION

The purpose of the data evaluation is to develop a set of chemical data suitable for use in the HHRA. This chapter provides a description of the data evaluation process used to identify COPCs for FBQ. The data evaluation process is conducted in accordance with the FWHHRAM (USACE 2004b). The purpose of the HHRA data evaluation screening process is to eliminate chemicals for which no further risk evaluation is needed.

A summary of available data is presented in Chapter 4.0. Data collected at FBQ are aggregated by environmental medium (e.g., surface soil). Samples included in the HHRA data sets for groundwater, shallow surface soil, deep surface soil, subsurface soil, sediment, and surface water are listed in Tables 6-1 through 6-6, respectively. A description of the media for which human receptors are potentially exposed follows.

Table 6-1. Human Health Risk Assessment Data Set for Groundwater

Station	Sample ID
Bedrock Aquifer	
FBQmw-170	FBQmw-170-0314-GW
FBQmw-170	FBQmw-170-0315-GF
FBQmw-171	FBQmw-171-0316-GW
FBQmw-171	FBQmw-171-0317-GF
FBQmw-172	FBQmw-172-0318-GW
FBQmw-172	FBQmw-172-0319-GF
FBQmw-173	FBQmw-173-0320-GW
FBQmw-173	FBQmw-173-0321-GF
FBQmw-174	FBQmw-174-0322-GW
FBQmw-174	FBQmw-174-0323-GF
FBQmw-175	FBQmw-175-0324-GW
FBQmw-175	FBQmw-175-0325-GF
Unconsolidated Aquifer	
FBQmw-166	FBQmw-166-0306-GW
FBQmw-166	FBQmw-166-0307-GF
FBQmw-167	FBQmw-167-0308-GW
FBQmw-167	FBQmw-167-0309-GF
FBQmw-168	FBQmw-168-0310-GW
FBQmw-168	FBQmw-168-0311-GF
FBQmw-169	FBQmw-169-0312-GW
FBQmw-169	FBQmw-169-0313-GF
FBQmw-176	FBQmw-176-0326-GW
FBQmw-176	FBQmw-176-0327-GF
FBQmw-177	FBQmw-177-0328-GW
FBQmw-177	FBQmw-177-0329-GF

Table 6-2. Human Health Risk Assessment Data Set for Shallow (0-1 ft bgs) Surface Soil

Station	Sample ID	Depth (ft bgs)
FBQso-001	FBQss-001-0001-SO	0 - 1
FBQso-002	FBQss-002-0003-SO	0 - 1
FBQso-003	FBQss-003-0005-SO	0 - 1
FBQso-004	FBQss-004-0007-SO	0 - 1
FBQso-005	FBQss-005-0009-SO	0 - 1
FBQso-006	FBQss-006-0011-SO	0 - 1
FBQso-007	FBQss-007-0013-SO	0 - 1
FBQso-008	FBQss-008-0015-SO	0 - 1
FBQso-009	FBQss-009-0017-SO	0 - 1
FBQso-010	FBQss-010-0019-SO	0 - 1
FBQso-011	FBQss-011-0021-SO	0 - 1
FBQso-012	FBQss-012-0023-SO	0 - 1
FBQso-013	FBQss-013-0025-SO	0 - 1
FBQso-014	FBQss-014-0027-SO	0 - 1
FBQso-015	FBQss-015-0029-SO	0 - 1
FBQss-016	FBQss-016-0031-SO	0 - 1
FBQso-017	FBQss-017-0033-SO	0 - 1
FBQss-018	FBQss-018-0035-SO	0 - 1
FBQso-019	FBQss-019-0037-SO	0 - 1
FBQso-020	FBQss-020-0039-SO	0 - 1
FBQso-021	FBQss-021-0041-SO	0 - 1
FBQso-022	FBQss-022-0043-SO	0 - 1
FBQso-023	FBQss-023-0045-SO	0 - 1
FBQss-024	FBQss-024-0047-SO	0 - 1
FBQss-025	FBQss-025-0049-SO	0 - 1
FBQso-026	FBQss-026-0051-SO	0 - 1
FBQss-027	FBQss-027-0053-SO	0 - 1
FBQso-028	FBQss-028-0055-SO	0 - 1
FBQso-029	FBQss-029-0057-SO	0 - 1
FBQso-030	FBQss-030-0059-SO	0 - 1
FBQss-031	FBQss-031-0061-SO	0 - 1
FBQso-032	FBQss-032-0063-SO	0 - 1
FBQso-033	FBQss-033-0065-SO	0 - 1
FBQss-034	FBQss-034-0067-SO	0 - 1
FBQss-035	FBQss-035-0069-SO	0 - 1
FBQso-036	FBQss-036-0071-SO	0 - 1
FBQss-037	FBQss-037-0073-SO	0 - 1
FBQso-038	FBQss-038-0075-SO	0 - 1
FBQss-039	FBQss-039-0077-SO	0 - 1
FBQso-040	FBQss-040-0079-SO	0 - 1
FBQss-041	FBQss-041-0081-SO	0 - 1
FBQss-042	FBQss-042-0083-SO	0 - 1

Table 6-2. Human Health Risk Assessment Data Set for Shallow (0-1 ft bgs) Surface Soil (continued)

Station	Sample ID	Depth (ft bgs)
FBQss-043	FBQss-043-0085-SO	0 - 1
FBQss-044	FBQss-044-0087-SO	0 - 1
FBQss-045	FBQss-045-0089-SO	0 - 1
FBQss-046	FBQss-046-0091-SO	0 - 1
FBQss-047	FBQss-047-0093-SO	0 - 1
FBQso-048	FBQss-048-0095-SO	0 - 1
FBQss-049	FBQss-049-0097-SO	0 - 1
FBQss-050	FBQss-050-0099-SO	0 - 1
FBQso-051	FBQss-051-0101-SO	0 - 1
FBQss-052	FBQss-052-0103-SO	0 - 1
FBQss-053	FBQss-053-0105-SO	0 - 1
FBQso-054	FBQss-054-0107-SO	0 - 1
FBQss-055	FBQss-055-0109-SO	0 - 1
FBQso-056	FBQss-056-0111-SO	0 - 1
FBQso-057	FBQss-057-0113-SO	0 - 1
FBQss-058	FBQss-058-0115-SO	0 - 1
FBQso-059	FBQss-059-0117-SO	0 - 1
FBQso-060	FBQss-060-0119-SO	0 - 1

Table 6-3. Human Health Risk Assessment Data Set for Deep (0-4 ft bgs) Surface Soil

Station	Sample ID	Depth (ft bgs)	Sample ID	Depth (ft bgs)
FBQso-001	FBQss-001-0001-SO	0 - 1	FBQso-001-0002-SO	1 - 3
FBQso-002	FBQss-002-0003-SO	0 - 1	FBQso-002-0004-SO	1 - 3
FBQso-003	FBQss-003-0005-SO	0 - 1	FBQso-003-0006-SO	1 - 3
FBQso-004	FBQss-004-0007-SO	0 - 1	FBQso-004-0008-SO	1 - 3
FBQso-005	FBQss-005-0009-SO	0 - 1	FBQso-005-0010-SO	1 - 3
FBQso-006	FBQss-006-0011-SO	0 - 1	FBQso-006-0012-SO	1 - 3
FBQso-007	FBQss-007-0013-SO	0 - 1	FBQso-007-0014-SO	1 - 3
FBQso-008	FBQss-008-0015-SO	0 - 1	FBQso-008-0016-SO	1 - 3
FBQso-009	FBQss-009-0017-SO	0 - 1	FBQso-009-0018-SO	1 - 3
FBQso-010	FBQss-010-0019-SO	0 - 1	FBQso-010-0020-SO	1 - 3
FBQso-011	FBQss-011-0021-SO	0 - 1	FBQso-011-0022-SO	1 - 3
FBQso-012	FBQss-012-0023-SO	0 - 1	FBQso-012-0024-SO	1 - 3
FBQso-013	FBQss-013-0025-SO	0 - 1	FBQso-013-0026-SO	1 - 3
FBQso-014	FBQss-014-0027-SO	0 - 1	FBQso-014-0028-SO	1 - 3
FBQso-015	FBQss-015-0029-SO	0 - 1	FBQso-015-0030-SO	1 - 3
FBQss-016	FBQss-016-0031-SO	0 - 1		
FBQso-017	FBQss-017-0033-SO	0 - 1	FBQso-017-0034-SO	1 - 3
FBQss-018	FBQss-018-0035-SO	0 - 1		
FBQso-019	FBQss-019-0037-SO	0 - 1	FBQso-019-0038-SO	1 - 3
FBQso-020	FBQss-020-0039-SO	0 - 1	FBQso-020-0040-SO	1 - 3
FBQso-021	FBQss-021-0041-SO	0 - 1	FBQso-021-0042-SO	1 - 3
FBQso-022	FBQss-022-0043-SO	0 - 1	FBQso-022-0044-SO	1 - 3
FBQso-023	FBQss-023-0045-SO	0 - 1	FBQso-023-0046-SO	1 - 3
FBQss-024	FBQss-024-0047-SO	0 - 1		
FBQss-025	FBQss-025-0049-SO	0 - 1		
FBQso-026	FBQss-026-0051-SO	0 - 1	FBQso-026-0052-SO	1 - 3
FBQss-027	FBQss-027-0053-SO	0 - 1		
FBQso-028	FBQss-028-0055-SO	0 - 1	FBQso-028-0056-SO	1 - 3
FBQso-029	FBQss-029-0057-SO	0 - 1	FBQso-029-0058-SO	1 - 3
FBQso-030	FBQss-030-0059-SO	0 - 1	FBQso-030-0060-SO	1 - 3
FBQss-031	FBQss-031-0061-SO	0 - 1		
FBQso-032	FBQss-032-0063-SO	0 - 1	FBQso-032-0064-SO	1 - 3
FBQso-033	FBQss-033-0065-SO	0 - 1	FBQso-033-0066-SO	1 - 3
FBQss-034	FBQss-034-0067-SO	0 - 1		
FBQss-035	FBQss-035-0069-SO	0 - 1		
FBQso-036	FBQss-036-0071-SO	0 - 1	FBQso-036-0072-SO	1 - 3
FBQss-037	FBQss-037-0073-SO	0 - 1		
FBQso-038	FBQss-038-0075-SO	0 - 1	FBQso-038-0076-SO	1 - 3
FBQss-039	FBQss-039-0077-SO	0 - 1		
FBQso-040	FBQss-040-0079-SO	0 - 1	FBQso-040-0080-SO	1 - 3
FBQss-041	FBQss-041-0081-SO	0 - 1		
FBQss-042	FBQss-042-0083-SO	0 - 1		

Table 6-3. Human Health Risk Assessment Data Set for Deep (0-4 ft bgs) Surface Soil (continued)

Station	Sample ID	Depth (ft bgs)	Sample ID	Depth (ft bgs)
FBQss-043	FBQss-043-0085-SO	0 - 1		
FBQss-044	FBQss-044-0087-SO	0 - 1		
FBQss-045	FBQss-045-0089-SO	0 - 1		
FBQss-046	FBQss-046-0091-SO	0 - 1		
FBQss-047	FBQss-047-0093-SO	0 - 1		
FBQso-048	FBQss-048-0095-SO	0 - 1	FBQso-048-0096-SO	1 - 3
FBQss-049	FBQss-049-0097-SO	0 - 1		
FBQss-050	FBQss-050-0099-SO	0 - 1		
FBQso-051	FBQss-051-0101-SO	0 - 1	FBQso-051-0102-SO	1 - 3
FBQss-052	FBQss-052-0103-SO	0 - 1		
FBQss-053	FBQss-053-0105-SO	0 - 1		
FBQso-054	FBQss-054-0107-SO	0 - 1	FBQso-054-0108-SO	1 - 3
FBQss-055	FBQss-055-0109-SO	0 - 1		
FBQso-056	FBQss-056-0111-SO	0 - 1	FBQso-056-0112-SO	1 - 3
FBQso-057	FBQss-057-0113-SO	0 - 1	FBQso-057-0114-SO	1 - 3
FBQss-058	FBQss-058-0115-SO	0 - 1		
FBQso-059	FBQss-059-0117-SO	0 - 1	FBQso-059-0118-SO	1 - 1.5
FBQso-060	FBQss-060-0119-SO	0 - 1	FBQso-060-0120-SO	1 - 3

Table 6-4. Human Health Risk Assessment Data Set for Subsurface Soil (1-3 ft bgs)

Station	Sample ID	Depth (ft bgs)
FBQso-001	FBQso-001-0002-SO	1 - 3
FBQso-002	FBQso-002-0004-SO	1 - 3
FBQso-003	FBQso-003-0006-SO	1 - 3
FBQso-004	FBQso-004-0008-SO	1 - 3
FBQso-005	FBQso-005-0010-SO	1 - 3
FBQso-006	FBQso-006-0012-SO	1 - 3
FBQso-007	FBQso-007-0014-SO	1 - 3
FBQso-008	FBQso-008-0016-SO	1 - 3
FBQso-009	FBQso-009-0018-SO	1 - 3
FBQso-010	FBQso-010-0020-SO	1 - 3
FBQso-011	FBQso-011-0022-SO	1 - 3
FBQso-012	FBQso-012-0024-SO	1 - 3
FBQso-013	FBQso-013-0026-SO	1 - 3
FBQso-014	FBQso-014-0028-SO	1 - 3
FBQso-015	FBQso-015-0030-SO	1 - 3
FBQso-017	FBQso-017-0034-SO	1 - 3
FBQso-019	FBQso-019-0038-SO	1 - 3
FBQso-020	FBQso-020-0040-SO	1 - 3
FBQso-021	FBQso-021-0042-SO	1 - 3
FBQso-022	FBQso-022-0044-SO	1 - 3
FBQso-023	FBQso-023-0046-SO	1 - 3
FBQso-026	FBQso-026-0052-SO	1 - 3
FBQso-028	FBQso-028-0056-SO	1 - 3
FBQso-029	FBQso-029-0058-SO	1 - 3
FBQso-030	FBQso-030-0060-SO	1 - 3
FBQso-032	FBQso-032-0064-SO	1 - 3
FBQso-033	FBQso-033-0066-SO	1 - 3
FBQso-036	FBQso-036-0072-SO	1 - 3
FBQso-038	FBQso-038-0076-SO	1 - 3
FBQso-040	FBQso-040-0080-SO	1 - 3
FBQso-048	FBQso-048-0096-SO	1 - 3
FBQso-051	FBQso-051-0102-SO	1 - 3
FBQso-054	FBQso-054-0108-SO	1 - 3
FBQso-056	FBQso-056-0112-SO	1 - 3
FBQso-057	FBQso-057-0114-SO	1 - 3
FBQso-059	FBQso-059-0118-SO	1 - 1.5
FBQso-060	FBQso-060-0120-SO	1 - 3

1 **Table 6-5. Human Health Risk Assessment Data Set for Sediment**

Station	Sample ID	Depth (ft bgs)
Ditch		
FBQsd-141	FBQsd-141-0266-SD	0 - 0.5
FBQsd-142	FBQsd-142-0267-SD	0 - 0.5
FBQsd-143	FBQsd-143-0268-SD	0 - 0.5
FBQsd-159	FBQsd-159-0284-SD	0 - 0.5
FBQsd-160	FBQsd-160-0285-SD	0 - 0.5
FBQsd-162	FBQsd-162-0287-SD	0 - 0.5
FBQsd-163	FBQsd-163-0288-SD	0 - 0.5
Quarry Ponds		
FBQsd-144	FBQsd-144-0269-SD	0 - 0.5
FBQsd-145	FBQsd-145-0270-SD	0 - 0.5
FBQsd-146	FBQsd-146-0271-SD	0 - 0.5
FBQsd-147	FBQsd-147-0272-SD	0 - 0.5
FBQsd-148	FBQsd-148-0273-SD	0 - 0.5
FBQsd-149	FBQsd-149-0274-SD	0 - 0.5
FBQsd-150	FBQsd-150-0275-SD	0 - 0.5
FBQsd-151	FBQsd-151-0276-SD	0 - 0.5
FBQsd-152	FBQsd-152-0277-SD	0 - 0.5
FBQsd-153	FBQsd-153-0278-SD	0 - 0.5
FBQsd-154	FBQsd-154-0279-SD	0 - 0.5
FBQsd-155	FBQsd-155-0280-SD	0 - 0.5
FBQsd-156	FBQsd-156-0281-SD	0 - 0.5
FBQsd-157	FBQsd-157-0282-SD	0 - 0.5
FBQsd-158	FBQsd-158-0283-SD	0 - 0.5
FBQsd-164	FBQsd-164-0289-SD	0 - 0.5
FBQsd-165	FBQsd-165-0290-SD	0 - 0.5
Settling Basins		
FBQsd-126	FBQsd-126-0251-SD	0 - 0.5
FBQsd-127	FBQsd-127-0252-SD	0 - 0.5
FBQsd-128	FBQsd-128-0253-SD	0 - 0.5
FBQsd-129	FBQsd-129-0254-SD	0 - 0.5
FBQsd-130	FBQsd-130-0255-SD	0 - 0.5
FBQsd-131	FBQsd-131-0256-SD	0 - 0.5
FBQsd-132	FBQsd-132-0257-SD	0 - 0.5
FBQsd-133	FBQsd-133-0258-SD	0 - 0.5
FBQsd-134	FBQsd-134-0259-SD	0 - 0.5
FBQsd-135	FBQsd-135-0260-SD	0 - 0.5
FBQsd-136	FBQsd-136-0261-SD	0 - 0.5
FBQsd-137	FBQsd-137-0262-SD	0 - 0.5
FBQsd-138	FBQsd-138-0263-SD	0 - 0.5
FBQsd-139	FBQsd-139-0264-SD	0 - 0.5
FBQsd-140	FBQsd-140-0265-SD	0 - 0.5

2

Table 6-5. Human Health Risk Assessment Data Set for Sediment (continued)

Station	Sample ID	Depth (ft bgs)
FBQsd-161	FBQsd-161-0286-SD	0 - 0.5
FBQsd-184	FBQsd-184-0415-SD	0 - 0.5
FBQsd-185	FBQsd-185-0416-SD	0 - 0.5
FBQsd-186	FBQsd-186-0418-SD	0 - 0.5
FBQsd-187	FBQsd-187-0419-SD	0 - 0.5
FBQsd-188	FBQsd-188-0420-SD	0 - 0.5
FBQsd-189	FBQsd-189-0422-SD	0 - 0.5
FBQsd-190	FBQsd-190-0423-SD	0 - 0.5
FBQsd-191	FBQsd-191-0424-SD	0 - 0.5
FBQsd-192	FBQsd-192-0425-SD	0 - 0.5

Table 6-6. Human Health Risk Assessment Data Set for Surface Water

Station	Sample ID
Ditch	
FBQsw-141	FBQsw-141-0298-SW
Quarry Ponds	
FBQsw-145	FBQsw-145-0291-SW
FBQsw-147	FBQsw-147-0292-SW
FBQsw-153	FBQsw-153-0294-SW
FBQsw-154	FBQsw-154-0293-SW
Settling Basins	
FBQsw-130	FBQsw-130-0295-SW
FBQsw-131	FBQsw-131-0296-SW
FBQsw-132	FBQsw-132-0297-SW
FBQsw-132	FBQsw-132-0414-SW
FBQsw-133	FBQsw-133-0299-SW
FBQsw-134	FBQsw-134-0300-SW
FBQsw-134	FBQsw-134-0410-SW
FBQsw-135	FBQsw-135-0301-SW
FBQsw-136	FBQsw-136-0302-SW
FBQsw-137	FBQsw-137-0303-SW
FBQsw-138	FBQsw-138-0304-SW
FBQsw-139	FBQsw-139-0305-SW

- Surface soil is defined as soil from 0 to 1 ft BGS (shallow surface soil) for all receptors except the National Guard Trainee. Surface soil is defined as 0 to 4 ft BGS (deep surface soil) for the National Guard Trainee; however, soil samples were taken to a maximum depth of 3 ft BGS. Many planned 1 to 3 ft BGS samples were collected to less than 3 ft due to the presence of shallow bedrock in the quarry.

- Subsurface soil is defined as soil from 1 to 12 ft BGS for the Resident Subsistence Farmer. No samples are available below 3 ft BGS; therefore, soil samples collected from 1 to 3 ft BGS are evaluated for the Resident Subsistence Farmer. Proposed land use at FBQ is mounted training/no digging; therefore, subsurface soil is not evaluated for the National Guard Trainee.

- Sediment and surface water data are evaluated in this HHRA for three aggregates: Quarry Ponds, Settling Basins, and Ditch (Figure 6-1).

- Groundwater data are available for two aggregates: Bedrock and Unconsolidated.

FBQ encompasses approximately 39 acres and is evaluated as a single EU in this HHRA for surface and subsurface soil. Evaluation as a single EU is appropriate for the potential current and future exposures at this site (i.e., National Guard mounted training with occasional use by hunters; see Section 6.3).

Section 6.2.1 provides a summary of the COPC selection process and the data assumptions used during that process. Section 6.2.2 presents the results of the COPC screening process.

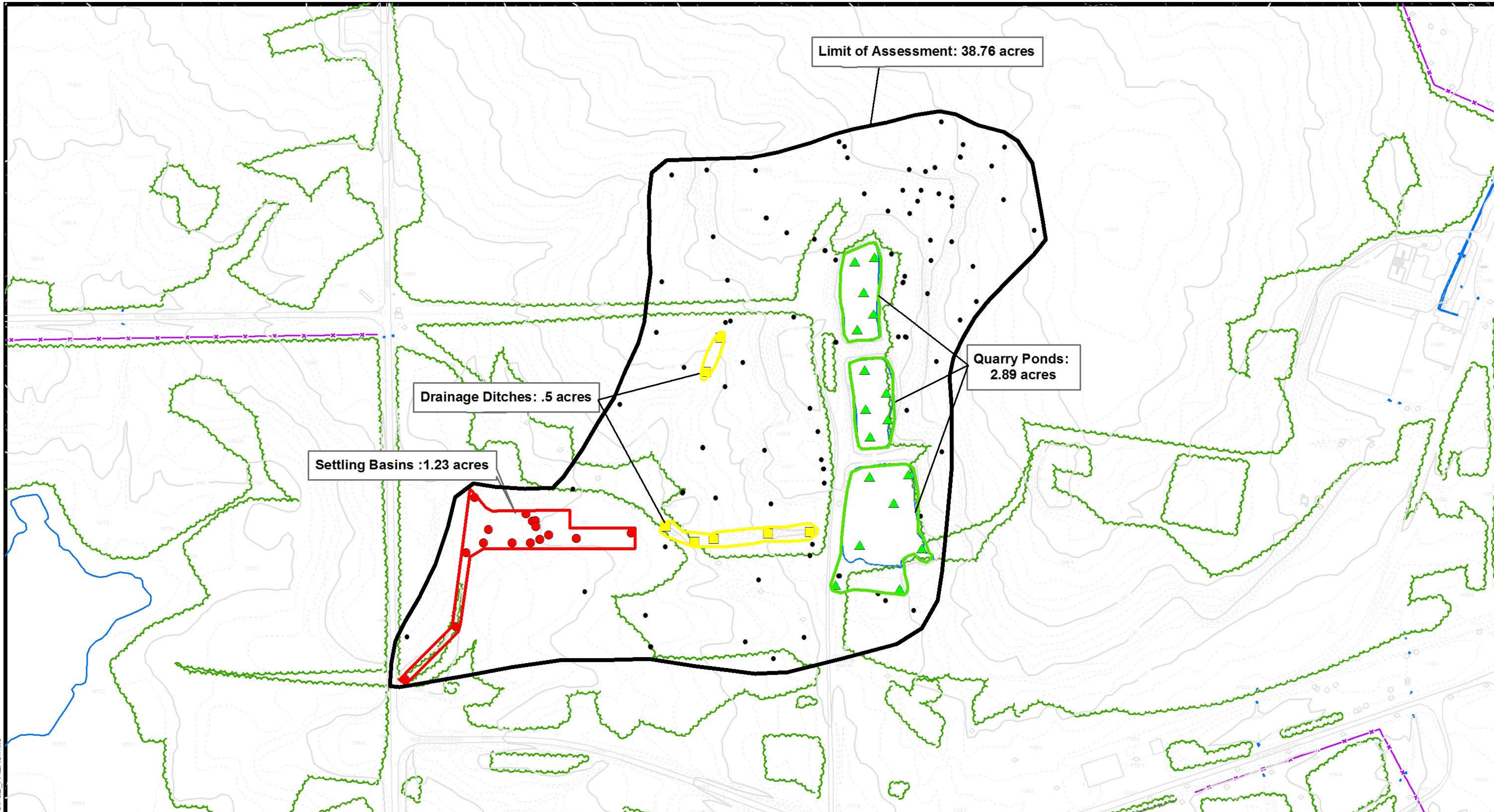
6.2.1 Chemical of Potential Concern Screening

This section provides a description of the screening process used to identify COPCs and the data assumptions used in the process.

COPCs are identified for each EU for groundwater, surface soil, subsurface soil, sediment, and surface water. This data evaluation consists of five steps per the FWHHRAM (USACE 2004b): (1) a DQA, (2) frequency-of-detection/WOE screening, (3) screening of essential human nutrients, (4) risk-based screening, and (5) background screening.

1. **Data Quality Assessment** – Analytical results were reported by the laboratory in electronic form and loaded into an FBQ database. Site data were then extracted from the database so that only one result is used for each station and depth sampled. QC data, such as sample splits and duplicates, and laboratory re-analyses and dilutions were not included in the determination of COPCs for this risk assessment. Samples rejected in the validation process are excluded from the risk assessment. The percentage of rejected data is 3.4%. A complete summary of data quality issues is presented in the DQSR for the Phase I and II RIs (see Appendix J).

2. **Frequency-of-Detection/WOE Screen** – Each chemical in each medium was evaluated to determine its frequency of detection (see Section 4.1.3.2). Chemicals that were never detected for a given medium were eliminated as COPCs. For chemicals with at least 20 samples and a frequency of detection of less than 5%, a WOE approach was used to determine if the chemical is AOC-related. The magnitudes and locations (clustering) of the detections and potential source of the chemical were evaluated. If the detected results showed no clustering, the concentrations are not substantially elevated relative to the detection limit, and the chemical was not used in the area under investigation, they are considered spurious, and the chemical was eliminated from further consideration. This screen is applied to all organic and inorganic chemicals with the exception of explosives and



FBQ Sample Data Aggregates

Drawn By: DAC

CAD FILES: R31718/R31617/R21718/R21617

Figure 6-1

Date: 2005/June/06

propellants. No detected explosives and propellants are excluded from the list of COPCs based on frequency of detection.

3. **Essential Nutrients** – Chemicals that are considered essential nutrients (i.e., calcium, chloride, iodine, iron, magnesium, potassium, phosphorus, and sodium) are an integral part of the human food supply and are often added to foods as supplements. EPA recommends that these chemicals not be evaluated as COPCs so long as they are (1) present at low concentrations (i.e., only slightly elevated above naturally occurring levels) and (2) toxic at very high doses (i.e., much higher than those that could be associated with contact at the site) (EPA 1989a). Recommended daily allowance (RDA) and recommended daily intake (RDI) values are available for seven of these metals. Based on these RDA/RDI values, a receptor ingesting 100 mg of soil/sediment per day would receive less than the RDA/RDI of calcium, magnesium, phosphorous, potassium, and sodium, even if the soil/sediment consisted of the pure mineral (i.e., soil concentrations > 1,000,000 mg/kg). Receptors ingesting 100 mg of soil per day would require soil/sediment concentrations of 1,500 mg/kg of iodine and 100,000 to 180,000 mg/kg of iron to meet their RDA/RDI for these metals. Receptors ingesting 1 L of groundwater per day would require groundwater concentrations of 1,000; 0.15; 10 to 18; 310 to 400; 3,500; 700; and 2,400 mg/L of calcium, iodine, iron, magnesium, potassium, phosphorus, and sodium, respectively, to meet their RDA/RDI. Receptors ingesting 0.1 L of surface water per day would require concentrations of 10,000; 1.5; 100 to 180; 3,100 to 4,000; 35,000; 7,000; and 24,000 mg/L of calcium, iodine, iron, magnesium, potassium, phosphorus, and sodium, respectively, to meet their RDA/RDI. Concentrations of essential nutrients do not exceed these levels at FBQ; thus, these constituents are not addressed as COPCs in this HHRA.

4. **Risk-based Screen** – The objective of this evaluation is to identify COPCs that may pose a potentially significant risk to human health. The risk-based screening values are conservative values published by EPA. The MDC of each chemical in each exposure medium is compared against the appropriate risk-based screening value. Chemicals detected below these concentrations are screened from further consideration. Detected chemicals without risk-based screening values are not eliminated from the COPC list. The risk-based screening values are described in Section 6.2.1.1.

5. **Background Screen** – For each inorganic constituent detected, concentrations in the FBQ samples are screened against available, naturally occurring background levels. This screening step, which applies only to the inorganics, is used to determine if detected inorganics are site related or naturally occurring. If the MDC of a constituent exceeds the background value, the constituent is considered AOC-related. All detected organic compounds are considered to be above background. Inorganic chemicals whose MDCs are below background levels are eliminated from the COPC list. Background screening values are described in Section 6.2.1.2.

6.2.1.1 Risk-based screening values

The risk-based screening values are conservative values published by EPA.

- For soil and sediment, a conservative screen is performed using the most current residential preliminary remediation goals (PRGs) published by EPA Region 9. To account for the potential effects of multiple chemicals, PRGs based on non-cancer endpoints are divided by 10. These screening values are very conservative [based on a 10^{-6} risk level and a hazard quotient (HQ) of 0.1]. Region 9 PRGs can be found on the EPA Region 9 World Wide Web site (http://www.epa.gov/region09/waste/sfund/prg/index.htm).

- Surface water and groundwater data are screened using the EPA Region 9 tap water PRGs, which are also available at http://www.epa.gov/region09/waste/sfund/prg/index.htm.

6.2.1.2 Background screening values

This FBQ Phase I/Phase II RI does not include determination of background data specific to FBQ. Analytical results are screened against the final facility-wide background values for RVAAP, published in the Final Phase II RI Report for WBG (USACE 2001b). Background values for soil are available for two soil depths: surface (0 to 1 ft BGS) and subsurface (1 to 12 ft BGS). Soil data at FBQ are aggregated into three depth intervals: shallow surface soil (0 to 1 ft BGS), deep surface soil (0 to 3 ft BGS), and subsurface soil (1 to 3 ft BGS). The following background depth intervals are used for identifying COPCs in FBQ soil.

- For shallow surface soil (0 to 1 ft BGS) the background screen is performed using background values for surface soil (0 to 1 ft BGS).
- For deep surface soil (0 to 3 ft BGS) the background screen is performed using background values for either surface soil (0 to 1 ft BGS) or subsurface soil (1 to 12 ft BGS), whichever is lower.
- For subsurface soil (1 to 3 ft BGS) the background screen is performed using background values for subsurface soil (1 to 12 ft BGS).

6.2.1.3 COPC screening assumptions

The following assumptions, used in the development of COPCs for the HHRA, are noted:

- Chemicals not detected in a medium are not considered to be COPCs.
- Physical chemical data (e.g., alkalinity, pH, etc.) are not considered to be COPCs for FBQ.
- Total chromium is evaluated conservatively by screening against the EPA Region 9 PRGs for hexavalent chromium. This is a conservative assumption since (1) hexavalent chromium was analyzed for, (2) hexavalent chromium is more toxic than trivalent chromium (the only other valence of chromium with screening values), and (3) hexavalent chromium is a less commonly occurring form of the metal.

6.2.2 Chemical of Potential Concern Screening Results

The COPC screening results are summarized for each medium in Appendix M, Tables M-1 to M-6. These tables include

- summary statistics, including frequency of detection, range of detected concentrations, arithmetic average concentration, and UCL_{95} on the mean concentration;
- all screening values (PRGs and background concentrations, as appropriate); and
- final COPC status.

Table 6-7 summarizes the resulting COPCs across all media evaluated in this HHRA. COPCs are categorized as quantitative (based on available toxicity values, these chemicals are further evaluated quantitatively in this HHRA) and qualitative (due to a lack of toxicity values, risks and hazards cannot be quantified for these chemicals in this HHRA); see the Toxicity Assessment (Section 6.4) for more details on toxicity.

6.2.2.1 Groundwater COPCs

Table 6-7 summarizes the COPCs for groundwater. Seven COPCs are identified for groundwater at FBQ: manganese; 2-amino-4,6-DNT; 4-amino-2,6-DNT; and nitrocellulose in the unconsolidated aquifer; and manganese; 2-amino-4,6-DNT; 4-amino-2,6-DNT; 2,4,6-TNT; 2,4-DNT; nitrocellulose; and TCE in the bedrock aquifer. Based on lack of toxicity information (see Section 6.3), three of these groundwater COPCs are classified as qualitative COPCs (2-amino-4,6-DNT; 4-amino-2,6-DNT; and nitrocellulose); risks and hazards cannot be quantified for these three COPCs.

Table 6-7. COPCs for each Medium at Fuze and Booster Quarry Landfill/Ponds[a]

COPC	Groundwater	Surface Water	Sediment	Surface Soil		Subsurface Soil
				Shallow	Deep	
Quantitative COPCs[b]						
Inorganics						
Aluminum			D,QP,SB		FBQ	FBQ
Antimony			D,QP	FBQ	FBQ	
Arsenic		SB	D,QP	FBQ	FBQ	FBQ
Barium			QP	FBQ	FBQ	
Cadmium			QP	FBQ	FBQ	
Chromium			QP,SB	FBQ	FBQ	FBQ
Chromium, hexavalent			QP			
Copper			QP	FBQ	FBQ	
Lead[c]		SB	QP,SB	FBQ	FBQ	
Manganese	B, U	D,SB	D,SB	FBQ	FBQ	
Mercury			QP			
Vanadium			D,QP,SB	FBQ	FBQ	FBQ
Zinc			QP			
Organics						
2,4,6-Trinitrotoluene	B			FBQ	FBQ	
2,4-Dinitrotoluene	B					
2,6-Dinitrotoluene				FBQ	FBQ	
Benz(*a*)anthracene			D,QP			
Benzo(*a*)pyrene			D,QP,SB	FBQ	FBQ	
Benzo(*b*)fluoranthene			D,QP			
Bis(2-ethylhexyl)phthalate		SB				
Indeno(1,2,3-*cd*)pyrene			QP			
Methylene Chloride		QP	QP			
Perchlorate		SB				
Trichloroethene	B					
Qualitative COPCs[d]						
Organics						
2-Amino-4,6-dinitrotoluene	B, U	SB	QP	FBQ	FBQ	
4-Amino-2,6-dinitrotoluene	B, U	SB	QP	FBQ	FBQ	
Acenaphthylene			D			
Benzo(*ghi*)perylene			D,QP			
Nitrocellulose	B, U	D,QP,SB	D,QP,SB	FBQ	FBQ	FBQ
Nitroglycerin			QP			
Phenanthrene			D,QP,SB			

[a] COPCs are shown for all medium/exposure unit combinations. Exposure unit codes are as follows:
B = Bedrock Aquifer
D = Ditch
FBQ = Fuze and Booster Quarry

QP = Quarry Ponds
SB = Settling Basins
U = Unconsolidated Aquifer
[b] Quantitative COPCs have approved toxicity values that allow for further quantitative evaluation in the human health risk assessment.
[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 U. S. Environmental Protection Agency.
[d] Qualitative COPCs do not have approved toxicity values that allow for further quantitative evaluation in the human health risk assessment.
COPC = Chemical of potential concern.

6.2.2.2 Surface soil COPCs

Table 6-7 summarizes the COPCs for shallow (0 to 1 ft BGS) and deep (0 to 3 ft BGS) surface soil.

Shallow surface soil COPCs

A total of 15 shallow surface soil COPCs are identified at FBQ. The 15 COPCs include:

- 9 inorganics (antimony, arsenic, barium, cadmium, chromium, copper, lead, manganese, and vanadium);
- 5 explosives (2,4,6-TNT; 2,6-DNT; 2-amino-4,6-DNT; 4-amino-2,6-DNT; and nitrocellulose); and
- 1 SVOC [benzo(*a*)pyrene].

Based on lack of toxicity information (see Section 6.3), three of these shallow surface soil COPCs are classified as qualitative COPCs [2-amino-4,6-DNT; 4-amino-2,6-DNT; and nitrocellulose]; risks and hazards cannot be quantified for these three COPCs.

Deep surface soil COPCs

A total of 16 deep surface soil COPCs are identified at FBQ. The 16 COPCs include:

- 10 inorganics (aluminum, antimony, arsenic, barium, cadmium, chromium, copper, lead, manganese, and vanadium);
- 5 explosives (2,4,6-TNT; 2-amino-4,6-DNT; 4-amino-2,6-DNT; 2,6-DNT; and nitrocellulose); and
- 1 SVOC [benzo(*a*)pyrene].

Based on lack of toxicity information (see Section 6.3), three of these deep surface soil COPCs are classified as qualitative COPCs (2-amino-4,6-DNT; 4-amino-2,6-DNT; and nitrocellulose); risks and hazards cannot be quantified for these three COPCs.

6.2.2.3 Subsurface soil COPCs

Table 6-7 summarizes the COPCs for subsurface soil. A total of five subsurface soil COPCs are identified at FBQ. The five COPCs include:

- four inorganics (aluminum, arsenic, chromium, and vanadium) and
- one explosive (nitrocellulose).

Based on lack of toxicity information (see Section 6.3), one of these subsurface soil COPCs is classified as a qualitative COPC (nitrocellulose); risks and hazards cannot be quantified for this COPC.

6.2.2.4 Sediment COPCs

As seen on Table 6-7, a total of 24 sediment COPCs are identified at FBQ. The 24 COPCs include:

- 13 inorganics (aluminum, antimony, arsenic, barium, cadmium, chromium, hexavalent chromium, copper, lead, manganese, mercury, vanadium, and zinc);
- 4 explosives (2-amino-4,6-DNT; 4-amino-2,6-DNT; nitrocellulose; and nitroglycerin); and
- 7 SVOCs [acenaphthylene, benz(*a*)anthracene, benzo(*a*)pyrene, benzo(*b*)fluoranthene, benzo(*ghi*)perylene, indeno(1,2,3-*cd*)pyrene and phenanthrene].

Twenty-two of these COPCs are identified at the Quarry Ponds (all but manganese and acenaphthylene). Twelve COPCs are identified at the Ditch (aluminum, antimony, arsenic, manganese, vanadium, acenaphthylene, benz(*a*)anthracene, benzo(*a*)pyrene, benzo(*b*)fluoranthene, benzo(*ghi*)perylene, nitrocellulose, and phenanthrene). Eight COPCs are identified at the Settling Basins (aluminum, chromium, lead, manganese, vanadium, benzo(*a*)pyrene, nitrocellulose, and phenanthrene). Based on lack of toxicity information (see Section 6.3), seven of these sediment COPCs are classified as qualitative COPCs [2-amino-4,6-DNT; 4-amino-2,6-DNT; acenaphthylene; benzo(*ghi*)perylene; nitrocellulose; nitroglycerin; and phenanthrene]; risks and hazards cannot be quantified for these seven COPCs.

6.2.2.5 Surface water COPCs

Table 6-7 summarizes the COPCs for surface water. As seen, a total of nine surface water COPCs are identified at FBQ. The nine COPCs include:

- three inorganics (arsenic, lead, and manganese),
- three explosives (2-amino-4,6-DNT; 4-amino-2,6-DNT; and nitrocellulose),
- one SVOC [bis(2-ethylhexyl)phthalate],
- one VOC (methylene chloride), and
- perchlorate.

Eight of these COPCs are identified at the Settling Basins (all but methylene chloride). Only two COPCs are identified at the Drainage Ditch (manganese and nitrocellulose) and the Quarry Ponds (methylene chloride and nitrocellulose). Based on lack of toxicity information (see Section 6.3), three of these surface water COPCs are classified as qualitative COPCs (2-amino-4,6-DNT; 4-amino-2,6-DNT; and nitrocellulose); risks and hazards cannot be quantified for these three COPCs.

6.2.2.6 Summary of COPCs

Table 6-7 summarizes the resulting COPCs for groundwater, surface soil, sediment, and surface water at FBQ. A total of 31 COPCs are identified at FBQ. The 31 COPCs include:

- 13 inorganics (aluminum, antimony, arsenic, barium, cadmium, chromium, hexavalent chromium, copper, lead, manganese, mercury, vanadium, and zinc);
- 7 explosives (2,4,6-TNT; 2-amino-4,6-DNT; 4-amino-2,6-DNT; 2,4-DNT; 2,6-DNT; nitrocellulose; and nitroglycerin);

- 8 SVOCs [acenaphthylene, benz(*a*)anthracene, benzo(*a*)pyrene, benzo(*b*)fluoranthene, benzo(*ghi*)perylene, bis(2-ethylhexyl)phthalate, indeno(1,2,3-*cd*)pyrene, and phenanthrene];
- 2 VOCs (methylene chloride and TCE), and
- perchlorate.

Based on lack of toxicity information (see Section 6.3), seven of these COPCs are classified as qualitative COPCs [2-amino-4,6-DNT; 4-amino-2,6-DNT; acenaphthylene; benzo(*ghi*)perylene; nitrocellulose; nitroglycerin; and phenanthrene]; risks and hazards cannot be quantified for these seven COPCs.

6.3 EXPOSURE ASSESSMENT

The objectives of the exposure assessment are to estimate the magnitude, frequency, and duration of potential human exposure to COPCs. The four primary steps of the exposure assessment are to

1. identify current and future land use;
2. identify potentially exposed populations, exposure media, and exposure pathways;
3. calculate exposure point concentrations (EPCs); and
4. estimate each receptor's potential intake of each COPC.

The output of the exposure assessment is used in conjunction with the output of the toxicity assessment (Section 6.4) to quantify risks and hazards to receptors in the risk characterization (Section 6.5).

6.3.1 Current and Future Land Use

Land use within the RVAAP and RTLS is restricted access. Personnel from OHARNG may occasionally travel through AOCs but generally restrict training to areas outside of AOCs. No training exercises are currently conducted within FBQ. This BHHRA focuses on the potential future land use at FBQ. The intended future land use at FBQ is mounted training/no digging (USACE 2004b). Projected use of surface water includes dust suppression, fire control, fishing, trapping, and waterfowl hunting. FBQ may contain MEC and contains environmentally sensitive areas (i.e., wetlands).

6.3.2 Potentially Exposed Populations, Exposure Media, and Exposure Pathways

Potentially contaminated media at FBQ are surface soil, subsurface soil, groundwater, surface water, and sediment.

Given the intended future land use, FBQ may be used in the future by four receptor populations:

- National Guard personnel for training (National Guard Trainee and Fire/Dust Suppression).
- National Guard Security Guard/Maintenance Worker.
- Recreational users involved in fishing and waterfowl hunting.

Hunting not currently allowed at FBQ. Hunters are not allowed at areas that are restricted for environmental reasons (i.e., due to known contamination hazards or during the RI process). Hunting at RVAAP is also restricted for reasons other than environmental – including logistics, general safety, security, and military operations. Military and training site employees are occasionally allowed hunting access to some restricted areas under direct supervision of someone knowledgeable about the site and the security and safety issues associated with it. If hunting is allowed at FBQ in the future, hunters will be restricted as they are anywhere at RVAAP. That is, hunters are told where they can and cannot hunt and volunteers are responsible for making sure hunters know the boundaries of their areas and for patrolling the perimeter of hunting areas. All hunters are briefed before they go into the field and told to stay within their assigned areas and to keep vehicles on the roads.

These four receptors are evaluated as outlined in Table 5 of the FWHHRAM (USACE 2004b) and summarized below.

National Guard Trainee

National Guard Trainees may be present at the site up to 24 hr/day for 24 day/year on inactive duty training and/or 24 hr/day for 15 day/year during annual training. As a conservative estimate for this BHHRA, it is assumed that the same individual is present at FBQ for both inactive duty training (24 day/year) and annual training (15 day/year) for a total exposure frequency of 39 day/year. This receptor is assumed to belong to the National Guard for 25 years (default worker exposure duration) and to use FBQ for training every year of his/her enlistment.

FBQ will be used for mounted training. Digging and occupying fighting positions, tank defilade positions, tank ditches, and battle positions that extend BGS will be prohibited. Tracked and wheeled operations may result in maneuver damage up to 4 ft BGS. Because of this maneuver damage, the National Guard Trainee is assumed to be exposed to deep surface soil defined as 0 to 3 ft BGS. This receptor is exposed to soil via incidental ingestion, dermal contact, and inhalation of vapors and fugitive dust.

The National Guard Trainee is also assumed to be exposed to surface water and sediment during training. Exposure to these media is assumed to occur daily (i.e., 39 day/year) via incidental ingestion, dermal contact, and inhalation of vapors and fugitive dust. According to RTLS staff, all potable water will come from the local municipal water supply. There are currently no plans to obtain water from groundwater wells. However, groundwater is included as a conservative assumption since the municipal water supply is not currently in place.

National Guard Fire/Dust Suppression

The National Guard fire/dust suppression worker is assumed to spend 4 hr/day for 5 days/year for fire suppression and 4 hr/day for 10 days/year (i.e., 40 hr/year) for dust suppression and is assumed to return to RVAAP and the AOC of interest every year for their entire 25-year enlistment. It is assumed that both fire and dust suppression are conducted by the same individual.

Use of surface water for fire and dust suppression is assumed to result in exposure to surface water via incidental ingestion and dermal contact while setting pumps and hoses in the surface water body and while spraying water. Only one VOC (methylene chloride) was identified as a COPC in surface water (at Quarry Ponds only) slightly above its PRG. Inhalation is not included in the surface water exposure model; however, the surface water ingestion rate (100 mL/day) is assumed to include potential incidental inhalation exposure.

This receptor is also assumed to be exposed to shallow surface soil and sediment via incidental ingestion, dermal contact, and inhalation of vapors and fugitive dust.

National Guard Security Guard/Maintenance Worker

Current government activities at FBQ are limited to maintenance activities (including checking on beaver damage) and environmental remediation activities. There are no buildings at FBQ and this area is not mowed. Security patrols occur daily across the installation, but not within FBQ; patrolmen usually remain within their vehicles during these patrols. Although the security guard is not currently exposed to contaminated media at FBQ on a daily basis, the potential exposure of this receptor is evaluated in this BHHRA. Therefore, as a worst-case assumption, it is assumed that a security guard leaves his or her vehicle on a daily basis and is exposed to surface soil.

This scenario assumes a Security Guard/Maintenance Worker patrols FBQ every day for 1 hr. The Security Guard/Maintenance Worker is assumed to be exposed to surface soil (0 to 1 ft BGS) only. Subsurface soil is not evaluated for this receptor because they are not engaged in intrusive activities and are not exposed to this medium per Tables 1 and 5 of the FWHHRAM (USACE 2004b). Groundwater use is not a completed exposure pathway for this receptor. This receptor is not involved in recreational or training activities that would result in exposure to surface water or sediment.

Recreational Hunter/Trapper/Fisher

For this BHHRA it is assumed that hunting, trapping, and fishing are conducted by the same individual for a total exposure period of 4.57 hr/day, 7 day/year (i.e., 6 hr/day for 2 day/year to hunt and trap plus 4 hr/day for 5 day/year to fish). The Hunter/Trapper/Fisher is assumed to visit FBQ every year that they live in the area (i.e., residential exposure duration of 30 years). FBQ is not currently included in the RVAAP catch and release program. Permitted waterfowl hunting is managed jointly by the facility staff and the State Division of Wildlife.

The Hunter/Trapper/Fisher may be exposed to shallow surface soil (0 to 1 ft BGS), surface water, and sediment. Subsurface soil is not evaluated for this receptor because he is not engaged in intrusive activities and is not exposed to this medium per Tables 1 and 5 of the FWHHRAM (USACE 2004b). Groundwater use is not a completed exposure pathway for hunter/trapper/fisher.

Catch and release fishing is allowed for personnel permanently assigned to RTLS and their guests (OHARNG 2001). It is the goal, when the IRP is done, to have unrestricted fishing and taking of fish from all ponds. Therefore, the Hunter/Trapper/Fisher receptor is assumed to ingest fish caught on-site. This receptor is also assumed to ingest waterfowl. It is assumed that a hunter will harvest the 1-day bag limit of ducks and Canada Geese. Using the body weight for mallards, this results in an ingestion rate of 0.0132 kg/day (10.6 lbs/year) calculated as six mallard ducks weighing 1.134 kg (EPA 1993), each with 34% edible tissue and two Canada Geese weighing 3.8671 kg (EPA 1993), each with 32.6% edible tissue. This ingestion rate assumes (1) the hunter consumes his entire 1-day catch each year, (2) the ducks are all represented by the body weight of a mallard rather than the smaller wood duck, and (3) there is no loss due to preparation and cooking. It is assumed that trapping is primarily for fur and population control of beaver and raccoon, and the trapper does not consume his catch.

Fish are present in the Quarry Ponds. The Ditch and Settling Basins are shallow and ephemeral; therefore, no fish are present and fishing is not assumed to occur at these water bodies. Similarly, the Quarry Ponds are good waterfowl habitat but the Ditch and Settling Basins are not. Thus the hunter/trapper/fisher is evaluated for the Quarry Ponds only.

Other Receptors

In addition to the representative receptors described above, a Resident Subsistence Farmer (adult and child)] is evaluated to provide a baseline for evaluating this site with respect to unrestricted release. These additional receptors are not anticipated at FBQ due to physical constraints (e.g., wetlands, MEC) and intended future land use by OHARNG.

6.3.3 Exposure Point Concentrations

6.3.3.1 EPCs in groundwater, surface soil, subsurface soil, sediment, and surface water

This HHRA for FBQ evaluates the reasonable maximum exposure (RME). The RME is an estimate of the highest exposure reasonably expected to occur at the site. Because of the uncertainty associated with any estimate of exposure concentration, the UCL_{95} for either a normal or lognormal distribution is the recommended statistic for evaluating the RME. In cases where the UCL_{95} exceeds the MDC, the maximum concentration is used as an estimate of the RME.

EPCs in groundwater, surface soil, subsurface soil, sediment, and surface water are calculated using equations from EPA guidance*, Supplemental Guidance to RAGS: Calculating the Concentration Term* (EPA 1992a). The data are tested using the Shapiro-Wilk test to determine distribution, normal or lognormal, of the concentrations. This guidance notes that environmental data are often lognormally distributed but does not give specific guidance for data sets with unknown distributions.

For FBG, the UCL_{95} on the mean is calculated using the normal distribution equation (see Equation 6-1) when the concentrations are normally distributed, when concentrations are not judged to be normally or lognormally distributed, when the data set contains fewer than five detections, or when the frequency of detection is less than 50%. For these situations, the UCL_{95} on the mean is calculated using the following equation:

$$UCL_{95}(normal) = \overline{x_n} + \frac{(t)(s_x)}{\sqrt{n}}, \qquad \textbf{(6-1)}$$

where

$\overline{x}_n$ = mean of the untransformed data,
t = student-t statistic,
s_x = standard deviation of the untransformed data,
n = number of sample results available.

EPA guidance *Calculating Upper Confidence Limits for Exposure Point Concentrations at Hazardous Waste Sites* (EPA 2002a) provides several methods for calculating the UCL_{95} for data sets that are neither normally nor log-normally distributed. All of the methods in this guidance are based on the assumption of random sampling. Sampling at FBG was biased toward areas with the greatest potential for contamination. The reason for defaulting to the t-distribution (i.e., assumption of normality) when the distribution cannot be determined is that this method is simple and robust; even when the assumption that the underlying distribution is normal is violated, the estimate of the UCL_{95} is reasonably close to the true value.

For lognormally distributed concentrations, the UCL_{95} on the mean is calculated using the following equation:

$$UCL_{95}(lognormal) = e^{\left(\overline{x_l} + 0.5(s_l^2) + \frac{(S_l)(H)}{\sqrt{n-1}}\right)}, \qquad \textbf{(6-2)}$$

where

- e = constant (base of the natural log, equal to 2.718),
- $\overline{x_l}$ = mean of the transformed data [$l = \log(x)$],
- s_l = standard deviation of the transformed data,
- H = H-statistic,
- N = number of sample results available.

EPA guidance (EPA 2002a) notes that use of the H statistic may result in overestimating the true UCL_{95} on the mean if the data are not lognormal. Even small deviations from lognormality can greatly influence the results using the H-statistic, yielding upper bounds that are much too large (Singh et al. 1997).

EPCs for groundwater, surface soil, sediment, and surface water are provided in Appendix M, Tables M-1 through M-6.

6.3.3.2 EPCs in foodstuffs for Resident Subsistence Farmer

Direct sampling results are not available for the evaluation of ingestion of foodstuffs (i.e., beef, milk, venison, and vegetables). Exposure concentrations were modeled for these media using the equations presented below. The starting concentration of COPCs in soil is equal to the EPC calculated for direct exposure pathways as described in Section 6.3.3.1 above. Other parameter values are provided in Table 6-8.

Chemical Concentration in beef

Concentrations in beef cattle are calculated from the concentration in the cattle's food sources due to soil contamination. The contaminant levels in pastures are estimated by the equation:

$$C_p = C_s \times (R_{upp} + R_{es}), \quad \textbf{(6-3)}$$

where

- C_p = concentration of contaminant in pasture (mg/kg, calculated),
- C_s = concentration of contaminant in soil (mg/kg),
- R_{upp} = multiplier for dry root uptake for pasture (unitless),
- R_{es} = resuspension multiplier (unitless).

The multiplier for dry root uptake for pasture, R_{upp}, is chemical-specific and is estimated as:

$$R_{upp} = Bv_{dry}, \quad \textbf{(6-4)}$$

where

- R_{upp} = multiplier for dry root uptake for pasture (unitless),
- Bv_{dry} = soil-to-plant uptake, dry weight (kg/kg, chemical-specific, or $38 \times K_{ow}^{-0.58}$; see Table M-7),
- K_{ow} = octanol-water partitioning coefficient (unitless, chemical-specific).

Table 6-8. Parameters Used to Quantify Exposures for Each Medium and Receptor at Fuze and Booster Quarry Landfill/Ponds[a]

Exposure Pathway and Parameter	Units	Potential Receptor					
		National Guard Personnel				Resident Subsistence Farmer	
		Security Guard/ Maintenance Worker[b]	Dust/Fire Control[b]	Trainee[b]	Hunter/ Trapper/ Fisher[b,c]	Adult	Child
Surface Soil[d]							
Incidental Ingestion							
Soil ingestion rate	kg/day	0.0001	0.0001	0.0001	0.0001	0.0001	0.0002
Exposure time	hr/day	1	4	24	4.57[e]	24	24
Exposure frequency	day/year	250	15	39	7[e]	350	350
Exposure duration	Years	25	25	25	30	30	6
Body weight	kg	70	70	70	70	70	15
Carcinogen averaging time	day	25,550	25,550	25,550	25,550	25,550	25,550
Non-carcinogen averaging time	day	9,125	9,125	9,125	10,950	10,950	2,190
Fraction ingested	Unitless	1	1	1	1	1	1
Conversion factor	day/hr	0.042	0.042	0.042	0.042	0.042	0.042
Dermal Contact							
Skin area	m^2/event	0.33	0.33	0.33	0.52[f]	0.57	0.22
Adherence factor	mg/cm^2	0.7	0.3	0.3	0.3	0.4	0.2
Absorption fraction	Unitless	Chemical Specific – See Table M-7					
Exposure frequency	events/year	250	15	39	7[e]	350	350
Exposure duration	years	25	25	25	30	30	6
Body weight	kg	70	70	70	70	70	15
Carcinogen averaging time	day	25,550	25,550	25,550	25,550	25,550	25,550
Non-carcinogen averaging time	day	9,125	9,125	9,125	10,950	10,950	2,190
Conversion factor	$(kg\text{-}cm^2)/(mg\text{-}m^2)$	0.01	0.01	0.01	0.01	0.01	0.01
Inhalation of VOCs and Dust							
Inhalation rate	m^3/day	20	44.4	44.4	20	20	10
Exposure time	hr/day	1	4	24	4.57[e]	24	24
Exposure frequency	day/year	250	15	39	7[e]	350	350
Exposure duration	years	25	25	25	30	30	6
Body weight	kg	70	70	70	70	70	15
Carcinogen averaging time	day	25,550	25,550	25,550	25,550	25,550	25,550
Non-carcinogen averaging time	day	9,125	9,125	9,125	10,950	10,950	2,190
Conversion factor	day/hr	0.042	0.042	0.042	0.042	0.042	0.042
Subsurface Soil							
Incidental Ingestion							
Soil ingestion rate	kg/day	NA	NA	NA	NA	0.0001	0.0002
Exposure time	hr/day	NA	NA	NA	NA	24	24

Table 6-8. Parameters Used to Quantify Exposures for Each Medium and Receptor at Fuze and Booster Quarry Landfill/Ponds[a] (continued)

Exposure Pathway and Parameter	Units	Potential Receptor					
		National Guard Personnel				Resident Subsistence Farmer	
		Security Guard/ Maintenance Worker[b]	Dust/Fire Control[b]	Trainee[b]	Hunter/ Trapper/ Fisher[bc]	Adult	Child
Exposure frequency	day/year	NA	NA	NA	NA	350	350
Exposure duration	years	NA	NA	NA	NA	30	6
Body weight	kg	NA	NA	NA	NA	70	15
Carcinogen averaging time	day	NA	NA	NA	NA	25,550	25,550
Non-carcinogen averaging time	day	NA	NA	NA	NA	10,950	2,190
Fraction ingested	Unitless	NA	NA	NA	NA	1	1
Conversion factor	day/hr	NA	NA	NA	NA	0.042	0.042
Dermal Contact							
Skin area	m^2/event	NA	NA	NA	NA	0.57	0.22
Adherence factor	mg/cm^2	NA	NA	NA	NA	0.4	0.2
Absorption fraction	Unitless	NA	NA	NA	NA	Chem. Spec. See Table M-7	
Exposure frequency	events/year	NA	NA	NA	NA	350	350
Exposure duration	years	NA	NA	NA	NA	30	6
Body weight	kg	NA	NA	NA	NA	70	15
Carcinogen averaging time	day	NA	NA	NA	NA	25,550	25,550
Non-carcinogen averaging time	day	NA	NA	NA	NA	10,950	2,190
Conversion factor	$(kg\text{-}cm^2)/(mg\text{-}m^2)$	NA	NA	NA	NA	0.01	0.01
Inhalation of VOCs and Dust							
Inhalation rate	m^3/day	NA	NA	NA	NA	20	10
Exposure time	hr/day	NA	NA	NA	NA	24	24
Exposure frequency	day/year	NA	NA	NA	NA	350	350
Exposure duration	years	NA	NA	NA	NA	30	6
Body weight	kg	NA	NA	NA	NA	70	15
Carcinogen averaging time	day	NA	NA	NA	NA	25,550	25,550
Non-carcinogen averaging time	day	NA	NA	NA	NA	10,950	2,190
Conversion factor	day/hr	NA	NA	NA	NA	0.042	0.042
Sediment							
Incidental Ingestion							
Soil ingestion rate	kg/day	NA	0.0001	0.0001	0.0001	0.0001	0.0002
Exposure time	hr/day	NA	4	24	4.57[e]	24	24
Exposure frequency	day/year	NA	15	39	7[e]	350	350
Exposure duration	years	NA	25	25	30	30	6
Body weight	kg	NA	70	70	70	70	15

Table 6-8. Parameters Used to Quantify Exposures for Each Medium and Receptor at Fuze and Booster Quarry Landfill/Ponds[a] (continued)

Exposure Pathway and Parameter	Units	Potential Receptor					
		National Guard Personnel				Resident Subsistence Farmer	
		Security Guard/ Maintenance Worker[b]	Dust/Fire Control[b]	Trainee[b]	Hunter/ Trapper/ Fisher[bc]	Adult	Child
Carcinogen averaging time	day	NA	25,550	25,550	25,550	25,550	25,550
Non-carcinogen averaging time	day	NA	9,125	9,125	10,950	10,950	2,190
Fraction ingested	Unitless	NA	1	1	1	1	1
Conversion factor	day/hr	NA	0.042	0.042	0.042	0.042	0.042
Dermal Contact							
Skin area	m^2/event	NA	0.33	0.33	0.52	0.57	0.22
Adherence factor	mg/cm^2	NA	0.3	0.3	0.3	0.4	0.2
Absorption fraction	Unitless	NA	Chemical Specific – See Table M-7				
Exposure frequency	events/year	NA	15	39	7[e]	350	350
Exposure duration	years	NA	25	25	30	30	6
Body weight	kg	NA	70	70	70	70	15
Carcinogen averaging time	day	NA	25,550	25,550	25,550	25,550	25,550
Non-carcinogen averaging time	day	NA	9,125	9,125	10,950	10,950	2,190
Conversion factor	$(kg\text{-}cm^2)/(mg\text{-}m^2)$	NA	0.01	0.01	0.01	0.01	0.01
Inhalation of VOCs and Dust							
Inhalation rate	m^3/day	NA	44.4	44.4	20	20	10
Exposure time	hr/day	NA	4	24	4.57[e]	24	24
Exposure frequency	day/year	NA	15	39	7[e]	350	350
Exposure duration	years	NA	25	25	30	30	6
Body weight	kg	NA	70	70	70	70	15
Carcinogen averaging time	day	NA	25,550	25,550	25,550	25,550	25,550
Non-carcinogen averaging time	day	NA	9,125	9,125	10,950	10,950	2,190
Conversion factor	day/hr	NA	0.042	0.042	0.042	0.042	0.042
Surface Water							
Incidental Ingestion							
Incidental water ingestion rate	L/day	NA	0.1	0.1	0.05[g]	0.1	0.1
Exposure frequency	day/year	NA	15	39	7[e]	350	350
Exposure duration	years	NA	25	25	30	30	6
Body weight	kg	NA	70	70	70	70	15
Carcinogen averaging time	day	NA	25,550	25,550	25,550	25,550	25,550
Non-carcinogen averaging time	day	NA	9,125	9,125	10,950	10,950	2,190
Dermal Contact							
Skin area	m^2	NA	0.33	0.33	0.52	0.57	0.22
Exposure time	hr/day	NA	4	24	4.57[e]	2.5	2.5
Exposure frequency	day/year	NA	15	39	7[e]	350	350

Table 6-8. Parameters Used to Quantify Exposures for Each Medium and Receptor at Fuze and Booster Quarry Landfill/Ponds[a] (continued)

Exposure Pathway and Parameter	Units	Potential Receptor					
		National Guard Personnel				Resident Subsistence Farmer	
		Security Guard/ Maintenance Worker[b]	Dust/Fire Control[b]	Trainee[b]	Hunter/ Trapper/ Fisher[bc]	Adult	Child
Exposure duration	years	NA	25	25	30	30	6
Body weight	kg	NA	70	70	70	70	15
Carcinogen averaging time	day	NA	25,550	25,550	25,550	25,550	25,550
Non-carcinogen averaging time	day	NA	9,125	9,125	10,950	10,950	2,190
Conversion factor	(m/cm)(L/m^3)	NA	10	10	10	10	10
Groundwater							
Drinking Water Ingestion							
Drinking water ingestion rate	L/day	NA	NA	2	NA	2	1.5
Exposure frequency	day/year	NA	NA	39	NA	350	350
Exposure duration	years	NA	NA	25	NA	30	6
Body weight	kg	NA	NA	70	NA	70	15
Carcinogen averaging time	day	NA	NA	25,550	NA	25,550	25,550
Non-carcinogen averaging time	day	NA	NA	9,125	NA	10,950	2,190
Dermal Contact While Showering							
Skin area	m^2	NA	NA	1.94	NA	1.94	0.866
Exposure time	hr/day	NA	NA	0.25	NA	0.25	0.25
Exposure frequency	day/year	NA	NA	39	NA	350	350
Exposure duration	years	NA	NA	25	NA	30	6
Body weight	kg	NA	NA	70	NA	70	15
Carcinogen averaging time	day	NA	NA	25,550	NA	25,550	25,550
Non-carcinogen averaging time	day	NA	NA	9,125	NA	10,950	2,190
Conversion factor	(m/cm)(L/m^3)	NA	NA	10	NA	10	10
Inhalation of VOCs During Household Water Use							
Inhalation rate	m^3/day	NA	NA	20	NA	20	10
Exposure frequency	day/year	NA	NA	39	NA	350	350
Exposure duration	years	NA	NA	25	NA	30	6
Body weight	kg	NA	NA	70	NA	70	15
Carcinogen averaging time	day	NA	NA	25550	NA	25,550	25,550
Non-carcinogen averaging time	day	NA	NA	9125	NA	10,950	2,190
Volatilization factor	L/m^3	NA	NA	0.5	NA	0.5b	0.5b
Foodstuffs							
Ingestion of Waterfowl							
Waterfowl ingestion rate	kg/day	NA	NA	NA	0.0132	NA	NA
Fraction ingested	Unitless	NA	NA	NA	1	NA	NA
Exposure frequency	day/year	NA	NA	NA	365	NA	NA

Table 6-8. Parameters Used to Quantify Exposures for Each Medium and Receptor at Fuze and Booster Quarry Landfill/Ponds[a] (continued)

Exposure Pathway and Parameter	Units	Potential Receptor					
		National Guard Personnel				Resident Subsistence Farmer	
		Security Guard/ Maintenance Worker[b]	Dust/Fire Control[b]	Trainee[b]	Hunter/ Trapper/ Fisher[bc]	Adult	Child
Exposure duration	years	NA	NA	NA	30	NA	NA
Body weight	kg	NA	NA	NA	70	NA	NA
Carcinogen averaging time	day	NA	NA	NA	25,550	NA	NA
Non-carcinogen averaging time	day	NA	NA	NA	10,950	NA	NA
Ingestion of Venison							
Conversion factor	unitless	NA	NA	NA	NA	1.25	1.25
Browse ingestion rate	kg dry weight/day	NA	NA	NA	NA	0.87	0.87
Fraction browse ingested from site	unitless	NA	NA	NA	NA	0.08[h]	0.08[h]
Fat ratio (venison to beef)	unitless	NA	NA	NA	NA	0.2	0.2
Venison ingestion rate	kg/day	NA	NA	NA	NA	0.03	0.03
Fraction ingested	unitless	NA	NA	NA	NA	1	1
Exposure frequency	days/year	NA	NA	NA	NA	365	365
Exposure duration	years	NA	NA	NA	NA	30	6
Body weight	kg	NA	NA	NA	NA	70	15
Carcinogen averaging time	days	NA	NA	NA	NA	25,550	25,550
Noncarcinogen averaging time	days	NA	NA	NA	NA	10,950	2,190
Ingestion of beef, pork							
Resuspension multiplier	unitless	NA	NA	NA	NA	0.25	0.25
Quantity of pasture ingested	kg dry weight/day	NA	NA	NA	NA	7.2	7.2
Fraction of year cow is on-site	unitless	NA	NA	NA	NA	1	1
Fraction of cow's food from on-site	unitless	NA	NA	NA	NA	0.9	0.9
Quantity of soil ingested by cow	kg/day	NA	NA	NA	NA	1	1
Beef ingestion rate	kg/day	NA	NA	NA	NA	0.075	0.075
Fraction ingested	unitless	NA	NA	NA	NA	1	1
Exposure frequency	days/year	NA	NA	NA	NA	365	365
Exposure duration	years	NA	NA	NA	NA	30	6
Body weight	kg	NA	NA	NA	NA	70	15
Carcinogen averaging time	days	NA	NA	NA	NA	25,550	25,550
Noncarcinogen averaging time	days	NA	NA	NA	NA	10,950	2,190
Ingestion of milk products							
Resuspension multiplier	unitless	NA	NA	NA	NA	0.25	0.25
Quantity of pasture ingested	kg dry weight/day	NA	NA	NA	NA	16.1	16.1
Fraction of year cow is on-site	unitless	NA	NA	NA	NA	1	1
Fraction of cow's food from on-site	unitless	NA	NA	NA	NA	0.6	0.6

Table 6-8. Parameters Used to Quantify Exposures for Each Medium and Receptor at Fuze and Booster Quarry Landfill/Ponds[a] (continued)

Exposure Pathway and Parameter	Units	Potential Receptor					
		National Guard Personnel				Resident Subsistence Farmer	
		Security Guard/ Maintenance Worker[b]	Dust/Fire Control[b]	Trainee[b]	Hunter/ Trapper/ Fisher[bc]	Adult	Child
Quantity of soil ingested by cow	kg/day	NA	NA	NA	NA	1	1
Milk ingestion rate	kg/day	NA	NA	NA	NA	0.305	0.509
Fraction ingested	unitless	NA	NA	NA	NA	1	1
Exposure frequency	days/year	NA	NA	NA	NA	365	365
Exposure duration	years	NA	NA	NA	NA	30	6
Body weight	kg	NA	NA	NA	NA	70	15
Carcinogen averaging time	days	NA	NA	NA	NA	25,550	25,550
Noncarcinogen averaging time	days	NA	NA	NA	NA	10,950	2,190
Ingestion of vegetables							
Resuspension multiplier	unitless	NA	NA	NA	NA	0.26	0.26
Vegetable ingestion rate	kg/day	NA	NA	NA	NA	0.2	0.2
Fraction ingested	unitless	NA	NA	NA	NA	0.4	0.4
Exposure frequency	days/year	NA	NA	NA	NA	365	365
Exposure duration	years	NA	NA	NA	NA	30	6
Body weight	kg	NA	NA	NA	NA	70	15
Carcinogen averaging time	days	NA	NA	NA	NA	25,550	25,550
Noncarcinogen averaging time	days	NA	NA	NA	NA	10,950	2,190

[a] All parameters are from Table 5 of *RVAAP's Facility Wide Human Health Risk Assessor Manual* (FWHHRAM) (USACE 2004b), unless otherwise noted.
[b] National Guard Trainee, Fire/Dust Suppression Worker, Security Guard/Maintenance Worker, and Hunter/Trapper are representative receptors at the Fuze and Booster Quarry Landfill/Ponds (FBQ).
[c] The Ditch and Settling Basins are ephemeral; therefore, the hunter/trapper/fisher receptor is evaluated for the Quarry Ponds only.
[d] Surface soil is defined as 0 to 1 ft below ground surface (BGS) (shallow surface soil) for all receptors except the National Guard Trainee. Surface soil is defined as 0 to 4 ft BGS (deep surface soil) for the National Guard Trainee; however, at FBQ samples were collected to a maximum depth of 3 ft BGS.
[e] Per the FWHHRAM: 6 hr/day for 2 day/year to hunt and trap plus 4 hr/day for 5 day/year to fish.
[f] Per footnote d of Table 5 in FWHHRAM. Value in Table 5 (0.57) is incorrect and is inconsistent with skin area listed in Table 5 for this receptor for other media.
[g] Per footnote b of Table 5 in FWHHRAM Hunter/Trapper/Fisher is assumed to ingest 0.05 L/day due to splashing while setting traps or wading. Value in Table 5 (0.1) is incorrect.
[h] Fraction browse calculated as FBQ terrestrial exposure area (35 acres or 14 ha) divided by deer home range (175 ha).
NA = Not applicable for this scenario.
VOC = Volatile organic compound.

The concentration of contaminants in beef cattle from ingestion of contaminated pasture and soil is estimated using the following equation:

$$C_b = BTF_{beef} \times [(C_p \times Q_{pb} \times f_{pb} \times f_{sb}) + (C_s \times Q_{sb} \times f_{pb})], \qquad \textbf{(6-5)}$$

where

C_b = concentration of contaminant in beef (mg/kg dry weight),
BTF_{beef} = beef transfer coefficient (day/kg; see Table M-7),
C_p = concentration of contaminant in pasture (mg/kg, calculated),
Q_{pb} = quantity of pasture ingested by beef cattle (kg/day),
f_{pb} = fraction of year beef cattle is on-site (unitless),
f_{sb} = fraction of beef cattle's food that is from the site (unitless),
C_s = concentration of contaminant in soil (mg/kg),
Q_{sb} = quantity of soil ingested by beef cattle (kg/day).

The BTF_{beef} for metals is taken from available literature. The BTF_{beef} for SVOCs is calculated as $2.5 \times 10^{-8} \times K_{ow}$. No VOCs were identified as COPCs in soil at FBQ.

Chemical concentration in milk

Milk concentrations from dairy cattle are calculated from the concentration in the cattle's food sources due to soil contamination. The contaminant levels in pastures are estimated in the same fashion as for beef cattle.

The concentration of contaminants in dairy cattle's milk, from ingestion of contaminated pasture and soil is estimated using the following equation:

$$C_m = BTF_{milk} \times [(C_p \times Q_{pd} \times f_{pd} \times f_{sd}) + (C_s \times Q_{sd} \times f_{pd})], \qquad \textbf{(6-6)}$$

where

C_m = concentration of contaminant in milk (mg/kg),
BTF_{milk} = milk transfer coefficient (day/kg; see Table M-7),
C_p = concentration of contaminant in pasture (mg/kg, calculated),
Q_{pd} = quantity of pasture ingested by dairy cattle (kg/day),
f_{pd} = fraction of year dairy cattle is on-site (unitless),
f_{sd} = fraction of dairy cattle's food that is from the site (unitless),
C_s = concentration of contaminant in soil (mg/kg),
Q_{sd} = quantity of soil ingested by dairy cattle (kg/day).

The BTF_{milk} for metals is taken from available literature. The BTF_{milk} for SVOCs is calculated as $7.5 \times 10^{-9} \times K_{ow}$. No VOCs were identified as COPCs in soil at FBQ.

Chemical concentration in venison

Concentrations in venison are estimated by calculating the concentration in venison food sources due to soil contamination. The contaminant levels in forage are estimated by the following:

$$C_p = (CF)(C_s)(B_p) \qquad \textbf{(6-7)}$$

where

C_p = concentration of contaminant in forage (mg/kg dry weight),
CF = conversion factor to adjust for soil containing 20% moisture (1.25 unitless),
C_s = concentration of contaminant in soil (mg/kg),
B_p = soil-to-forage biotransfer factor (mg chemical per kg of dry plant/mg of chemical per kg or dry soil)(chemical-specific; see Bv_{dry} in Table M-7).

The B_p for metals is taken from the available literature. The B_p for SVOCs is calculated using the following formula:

$$\log B_p = 1.588 - 0.578 \log K_{ow} \qquad \textbf{(6-8)}$$

where

B_p = soil-to-forage biotransfer factor (mg chemical per kg of dry plant/mg of chemical per kg or dry soil)(chemical-specific; see Bv_{dry} in Table M-7),
K_{ow} = octanol-water partitioning coefficient (unitless, chemical-specific).

No VOCs were identified as COPCs in soil at FBQ.

The concentration of contaminants in venison from ingestion of contaminated forage is estimated using the following equation:

$$C_v = (Q_p)(C_p)(FI_e)(B_v) \qquad \textbf{(6-9)}$$

where

C_v = contaminant concentration in venison (mg/kg),
Q_p = browse ingestion rate (0.87 kg dry weight/day),
C_p = contaminant concentration in browse (mg/kg dry weight),
FI_e = fraction browse ingested from the contaminated site (site area/home range),
B_v = biotransfer factor for venison (days/kg).

The B_v for beef is used for deer due to a lack of available literature values for deer. Both of these animals are ruminants; therefore, the uptake and bioaccumulation of contaminants is likely to be similar. The meat of deer contains less fat than commercial beef — 14.4% fat for beef, compared to 2.9% for venison. Organic chemicals have a greater affinity to fat and thus would not accumulate as much in venison. Therefore, the beef biotransfer factors for organics are adjusted by 2.9/14.4 (0.20) to reflect this lower accumulation rate.

The fraction browse ingested from the contaminated site is exposure unit-specific. The FBQ area of investigation is approximately 39 acres with surface water bodies (Quarry Ponds, Settling Basins, and Ditch) making up approximately 5 acres of the total area. Fraction browse for the 34 terrestrial acres (14 ha) at FBQ is 0.08 (14 ha/175 ha) based on a 175-ha home range for deer.

The B_v values for metals are taken from the published literature. The B_v values for organics are calculated as follows:

$$B_v = R_f \times 10^{-7.6 + \log K_{ow}}, \qquad \textbf{(6-10)}$$

where

B_v = biotransfer factor for venison (days/kg),
R_f = ratio of the fat content in venison to the fat content of beef (0.20),
K_{ow} = octanol-water partitioning coefficient (unitless, chemical-specific).

Chemical concentration in homegrown vegetables

The chemical concentration in homegrown vegetables is estimated with the equation:

$$C_{veg} = C_s \times (Bv_{wet} + MLF), \quad \textbf{(6-11)}$$

where

C_{veg} = contaminant concentration in homegrown vegetable (mg/kg),
C_s = concentration of contaminant in soil (mg/kg),
Bv_{wet} = soil-to-plant uptake, wet weight (kg/kg, chemical-specific, or $7.7 \times K_{ow}^{-0.58}$; see Table M-7),
K_{ow} = octanol-water partitioning coefficient (unitless, chemical-specific),
MLF = plant mass loading factor (unitless, 0.26 for vegetables).

No VOCs were identified as COPCs in soil at FBQ.

Chemical concentration in fish

The contaminant concentration in fish due to bioconcentrating contaminants from surface water is estimated using the following equation:

$$C_f = (C_w)(BCF), \quad \textbf{(6-12)}$$

where

C_f = contaminant concentration in fish (mg/kg),
C_w = contaminant concentration in water (mg/L),
BCF = fish bioconcentration factor (L/Kg; see Table M-7).

Many BCF factors for fish are available from the literature. In the absence of a BCF literature value for an organic, the value is estimated using the following equation:

$$\log BCF = 0.76 \times K_{ow}^{-0.23}, \quad \textbf{(6-13)}$$

where

BCF = fish bioconcentration factor (L/kg; see Table M-7),
K_{ow} = octanol-water partitioning coefficient (unitless, chemical-specific).

6.3.3.3 EPCs in waterfowl

The determination of EPCs in waterfowl/waterfowl is described in detail in Appendix M, Section M3. EPCs for waterfowl are found in Table M-37. These EPCs are calculated assuming waterfowl are exposed continuously to contaminants at FBQ only. This assumption is conservative for two reasons:

- Waterfowl are migratory and spend only a portion of their time at RVAAP.

- The home range of waterfowl at RVAAP is larger than FBQ; therefore, while at RVAAP waterfowl spend only a portion of their time at FBQ.

6.3.4 Exposure Parameters and Calculations for Estimating Intakes

Standard intake equations from EPA guidance (EPA 1989a) for ingestion, dermal contact, and inhalation of chemicals in water and soil/sediment (shown below) are used along with the exposure parameters shown in Table 6-8. Exposure parameters and intake equations are from the FWHHRAM (USACE 2004b).

6.3.4.1 Surface soil and sediment exposure pathways

Incidental ingestion of soil and sediment is estimated using Equation 6-14:

$$\textit{Chemical Intake (mg/kg-day)} = \frac{C_S \times IR_S \times EF \times ED \times FI \times ET \times CF}{BW \times AT}, \qquad \textbf{(6-14)}$$

where

C_s = chemical concentration in soil or sediment (mg/kg),
IR_s = ingestion rate (kg/day),
EF = exposure frequency (days/year),
ED = exposure duration (years),
FI = fraction ingested (value of 1, unitless),
ET = exposure time (hr/day),
CF = conversion factor for ET (day/hr),
BW = body weight (kg),
AT = averaging time (days) for carcinogens or non-carcinogens.

The dermally absorbed dose (DAD) from chemicals in soil or sediment is calculated using Equation 6-15:

$$\textit{Chemical DAD (mg/kg-day)} = \frac{C_S \times CF \times SA \times AF \times ABS \times EF \times ED}{BW \times AT}, \qquad \textbf{(6-15)}$$

where

C_s = chemical concentration in soil or sediment (mg/kg),
CF = conversion factor $[(10^{-6}\ kg/mg) \times (10^4\ cm^2/m^2)]$,
SA = skin surface area exposed to soil (m^2/event),
AF = soil to skin adherence factor (mg/cm^2),
ABS = chemical-specific dermal absorption factor (unitless; see Table M-7),
EF = exposure frequency (events/year),
ED = exposure duration (years),
BW = body weight (kg),
AT = averaging time (days) for carcinogens or non-carcinogens.

Inhalation of soil or sediment is calculated using Equation 6-16:

$$Chemical\ Intake\ (mg/kg\text{-}day) = \frac{C_S \times IR_a \times EF \times ED \times \left(VF^{-1} + PEF^{-1}\right) \times ET \times CF}{BW \times AT}, \qquad \textbf{(6-16)}$$

where

C_s = chemical concentration in soil or sediment (mg/kg),
IR_a = inhalation rate (m^3/day),
EF = exposure frequency (days/year),
ED = exposure duration (years),
VF = chemical-specific volatilization factor (m^3/kg; see Table M-7),
PEF = particulate emission factor (m^3/kg),
ET = exposure time (hr/day)
CF = conversion factor for ET (day/hr),
BW = body weight (kg),
AT = averaging time (days) for carcinogens or non-carcinogens.

Per the FWHHRAM (USACE, 2004b) the general PEF value used for all receptors except the National Guard Trainee is the default value for Cleveland, Ohio (9.24E+08 m^3/kg) from the EPA Soil Screening Guidance on-line at http://risk.lsd.ornl.gov/epa/ssl1.htm. A smaller PEF value (1.67×10^6) is used for the National Guard Trainee scenario because the activities of this receptor are assumed to generate more dust. This PEF value was calculated from a dust-loading factor (DLF) of 600 µg/m^3 (DOE 1983) as:

PEF = 1/(DLF × Conversion Factor) = 1/(600 µg/m^3 × 1E-09 kg/µg) = 1.67E+06 m^3/kg.

6.3.4.2 Surface water and groundwater exposure pathways

Ingestion of surface water and groundwater is estimated using Equation 6-17:

$$Chemical\ Intake\ (mg/kg\text{-}day) = \frac{C_W \times IR_W \times EF \times ED}{BW \times AT}, \qquad \textbf{(6-17)}$$

where

C_w = chemical concentration in water (mg/L),
IR_w = ingestion rate (L/day),
EF = exposure frequency (day/year),
ED = exposure duration (years),
BW = body weight (kg),
AT = averaging time (days) for carcinogens or non-carcinogens.

The DAD from dermal contact with chemicals in surface water and groundwater is calculated by using Equation 6-18:

$$Chemical\ DAD\ (mg/kg\text{-}day) = \frac{C_W \times CF \times PC \times SA \times ET \times EF \times ED}{BW \times AT}, \qquad \textbf{(6-18)}$$

where

C_w = chemical concentration in water (mg/L),
CF = conversion factor [(m/100 cm) × (1,000 L/m^3)],
PC = chemical-specific permeability constant (cm/h; see Table M-7),
SA = skin surface area exposed to water (m^2),
ET = exposure time (h/day),
EF = exposure frequency (days/year),
ED = exposure duration (years),
BW = body weight (kg),
AT = averaging time (days) for carcinogens or non-carcinogens.

Inhalation of VOCs from groundwater was estimated by using Equation 6-19:

$$Chemical\ Intake\ (mg/kg\text{-}day) = \frac{C_w \times IR_w \times K \times EF \times ED \times ET \times CF}{BW \times AT}, \quad \textbf{(6-19)}$$

where:

C_w = chemical concentration in water (mg/L),
IR_w = inhalation rate (m^3/day),
K = volatilization factor (0.0005 × 1,000 L/m^3),
EF = exposure frequency (days/year),
ED = exposure duration (years),
ET = exposure time adjustment (hr/day),
CF = conversion factor for ET (day/hr),
BW = body weight (kg),
AT = averaging time (days) for carcinogens or non-carcinogens.

Only one VOC (methylene chloride) was identified as a COPC in surface water (identified in two samples at Quarry Ponds only), slightly above its PRG. Inhalation is not included in the surface water exposure model; however, the surface water ingestion rate is assumed to include potential incidental inhalation exposure.

6.3.4.3 Ingestion of food pathway

Ingestion of foodstuffs (waterfowl, beef, milk, vegetables, venison, and fish) is estimated using Equation 6-20:

$$Chemical\ Intake\ (mg/kg\text{-}day) = \frac{Cf \times IRf \times EF \times ED \times FI}{BW \times AT}, \quad \textbf{(6-20)}$$

where

C_f = chemical-specific concentration in food product (mg/kg),
IR_f = ingestion rate of food product (kg/day),
EF = exposure frequency (days/year),
ED = exposure duration (years),
FI = fraction ingested (value of 1, unitless),
BW = body weight (kg),
AT = averaging time (days) for carcinogens or non-carcinogens.

6.4 TOXICITY ASSESSMENT

The purpose of the toxicity assessment is to evaluate the potential for COPCs to cause adverse health effects in exposed individuals. Where possible, it provides an estimate of the relationship between the intake or dose of a COPC and the likelihood or severity of adverse health effects as a result of that exposure. Toxic effects have been evaluated extensively by EPA. This chapter provides the results of the EPA evaluation of the chemicals identified as COPCs at FBQ.

The primary source of toxicity information is IRIS. However, some chemicals have no values in IRIS or have no values for some exposure pathways in IRIS. For chemicals without values on IRIS, in accordance with the U.S. EPA - OSWER Directive (2003) and Ohio EPA DERR Technical Decision Compendium (2004), the following additional sources are used:

- U.S. EPA Office of Research and Development Provisional Peer Reviewed Toxicity Values (PPRTVs), EPA Superfund Health Risk Technical Support Center (STSC), and National Center for Environmental Assessment (NCEA).

- In the case where PPRTVs are not available and NCEA cannot provide any provisional toxicity values, the following resources are used:

    - California Environmental Protection Agency toxicity values (peer reviewed: http://www.oehha.ca.gov/risk/chemicalDB//index.asp);

    - U.S. CDC - ATSDR Toxicological Profiles (peer reviewed: http://www.atsdr.cdc.gov/mrls.html);

    - HEAST values (not yet peer reviewed, HEAST values are generally used only if no other values are available);

    - U.S. EPA Criteria Documents (the documents include but are not limited to: drinking water criteria documents; drinking water health advisory summaries; ambient water quality criteria documents; and air quality criteria documents).

A complete listing of toxicity values used in this Baseline HHRA is provided in Appendix M, Tables M-8 and M-9.

6.4.1 Toxicity Information and U. S. Environmental Protection Agency Guidance for Non-carcinogens

Non-carcinogenic effects are evaluated by comparing an exposure or intake/dose with a reference dose (RfD) or reference concentration (RfC). The RfD and RfCs are determined using available dose-response data for individual chemicals. Scientists determine the exposure concentration or intake/dose below which no adverse effects are seen and apply a safety factor (from 10 to 1,000) to determine the RfD or RfC. RfDs and RfCs are identified by scientific committees supported by EPA. The RfDs available for the COPCs present in the exposure media at FBQ are listed in Table M-8 (EPA 1997b, 2005). In this HHRA, RfCs, measured in mg/m^3, were converted to RfDs expressed in units of mg/kg body weight per day by using the default adult inhalation rate and body weight [i.e., (RfC $\times$ 20 m^3/d)/70 kg = RfD] (EPA 1989a).

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)

(EPA 1989a). Since the potential receptors at FBQ are not considered to have short-term exposure, only chronic RfDs are used in this HHRA.

Toxic effects are diverse and measured in various target body organs (e.g., they range from eye irritation to kidney or liver damage). EPA is currently reviewing methods for accounting for the difference in severity of effects; however, existing RfDs do not address this issue.

6.4.2 Toxicity Information and U. S. Environmental Protection Agency Guidance for Carcinogens

For carcinogens, risks are estimated as the probability that an individual will develop cancer over a lifetime as a result of exposure to the carcinogen. Cancer risk from exposure to contamination is expressed as excess or incremental cancer risk, which is cancer occurrence in addition to normally expected rates of cancer development. Excess cancer risk is estimated using a cancer slope factor (CSF). The CSF is defined as a plausible upper-bound estimate of the probability of a response (i.e., cancer) per unit intake of a chemical over a lifetime (EPA 1989a).

EPA expresses inhalation cancer potency as the unit risk based on the chemical concentration in air [i.e., risk per microgram (µg) of chemical per cubic meter (m^3) of ambient air]. These unit risks were converted to CSFs expressed in units of risk per mg of chemical per kg body weight per day by using the default adult inhalation rate and body weight [i.e., (Unit Risk × 70 kg × 1,000 µg/mg)/20 m^3/day].

CSFs used in the evaluation of risk from carcinogenic COPCs are listed in Table M-9 (EPA 1997b, 2005).

6.4.3 Estimated Toxicity Values for Dermal Exposure

Oral and inhalation RfDs and CSFs are currently available. Dermal RfDs and CSFs are estimated from oral toxicity values using chemical-specific gastrointestinal absorption factors (GAFs) to calculate total absorbed dose. This conversion is necessary because most oral RfDs and CSFs are expressed as the amount of chemical administered per time and body weight; however, dermal exposure is expressed as an absorbed dose. Dermal toxicity factors are calculated from oral toxicity factors as shown below (EPA 2004a):

$$RfD_{dermal} = RfD_{oral} \times GAF \tag{6-21}$$

$$CSF_{dermal} = CSF_{oral}/GAF \tag{6-22}$$

Per FWHHRAM, dermal CSFs and RfDs are estimated from the oral toxicity values using chemical-specific GAFs to calculate the total absorbed dose only for chemicals with GAF values < 0.5. Chemical-specific GAF values available from EPA (2004a) are used whenever possible. Not all COPCs have specific GAF values. When quantitative data are insufficient, a default GAF is used. A default value of 1.0 for organic and inorganic chemicals is used (EPA 2004a). The GAF and resulting dermal toxicity values used in this HHRA are listed in Tables M-8 and M-9.

6.4.4 Assumptions Used in the Toxicity Assessment

Assumptions made in assigning toxicity values for COPCs at FBQ are as follows:

- Total chromium is evaluated using the toxicity values for trivalent chromium because hexavalent chromium is a separate analyte at FBQ.

- Toxicity equivalency factors (TEFs) are applied to carcinogenic polycyclic aromatic hydrocarbons (cPAHs). The following TEFs are used to convert the cPAHs identified as COPCs at FBQ to an equivalent concentration of benzo(*a*)pyrene.

cPAH	TEF
Benzo(*a*)pyrene	1
Benz(*a*)anthracene	0.1
Benzo(*b*)fluoranthene	0.1
Indeno(1,2,3-*cd*)pyrene	0.1

6.4.5 Chemicals without U. S. Environmental Protection Agency Toxicity Values

No RfDs or CSFs are available for some detected chemicals at FBQ 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 at FBQ, 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; acenaphthylene; benzo(*ghi*)perylene; nitrocellulose; nitroglycerin; and phenanthrene.

No RfDs or CSFs are available for lead, which is a COPC for surface soil, sediment, and surface water (see Table 6-7). EPA (1999a) recommends the use of the Interim Adult Lead Methodology (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 (EPA 2003a). The model-supplied default values were used for all parameters, with the exception of the site-specific media concentration and exposure frequency. Input parameters and results of this model are provided in Appendix M. The ALM was used to evaluate exposure to lead in soil for the Security Guard/Maintenance Worker (Table M-10) and Resident Subsistence Farmer Adult (Tables M-11, M-13, M-15). The ALM was not used to evaluate the National Guard Trainee, Fire/Dust Suppression Worker, or Hunter/Trapper because the exposure frequency of these receptors does not meet the steady state assumptions of the model [i.e., the first-order elimination half-life of lead of approximately 30 days requires a constant lead intake over a duration of 90 days to reach quasi-steady state; shorter exposures are expected to produce oscillations in blood lead concentrations as a result of absorption and subsequent clearance of lead between each exposure event (EPA 2003a)].

The Integrated Exposure Uptake Biokinetic (IEUBK) model for lead in children (available at http://www.epa.gov/superfund/programs/lead/ieubk.htm) was used to evaluate the On-Site Resident Subsistence Farmer Child. The IEUBK model is used to predict the risk of elevated blood lead (PbB) levels in children (under the age of seven) that are exposed to environmental lead (Pb) from many sources. The model also predicts the risk (e.g., probability) that a typical child, exposed to specified media Pb concentrations, will have a PbB level greater or equal to the level associated with adverse health effects (10 μg/dL). Default input parameters were used. Input parameters and results of this model are provided in Appendix M, Tables M-12, M-14, and M-16.

6.5 RISK CHARACTERIZATION

The purpose of the risk characterization is to evaluate the information obtained through the exposure and toxicity assessments to estimate potential risks and hazards. Potential carcinogenic effects are characterized by using projected intakes and chemical-specific, dose-response data (i.e., CSFs) to estimate the probability that an individual will develop cancer over a lifetime. Potential non-carcinogenic effects are characterized by comparing projected intakes of contaminants to toxicity values (i.e., RfDs). The numerical risk and hazard estimates presented in this chapter must be interpreted in the context of the uncertainties and assumptions associated with the risk assessment process and with the data upon which the risk estimates are based.

6.5.1 Methodology

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 at FBQ.

6.5.1.1 Risk characterization for carcinogens

For carcinogens, risk is expressed as the probability that an individual will develop cancer over a lifetime as a result of exposure to the carcinogen. Cancer risk from exposure to contamination is expressed as the incremental lifetime cancer risk (ILCR), or the increased chance of cancer above the normal background rate of cancer. In the United States, the background chance of contracting cancer is a little more than 3 in 10, or 3×10^{-1} (American Cancer Society 2003). The calculated ILCRs are compared to the range specified in the National Oil and Hazardous Substances Pollution Contingency Plan of 10^{-6} to 10^{-4}, or 1-in-1 million to 1-in-10,000 exposed persons developing cancer (EPA 1990b). ILCRs below 10^{-6} are considered acceptable; ILCRs above 10^{-4} are considered unacceptable. The range between 10^{-6} and 10^{-4} is of concern, and any decisions to address ILCRs further in this range, either through additional study or engineered control measures, should account for the uncertainty in the risk estimates.

The ILCR is calculated using the equation below (EPA 1989a):

$$ILCR = I \times CSF \qquad \textbf{(6-23)}$$

where

I = chronic daily intake or DAD calculated in the exposure assessment (mg/kg-day),
CSF = cancer slope factor $(\text{mg/kg-day})^{-1}$.

For a given exposure pathway, the total risk to a receptor exposed to several carcinogenic COPCs is the sum of the ILCRs for each carcinogen, as shown in Equation 6-24 below:

$$ILCR_{total} = \Sigma ILCR_i \qquad \textbf{(6-24)}$$

where

$ILCR_{total}$ = total probability of cancer incidence associated with all carcinogenic COPCs,
$ILCR_i$ = ILCR for the i^{th} COPC.

In addition to summing risks across all carcinogenic COPCs, risks are summed across all exposure pathways for a given environmental medium (e.g., ingestion, inhalation, and dermal contact with surface soil). Per EPA (1989a) guidance, “there are two steps required to determine whether risks or hazard indices for two or more pathways should be combined for a single exposed individual or group of individuals. The first is to identify reasonable exposure pathway combinations. The second is to examine whether it is likely that the same individuals would consistently face the “reasonable maximum exposure” (RME) by more than one pathway.” It is reasonable to assume the same individual may be exposed at the RME by multiple pathways to a given exposure medium. For example, a Fire/Dust Suppression Worker present at FBQ can reasonably be assumed to both ingest surface soil and inhale contaminated dust from the same area.

6.5.1.2 Risk characterization for non-carcinogens

In addition to developing cancer from exposure to contaminants, an individual may experience other toxic effects. The term "toxic effects" is used here to describe a wide variety of systemic effects ranging from minor irritations, such as eye irritation and headaches, to more substantial effects, such as kidney or liver disease and neurological damage. The risks associated with toxic (i.e., non-carcinogenic) chemicals are evaluated by comparing an estimated exposure (i.e., intake or dose) from site media to an acceptable exposure expressed as an RfD. The RfD is the threshold level below which no toxic effects are expected to occur in a population, including sensitive subpopulations. The ratio of intake over the RfD is the HQ (EPA 1989a) and is calculated as:

$$HQ = I/RfD \qquad \textbf{(6-25)}$$

where

I = daily intake or DAD of a COPC (mg/kg-day),
RfD = reference dose (mg/kg-day).

The HQs for each COPC are summed to obtain a hazard index (HI), as shown below:

$$HI = \Sigma HQ_i \qquad \textbf{(6-26)}$$

where

HI = hazard index for all toxic effects,
HQ_i = hazard quotient for the i^{th} COPC.

An HI greater than 1 has been defined as the level of concern for potential adverse non-carcinogenic health effects (EPA 1989a). This approach differs from the probabilistic approach used to evaluate carcinogens. An HQ of 0.01 does not imply a 1-in-100 chance of an adverse effect but indicates only that the estimated intake is 100 times less than the threshold level at which adverse health effects may occur.

In addition to summing hazards across all COPCs, hazards are summed across all exposure pathways for a given environmental medium.

6.5.1.3 Identification of COCs

Risks are characterized for each exposure medium/receptor combination. COCs are identified if the total ILCR for a chemical exceeds 10^{-6} or if total HIs exceed 1 for a medium/receptor combination.

6.5.2 Results

Estimated risks for FBQ are evaluated for the National Guard Trainee, National Guard Fire/Dust Suppression Worker, Security Guard/Maintenance Worker, and Hunter/Trapper/Fisher as representative receptors exposed to surface soil, subsurface soil, groundwater, sediment, and surface water. Surface soil is evaluated as shallow surface soil (defined 0 to 1 ft BGS) for all receptors except the National Guard Trainee and deep surface soil (defined as 0 to 3 ft BGS) for the National Guard Trainee. Risks are also calculated for a Resident Subsistence Farmer (adult and child) to provide additional information for consideration in the FS. Detailed hazard and risk results are presented in Tables M-17 through M-32 for all exposure media for all six receptors evaluated. Results are summarized in the following sections for the representative receptors (National Guard Trainee, National Guard Fire/Dust Suppression Worker, Security Guard/Maintenance Worker, and Hunter/Trapper/Fisher) and the Resident Subsistence Farmer (to provide a baseline for unrestricted release of the property).

The EUs are evaluated to provide an estimate of risk from a RME. The RME incorporates a reasonable estimate of the concentration to which a receptor may be exposed (UCL_{95} on the mean). The use of the UCL_{95} on the mean as the EPC implies that a receptor may come into contact with contaminants throughout the EUs.

6.5.2.1 Surface soil results

Surface Soil – Direct Contact

Detailed hazard and risk results for all six receptors that have direct contact with COPCs in surface soil are presented in Tables M-17 and M-18 (shallow surface soil) and M-19 and M-20 (deep surface soil). Direct contact includes incidental ingestion of soil, inhalation of VOCs and particulates (i.e., dust) from soil, and dermal contact with soil. Hazard and risk results for the representative receptors and Resident Subsistence Farmer direct contact with COPCs in surface soil are summarized in Table 6-9.

Table 6-9. Summary of Surface Soil Risks and Hazards for Direct Contact at Fuze and Booster Quarry Landfill/Ponds

Receptor	Total HI	Non-carcinogenic COCs	Total ILCR	Carcinogenic COCs
National Guard Trainee	2.2	Manganese	4.4E-06	Arsenic
Fire/Dust Suppression Worker	0.0027	None	2.0E-07	None
Security Guard/Maintenance Worker	0.067	None	5.5E-06	Arsenic
Hunter/Trapper/Fisher	0.0017	None	1.6E-07	None
Resident Subsistence Farmer (Adult)	0.22	None	2.0E-05	Arsenic Benzo(*a*)pyrene
Resident Subsistence Farmer (Child)	1.2	None	2.3E-05	Arsenic

COC = Chemical of concern.
HI = Hazard index.
ILCR = Incremental lifetime cancer risk.

No COCs were identified for the Fire/Dust Suppression worker or Hunter/Trapper/Fisher exposed to surface soil.

Manganese was identified as a COC for the National Guard Trainee scenario with an HQ of 1.8. Manganese is naturally present in soils in the Ravenna area. The estimated HQ for a National Guard receptor exposed to the background concentration of manganese (1,450 mg/kg) is 6. The HQ related to manganese at the FBQ EPC does not exceed that estimated for facility-wide background.

Arsenic was identified as a COC for the National Guard Trainee, Security Guard/Maintenance Worker, and Resident Subsistence Farmer (adult and child) scenarios. Arsenic is also naturally present in soils in the Ravenna area. The estimated risks from exposure of these receptors to the background concentration of arsenic (15.4 mg/kg) in surface soil are:

National Guard Trainee	9E-06
Security Guard/Maintenance Worker	6E-06
On-Site Resident Farmer: Adult	2E-05
On-Site Resident Farmer: Child	3E-05

Risks to these receptors from arsenic at FBQ are below the risks associated with the background concentration of this metal.

Benzo(*a*)pyrene is also identified as a COC for the Resident Subsistence Farmer (adult) with an ILCR of 1.4E-06.

Surface Soil – Indirect Contact

Detailed hazard and risk results for the Resident Subsistence Farmer that have indirect contact with COPCs in surface soil are presented in Tables M-21 and M-22 and summarized in Table 6-10. Indirect contact includes ingestion of venison, beef, milk, and vegetables. The Resident Subsistence Farmer is the only receptor potentially exposed by these indirect pathways.

Table 6-10. Summary of Surface Soil Risks and Hazards for Ingestion of Foodstuffs at Fuze and Booster Quarry Landfill/Ponds

Receptor	Total HI	Non-carcinogenic COCs	Total ILCR	Carcinogenic COCs
Resident Subsistence Farmer (Adult)	27	Antimony, Arsenic, Manganese, 2,4,6-TNT	2.7E-03	Arsenic, 2,4,6-TNT, 2,6-DNT Benzo(*a*)pyrene
Resident Subsistence Farmer (Child)	130	Antimony, Arsenic, Barium, Copper, Manganese, Vanadium, 2,4,6-TNT	2.5E-03	Arsenic, 2,4,6-TNT, 2,6-DNT Benzo(*a*)pyrene

COC = Chemical of concern.
HI = Hazard index.
ILCR = Incremental lifetime cancer risk.

The total HIs for the Resident Subsistence Farmer Adult and Child exposed to surface soil COPCs via ingestion of foodstuffs are 27 and 130, respectively, with the largest contributor being arsenic (arsenic HQs are 13 for the adult and 60 for the child). Seven non-carcinogenic surface soil COCs are identified at FBQ for food ingestion by a resident subsistence farmer. The total risks across all COPCs for the Resident Subsistence Farmer Adult and Child exposed to surface soil are 2.7E-03 and 2.5E-03, respectively, coming predominantly from arsenic (arsenic ILCRs are 2.5E-03 for the adult and 2.3E-03 for the child). Four carcinogenic surface soil COCs are identified for this pathway.

These hazards and risks are driven primarily by ingestion of vegetables, followed by beef and milk ingestion. Ingestion of venison has a negligible contribution to hazard and risk.

Surface soil lead modeling results

Lead was identified as a surface soil COPC at FBQ. Lead model results for the Security Guard/Maintenance Worker and Resident Subsistence Farmer (adult and child) are provided in Appendix M Tables M-10 through M-16. The estimated probability of fetal blood lead concentrations exceeding acceptable levels ranged from 0.5 to 1.2% for the adult receptors at FBQ. For the Resident Subsistence

Farmer Child the estimated probability of blood lead concentrations exceeding acceptable levels is 0.7% at FBQ. Therefore, lead is not identified as a COC for surface soil at FBQ.

6.5.2.2 Subsurface soil results

Detailed hazard and risk results for all Resident Subsistence Farmer (Adult and Child) direct contact with COPCs in subsurface soil are presented in Tables M-23 and M-24. Direct contact includes incidental ingestion of soil, inhalation of VOCs and particulates (i.e., dust) from soil, and dermal contact with soil. The Resident Subsistence Farmer is the only receptor exposed to subsurface soil. Hazard and risk results for the Resident Subsistence Farmer are summarized in Table 6-11.

The total HIs for the Resident Subsistence Farmer Adult and Child are 0.16 and 0.98 respectively. Thus, the HIs are below the threshold of 1.0 and no non-carcinogenic surface soil COCs are identified at FBQ for the Resident Subsistence Farmer.

The total cancer risks for the Resident Subsistence Farmer Adult and Child are 2.4E-05 and 2.8E-05, respectively. Arsenic is the only COC identified for this receptor. Note that the EPC for arsenic is 15.9 mg/kg, which is just above the arsenic background soil concentration of 15.4 mg/kg. Thus, the cancer risk related to arsenic at FBQ barely exceeds the cancer risk for arsenic estimated from the facility-wide background.

Table 6-11. Summary of Subsurface Soil Risks and Hazards for Direct Contact at Fuze and Booster Quarry Landfill/Ponds

Receptor	Total HI	Non-carcinogenic COCs	Total ILCR	Carcinogenic COCs
Resident Subsistence Farmer (Adult)	0.16	None	2.4E-05	Arsenic
Resident Subsistence Farmer (Child)	0.98	None	2.8E-05	Arsenic

COC = Chemical of concern.
HI = Hazard index.
ILCR = Incremental lifetime cancer risk.

6.5.2.3 Groundwater risks and hazards

Detailed hazard and risk results for all applicable receptors (i.e., National Guard Trainee and Resident Subsistence Farmer) exposure to COPCs in groundwater are presented in Tables M-25 and M-26 and summarized in Table 6-12. Two groundwater EUs are evaluated: Bedrock Aquifer and Unconsolidated Aquifer. Groundwater exposure includes drinking water ingestion of groundwater, inhalation of VOCs from groundwater during household water use, and dermal contact with groundwater during bathing/showering.

Table 6-12. Summary of Groundwater Risks and Hazards at Fuze and Booster Quarry Landfill/Ponds

Receptor	Total HI	Non-carcinogenic COCs	Total ILCR	Carcinogenic COCs
National Guard Trainee				
Bedrock Aquifer	0.35	None	9.0E-07	None
Unconsolidated Aquifer	0.48	None	No COPC	None
Resident Subsistence Farmer (Adult)				
Bedrock Aquifer	3.2	Manganese	9.7E-06	2,4,6-TNT, 2,4-DNT TCE
Unconsolidated Aquifer	4.3	Manganese	No COPC	None
Resident Subsistence Farmer (Child)				
Bedrock Aquifer	11	Manganese 2,4,6-TNT	6.0E-06	2,4,6-TNT, 2,4-DNT TCE
Unconsolidated Aquifer	15	Manganese	No COPC	None

COC = Chemical of concern.
HI = Hazard index.
ILCR = Incremental lifetime cancer risk.
No COPC = No carcinogenic chemicals of potential concern (COPCs) identified for this aquifer.

No groundwater COCs are identified for the National Guard Trainee. Four groundwater COCs are identified for the Resident Subsistence Farmer.

6.5.2.4 Sediment results

Detailed hazard and risk results for all applicable receptors (i.e., National Guard Trainee, National Guard Fire/Dust Control worker, Hunter/Trapper/Fisher, and Resident Subsistence Farmer) that have direct contact with COPCs in sediment are presented in Tables M-27 and M-28. 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. Hazard and risk results for the representative receptors and Resident Subsistence Farmer direct contact with COPCs in sediment are summarized in Table 6-13.

Table 6-13. Summary of Sediment Risks and Hazards for Direct Contact at Fuze and Booster Quarry Landfill/Ponds

Receptor	Total HI	Non-carcinogenic COCs	Total ILCR	Carcinogenic COCs
Ditch				
National Guard Trainee	12	Manganese	7.3E-06	Arsenic
Fire/Dust Suppression Worker	0.0059	None	4.5E-07	None
Hunter/Trapper/Fisher	NA	NA	NA	NA
Resident Subsistence Farmer (Adult)	0.49	None	4.2E-05	Arsenic, Benz(*a*)anthracene, Benzo(*a*)pyrene, Benzo(*b*)fluoranthene
Resident Subsistence Farmer (Child)	2.8	Manganese	4.3E-05	Arsenic, Benzo(*a*)pyrene
Quarry Ponds				
National Guard Trainee	0.57	None	2.0E-05	Arsenic, Cadmium, hexavalent chromium
Fire/Dust Suppression Worker	0.0092	None	4.3E-07	None
Hunter/Trapper/Fisher	0.0057	None	3.5E-07	None
Resident Subsistence Farmer (Adult)	0.95	None	4.0E-05	Arsenic, Benzo(*a*)pyrene
Resident Subsistence Farmer (Child)	7.1	Antimony, Mercury	4.1E-05	Arsenic, Benzo(*a*)pyrene
Settling Basins				
National Guard Trainee	2.4	Manganese	1.1E-07	None
Fire/Dust Suppression Worker	0.00096	None	2.4E-08	None
Hunter/Trapper/Fisher	NA	NA	NA	NA
Resident Subsistence Farmer (Adult)	0.086	None	1.9E-06	Benzo(*a*)pyrene
Resident Subsistence Farmer (Child)	0.53	None	1.1E-06	Benzo(*a*)pyrene

COC = Chemical of concern.
HI = Hazard index.
ILCR = Incremental lifetime cancer risk.
NA = Not applicable; the Hunter/Trapper/Fisher is only exposed at the Quarry Ponds because the Ditch and Settling Basins do not provide habitat for fish or waterfowl.

No sediment COCs are identified for the National Guard Fire/Dust Suppression worker or Hunter/Trapper/Fisher.

Metals are identified as COCs for the National Guard Trainee at the Ditch (arsenic and manganese), Quarry Ponds (arsenic, cadmium, and hexavalent chromium), and Settling Basins (manganese).

Arsenic (Drainage Ditch and Quarry Ponds only), antimony (Quarry Ponds only), mercury (Quarry Ponds only), and PAHs [primarily benzo(*a*)pyrene] are identified as COCs for the On-Site Resident Farmer (adult and child) exposed to sediment. It should be noted that the EPC for arsenic at the Quarry Ponds (19 mg/kg) is smaller than the sediment background level for arsenic (19.5 mg/kg).

Lead is a COPC in sediment for the Quarry Ponds and Settling Basins. The probability of exceeding acceptable fetal blood levels for the Resident Subsistence Farmer Adult was estimated to be 0.8 to 1.5% for the Settling Basins and 9.0 to 11.5% at the Quarry Ponds (Table M-13). The probability of the Resident Subsistence Farmer Child exceeding acceptable child blood lead levels was estimated to be 1.9% at the Settling Basins and 62.5% at the Quarry Ponds (Table M-14). Based on these results lead is not identified as a COC for sediment at the Settling Basins, but is a sediment COC for the Quarry Ponds.

6.5.2.5 Surface water results

Surface Water – Direct Contact

Detailed hazard and risk results for all applicable receptors that have direct contact with COPCs in surface water are presented in Tables M-29 and M-30. Direct contact includes incidental ingestion of surface water and dermal contact with surface water. Hazard and risk results for the representative receptors and Resident Subsistence Farmer direct contact with COPCs in surface water are summarized in Table 6-14.

Table 6-14. Summary of Surface Water Risks and Hazards for Direct Contact at Fuze and Booster Quarry Landfill/Ponds

Receptor	Total HI	Non-carcinogenic COCs	Total ILCR	Carcinogenic COCs
Ditch				
National Guard Trainee	0.96	None	No COPC	None
Fire/Dust Suppression Worker	0.073	None	No COPC	None
Hunter/Trapper/Fisher	NA	NA	NA	NA
Resident Subsistence Farmer (Adult)	1.8	Manganese	No COPC	None
Resident Subsistence Farmer (Child)	4.2	Manganese	No COPC	None
Quarry Ponds				
National Guard Trainee	0.000054	None	8.7E-09	None
Fire/Dust Suppression Worker	0.0000073	None	1.2E-09	None
Hunter/Trapper/Fisher	0.0000033	None	6.5E-10	None
Resident Subsistence Farmer (Adult)	0.00018	None	3.4E-08	None
Resident Subsistence Farmer (Child)	0.00062	None	2.4E-08	None
Settling Basins				
National Guard Trainee	0.24	None	7.3E-06	Arsenic, bis(2-Ethylhexyl)phthalate
Fire/Dust Suppression Worker	0.020	None	7.0E-07	None
Hunter/Trapper/Fisher	NA	NA	NA	NA
Resident Subsistence Farmer (Adult)	0.49	None	2.1E-05	Arsenic, bis(2-Ethylhexyl)phthalate
Resident Subsistence Farmer (Child)	1.2	None	1.2E-05	Arsenic, bis(2-Ethylhexyl)phthalate

COC = Chemical of concern.
HI = Hazard index.
ILCR = Incremental lifetime cancer risk.
No COPC = No carcinogenic chemicals of potential concern (COPCs) identified for this exposure unit.
NA = Not applicable; the Hunter/Trapper/Fisher is only exposed at the Quarry Ponds because the Ditch and Settling Basins do not provide habitat for fish or waterfowl.

No COCs are identified for any receptor exposed to surface water at the Quarry Ponds. No COCs are identified for the representative receptors exposed to surface water at the Ditch. One COC (manganese) is identified for the Resident Subsistence Farmer (adult and child) exposed to surface water at the Ditch.

Two COCs [arsenic and bis(2-ethylhexyl)phthalate] are identified for the National Guard Trainee and Resident Subsistence Farmer (adult and child) at the Settling Basins.

Lead is a COPC in surface water for the Settling Basins. The probability of exceeding acceptable fetal PbBs for the Resident Subsistence Farmer Adult was estimated to be 0.3 to 0.6% (Table M-15). The probability of the Resident Subsistence Farmer Child exceeding acceptable child blood lead levels was estimated to be 1.5% (Table M-16). Based on these results lead is not identified as a COC for surface water at the Settling Basins.

Surface Water – Indirect Contact

In addition to the direct contact pathways described above, the Hunter/Trapper/Fisher and On-Site Resident Farmer (adult and child) may be exposed to COPCs in surface water via ingestion of fish. Risk and hazard results for ingestion of fish are presented in Table M-31 and summarized in Table 6-15. Ingestion of fish is evaluated only for the Quarry Ponds because the Settling Basins and Ditch are ephemeral and do not support fish.

Table 6-15. Total Hazards/Risks and COCs for Ingestion of Fish at the Fuze and Booster Quarry Landfill/Ponds

Receptor	Non-carcinogens		Carcinogens	
	HI	COCs	ILCR	COCs
Hunter/Trapper	0.00011	None	2.1E-08	None
On-Site Resident Farmer (Adult)	0.00011	None	2.1E-08	None
On-Site Resident Farmer (Child)	0.00051	None	2.0E-08	None

COC = Chemical of concern.
HI = Hazard index.
ILCR = Incremental lifetime cancer risk.

No COCs are identified for ingestion of fish at the Quarry Ponds.

6.5.2.6 Waterfowl results

Detailed hazard and risk results for the Hunter/Trapper's ingestion of waterfowl for all COPCs in sediment and surface water are presented in Table M-32; these hazards and risks are summarized in Table 6-16. Ingestion of waterfowl is evaluated only for the Quarry Ponds because the Settling Basins and Ditch are ephemeral and do not provide quality waterfowl habitat.

The total HI is 98 for the Hunter/Trapper/Fisher. Four metals are identified as non-carcinogenic COCs for the ingestion of waterfowl pathway at FBQ.

Table 6-16. Summary of Risks and Hazards from Ingesting Waterfowl at the Fuze and Booster Quarry Landfill/Ponds

Receptor	Total HI	Non-carcinogenic COCs	Total ILCR	Carcinogenic COCs
Hunter/Trapper/Fisher	98	Antimony, Arsenic, Mercury, Zinc	1.5E-03	Arsenic, Benz(*a*)anthracene, Benzo(*a*)pyrene, Benzo(*b*)fluoranthene, Indeno(1,2,3-*cd*)pyrene

COC = Chemical of concern.
HI = Hazard index.
ILCR = Incremental lifetime cancer risk.

The total cancer risk for the ingestion of waterfowl pathway is 1.5E-03 for the Hunter/Trapper/Fisher. Because the total cancer risk for the Hunter/Trapper is well above the threshold of 1.0E-06, carcinogenic COCs are identified for the ingestion of waterfowl pathway at FBQ for this receptor. Arsenic and four PAHs are identified as COCs for the Hunter/Trapper eating the waterfowl at FBQ.

The calculated risk from ingestion of all of these COCs in waterfowl tissue results primarily from the predicted bioaccumulation of these chemicals from sediment to sediment/benthic invertebrates and subsequent ingestion and bioaccumulation by waterfowl. None of these COCs are COPCs in surface water. The EPC of arsenic in sediment (19 mg/kg) results in a predicted risk to a hunter from ingestion of waterfowl of 2.1E-04. The background concentration for arsenic (19.5 mg/kg) results in a predicted risk to a hunter from ingestion of waterfowl of 2.2E-04.

The calculation of risks for waterfowl ingestion is highly uncertain. One source of uncertainty is that waterfowl tissue concentrations are calculated assuming waterfowl are exposed continuously to contaminants at the FBQ Quarry Ponds only. This assumption is extremely conservative for two reasons:

- Waterfowl are migratory and spend only a portion of their time at RVAAP.
- The home range of waterfowl at RVAAP is larger than FBQ Quarry Ponds; therefore, while at RVAAP, waterfowl spend only a portion of their time at the Quarry Ponds.

Likely residence times at ponds in Northeastern Ohio also vary from species to species. Mallards spend an average of 3 months (Ohio DNR 2005). Wood ducks and Canada geese spend much more time than mallards in the area with an average of 10 months. These residence times would result in temporal use factors (TUFs) ranging from 0.24 to 0.83.

The home ranges of waterfowl vary from species to species. For mallards, it averages 274 acres for laying ducks and 1156 acres for ducks during various activities (EPA 1993). For wood ducks, the average home range for breeding males is 499 acres (California DFG 2005). For Canada geese, the average home range is 2429 acres (EPA 1993). The FBQ area of investigation is approximately 39 acres, with the Quarry Ponds making up approximately 2.9 acres. These home ranges would result in area use factors (AUFs) ranging from 0.0012 to 0.011 for the Quarry Ponds.

The total HI would range from 0.062 to 0.48 with the application of these AUFs and TUFs (reduced from 98). The total ILCR would range from 9.6E-07 to 7.4E-06 with the application of these AUFs and TUFs (reduced from 1.5E-03). These revised risk estimates are also highly uncertain because they are based on assumptions that the entire 2.9 acres of the Quarry Ponds are uniformly contaminated and that bioaccumulation factors calculated for beef apply to waterfowl.

6.6 UNCERTAINTY ANALYSIS

This section identifies the uncertainties associated with each step of the risk assessment process, where possible. Uncertainties are not mutually exclusive.

6.6.1 Uncertainties Associated with the Data Evaluation

Although the data evaluation process used to select COPCs adheres to established procedures and guidance, it also requires making decisions and developing assumptions on the basis of historical information, disposal records, process knowledge, and best professional judgment about the data. Uncertainties are associated with all such assumptions. The background concentrations and PRGs used to screen analytes are also subject to uncertainty.

Another area of uncertainty involves the qualitative evaluation (and elimination from further consideration) of essential nutrients, many of which have no available toxicity values. In addition, the toxicity values used in the derivation of PRGs are subject to change as additional information becomes available from scientific research. These periodic changes in toxicity values may cause the PRG values to change as well.

Some unavoidable uncertainty is associated with the contaminant concentrations detected and reported by the analytical laboratory. The quality of the analytical data used in the risk assessment depends on the adequacy of the set of procedures that specifies how samples are selected and handled and how strictly these procedures are followed QA/QC procedures within the laboratories are used to minimize uncertainties; however, sampling errors, laboratory analysis errors, and data analysis errors can occur.

Some current analytical methods are limited in their ability to achieve detection limits at or below risk-based screening levels (i.e., PRG concentrations). Under these circumstances, it is uncertain whether the true concentration is above or below the PRGs, which are protective of human health. When analytes are on the COPC list and have a mixture of detected and non-detected concentrations, risk calculations may be affected by these detection limits. Risks may be overestimated as a result of some sample concentrations being reported as non-detected at the method detection limit (MDL), which may be greater than the PRG concentration (when the actual concentration may be much smaller than the MDL). Risks may also be underestimated because some analytes that are not detected in any sample are removed from the COPC list. If the concentrations of these analytes are below the MDL but are above the PRG, the risk from these analytes would not be included in the risk assessment results.

In the data assessment process, elevated levels of common laboratory contaminants [e.g., bis(2-ethylhexyl)phthalate] can be evaluated to see if the detected concentrations are likely to be "false positives" (i.e., at high concentrations due to laboratory interference). This process involves a check against the concentrations detected in the associated laboratory method blank.

6.6.2 Uncertainties Associated with the Exposure Assessment

Uncertainty is also introduced through the process of estimating representative exposure concentrations in the analyzed exposure media. Analytical results are used to calculate a mean concentration and the UCL_{95} on the mean concentration. The smaller of the MDC and the UCL_{95} concentration is used as the EPC for this HHRA. This method may underestimate the EPC for small data sets from areas with a high degree of variability in contaminant concentrations.

Moderate uncertainty can be introduced in the data aggregation process for estimating a representative exposure concentration in the exposure media. A statistical test (the Shapiro-Wilk test) is performed to determine whether the concentration data are best described by a normal or lognormal distribution. Each COPC's mean and UCL_{95} on the mean concentrations are calculated using both detected values and one-half of the reported detection limit for samples without a detected concentration. The EPC is the smaller of the MDC or the calculated UCL_{95}. This method may moderately overestimate the exposure concentration. In addition, when the resulting individual contaminant risks are summed to provide a total ILCR or HI, the compounding conservatism of this method for estimating EPCs will likely result in an overestimation of the total risk.

Representative exposure concentrations are calculated in this HHRA based on the assumption that the samples collected from the EU are truly random samples. This assumption may not be met for FBQ. Sample locations may be biased to identify areas of highest contaminant concentrations.

In addition, in the evaluation of the various media, environmental concentrations are assumed to be constant (i.e., concentrations are not reduced by loss due to natural removal processes such as volatilization, leaching, and/or biodegradation). This assumption is a source of uncertainty, especially for groundwater and surface water.

At best, quantification of exposure provides an estimate of the chemical intake for various exposure pathways identified at the site. Several uncertainties associated with the various components of the exposure assessment include uncertainties about the exposure pathway equations, exposure parameters, land use scenarios, representative exposure concentrations, and sampling and analysis of the media.

For each primary exposure pathway chosen for analysis in this HHRA, assumptions are made concerning the exposure parameters (e.g., amount of contaminated media a receptor can be exposed to and intake rates for different routes of exposure) and the routes of exposure. In the absence of site-specific data, the assumptions used are consistent with Ohio EPA-approved default values, which are assumed to be representative of potentially exposed populations (USACE 2004b). All contaminant exposures are assumed to be from site-related exposure media (i.e., no other sources contribute to the receptor's health risk).

Note that for the dermal contact with soil and sediment pathway, no exposure time is included in the equation. This is based on the assumption that the receptor may not bathe (i.e., remove the soil or sediment in contact with the skin surface) for 24 hr following the initial exposure; therefore, the receptor is actually exposed to soil and sediment contaminants for 24 hr/day. This may overestimate the risk associated with dermal contact with soil or sediment. This fact is especially important when the dermal pathway is the major contributor to the risks and/or hazards.

Most exposure parameters have been selected so that errors occur on the side of conservatism. When several of these upper-bound values are combined in estimating exposure for any one pathway, the resulting risks can be in excess of the 99th percentile and, therefore, outside of the range that may be reasonably expected. Therefore, the consistent conservatism employed in the estimation of these parameters generally leads to overestimation of the potential risks.

A great deal of uncertainty in the exposure assessment is associated with the prediction of contaminant concentrations in waterfowl and subsequent exposures to hunters ingesting waterfowl tissue. Predicted risks are for a hypothetical duck that lives its life within the FBQ, getting all of its food from the Quarry Ponds, and is harvested by a hunter there. In reality, if hunters are allowed at FBQ, the ducks harvested will come from a larger area. Waterfowl harvested at FBQ would be exposed to surface water and sediment in a large area around FBQ (i.e., the duck's home range is larger than FBQ) while in northeast Ohio and would be exposed to surface water and sediment across a multi-state area during migration and at wintering grounds in the southeastern United States.

Published data on whole-body tissue concentrations for ducks are not available – published data are for organs – so it is difficult to compare estimated duck tissue concentrations to published measurement data. Duck bioaccumulation factors (BAFs) are not for specific organs. Duck-tissue concentrations of metals (e.g., antimony, arsenic, lead, and zinc) may be overestimated due to the use of conservative sediment-to-sediment invertebrate BAFs, duck biouptake factors, and duck diet (50% sediment invertebrate, 50% plant). In fact, the calculated concentration of lead in duck tissue (6.0 mg/kg) is comparable to the concentrations of lead in liver and kidney of ducks with lead poisoning (Guitart et al. 1994). Comparisons of other COPCs are fraught with similar limitations. The predicted values are assumed to be conservative.

While a LUP has been drafted for the RTLS, and OHARNG will control the property, there is uncertainty in the details of the future land use (e.g., if the perimeter fence is not maintained, a trespasser could enter the property). There is little to no uncertainty associated with the assumption that the RVAAP will not be released for residential use; however, a resident subsistence farmer receptor was evaluated to provide a baseline scenario.

6.6.3 Uncertainties Associated with the Toxicity Assessment

The methodology used to develop a non-carcinogenic toxicity value (RfD or RfC) involves identifying a threshold level below which adverse health effects are not expected to occur. The RfD and RfC values are generally based on studies of the most sensitive animal species tested (unless adequate human data are available) and the most sensitive endpoint measured. Uncertainties exist in the experimental data set for such animal studies. These studies are used to derive the experimental exposure representing the highest dose level tested at which no adverse effects are demonstrated [i.e., the no-observed-adverse-effect level (NOAEL)]; in some cases, however, only a lowest-observed-adverse-effect level (LOAEL) is available. The RfD and/or RfC is derived from the NOAEL (or LOAEL) for the critical toxic effect by dividing the NOAEL (or LOAEL) by uncertainty factors. These factors usually are in multipliers of 10, with each factor representing a specific area of uncertainty in the extrapolation of the data. For example, an uncertainty factor of 100 is typically used when extrapolating animal studies to humans. Additional uncertainty factors are sometimes necessary when other experimental data limitations are found. Because of the large uncertainties (10 to 10,000) associated with some RfD or RfC toxicity values, exact safe levels of exposure for humans are not known. For non-carcinogenic effects, the amount of human variability in physical characteristics is important in determining the risks that can be expected at low exposures and in determining the NOAEL (EPA 1989a).

The toxicological data (CSFs and RfDs) for dose-response relationships of chemicals are frequently updated and revised, which can lead to overestimation or underestimation of risks. These values are often extrapolations from animals to humans, and this can also cause uncertainties in toxicity values because differences can exist in chemical absorption, metabolism, excretion, and toxic response between animals and humans.

Several toxicity values were used from HEAST (EPA, 1997) because more recent sources were not available. Use of values from this source introduces a high level of uncertainty into the results because (1) values in HEAST have not undergone the same level of review as values in IRIS and some other sources and (2) the last time HEAST was updated was 1997. Exclusion of these values would result in not being able to quantify potential risk from these chemicals/pathways which would also introduce risk into the evaluation. Chemicals with toxicity values taken from HEAST are: barium (inhalation RfD), methylene chloride (inhalation RfD), and vanadium (oral RfD).

EPA considers differences in body weight, surface area, and pharmacokinetic relationships between animals and humans to minimize the potential to underestimate the dose-response relationship; as a result, more conservatism is usually incorporated into these steps. In particular, toxicity factors that have high uncertainties may change as new information is evaluated. Therefore, a number of the COCs—particularly those with high uncertainties—may be subject to change. Finally, the toxicity of a contaminant may vary significantly with the chemical form present in the exposure medium. For example, risks from metals may be overestimated because they are conservatively assumed to be in their most toxic forms.

The carcinogenic potential of a chemical can be estimated through a two-part evaluation involving (1) a WOE assessment to determine the likelihood that a chemical is a human carcinogen, and (2) a slope factor assessment to determine the quantitative dose-response relationship. Uncertainties occur with both assessments. Chemicals fall into one of five groups on the basis of WOE studies of humans and laboratory animals (EPA 2005): (1) Group A – known human carcinogen; (2) Group B – probable human carcinogen based on limited human data or sufficient evidence in animals, but inadequate or no evidence in humans; (3) Group C – possible human carcinogens; (4) Group D – not classified as to human carcinogenicity; and (5) Group E – evidence of no carcinogenic effects in humans. Two COPCs identified at FBQ are Group A carcinogens (arsenic and hexavalent chromium), nine are Group B carcinogens [cadmium; 2,4-DNT; 2,6-DNT; benz(*a*)anthracene; benzo(*a*)pyrene; benzo(*b*)fluoranthene; bis(2-

ethylhexyl)phthalate; indeno(1,2,3-*cd*)pyrene; and methylene chloride], and one is classified as Group C (2,4,6-TNT).

The CSF for a chemical is a plausible upper-bound estimate of the probability of a response per unit intake of a chemical over a lifetime. It is used to estimate an upper-bound lifetime probability of an individual developing cancer as a result of exposure to a particular level of a potential carcinogen. The slope factor is derived by applying a mathematical model to extrapolate from a relatively high, administered dose to animals to the lower exposure levels expected for humans. The slope factor represents the UCL_{95} on the linear component of the slope (generally the low-dose region) of the tumorigenic dose-response curve. A number of low-dose extrapolation models have been developed, and EPA generally uses the linearized multi-stage model in the absence of adequate information to support other models.

For several analytes, no toxicity information for either the non-carcinogenic or carcinogenic health effects to humans is available in EPA's IRIS (EPA 2005) or HEAST (EPA 1997b). Therefore, until and unless additional toxicity information allows the derivation of toxicity factors, potential risk from certain chemicals cannot be quantified. COPCs falling into this category include 2-amino-4,6-DNT; 4-amino-2,6-DNT; nitrocellulose; nitroglycerin; acenaphthylene; benzo(*ghi*)perylene; and phenanthrene.

Uncertainties are associated with the GAF values used to modify the oral toxicity values to evaluate dermal toxicity. Similar uncertainties are associated with the TEF values used to estimate risks from exposure to PAHs. Many potential uncertainties are associated with the toxicity data used in this HHRA and can affect the risk, hazard, and COC determinations.

6.6.4 Uncertainties Associated with the Risk Characterization

Risk assessment, as a scientific activity, is subject to uncertainty. This is true even though the methodology used in this HHRA follows EPA guidelines. As noted previously, the risk evaluation in this report is subject to uncertainty pertaining to sampling and analysis, selection of COPCs, exposure estimates, and availability and quality of toxicity data.

6.6.4.1 Evaluation of total Risk

Uncertainties related to the summation of HQs and ILCRs across chemicals and pathways are a primary uncertainty in the risk characterization. In the absence of information on the toxicity of specific chemical mixtures, it is assumed that ILCRs and HQs are additive (i.e., cumulative) (EPA 1989a). The limitations of this approach for non-carcinogens are (1) the effects of a mixture of chemicals are generally unknown – it is possible that the interactions could be synergistic, antagonistic, or additive; (2) the RfDs have different accuracy and precision and are not based on the same severity or effect; and (3) HQ or intake summation is most properly applied to compounds that induce the same effects by the same mechanism. Therefore, the potential for occurrence of non-carcinogenic effects can be overestimated for chemicals that act by different mechanisms and on different target organs.

Limitations of the additive risk approach for multiple carcinogens are (1) the chemical-specific slope factors represent the upper 95th percentile estimate of potency; therefore, summing individual risks can result in an excessively conservative estimate of total lifetime cancer risk; and (2) the target organs of multiple carcinogens may be different, so the risks would not be additive. In the absence of data, additivity for ILCRs and HQs is assumed for this HHRA. However, because total risks and HIs are usually driven by a few chemicals, segregation of risks and HIs by target organ would most likely not have resulted in significantly different outcomes.

Additional uncertainty can be associated with the method of selection of COCs. For this HHRA, COCs are selected for a given medium/land use scenario as chemicals with individual ILCRs ≥ 1.0E-06 and/or individual HQs ≥ 1.0 for any medium/land use scenario.

Potential risks and hazards are not determined for the seven COPCs that could not be evaluated quantitatively due to the lack of toxicity information and/or values. This results in uncertainty that could underestimate the total risk/hazard to human health.

6.6.4.2 Contribution from background

Background concentrations of several COPCs may contribute significantly to the calculated risk as discussed below.

PAHs can be introduced to the environment by residential wood burning, cooking foods, and combustion of fossil fuels, as well as discharges from industrial plants, waste water treatment plants, and escape from waste storage containers. Other industrial sources of PAHs are machine lubricating, cutting, and color printing oils. PAHs are found in creosote, which is used as a wood preservative. PAHs are also found in coal tar, which is used in roofing, surface coatings, and as a binder for aluminum smelting electrons in the aluminum reduction process. PAHs are released to the environment in nature by volcanic activity and forest fires. Only a few PAHs are produced commercially. In general, PAHs are unintentionally generated during combustion or pyrolysis processes.

PAHs have a wide range of vapor pressures, and if released to the air may exist in both vapor and particulate phases. In general, PAHs with 3 rings exist predominately in the vapor phase, those with 4 rings can exist in both vapor and particulate phase, and those with 5 or more rings exist predominately in the particulate phase. Vapor-phase PAHs are degraded in the atmosphere by reaction with photochemically produced hydroxyl radicals; calculated half-lives for this reaction are generally less than one day. Under environmental conditions, PAHs with higher molecular weights are almost completely adsorbed onto fine particles and lower molecular weight PAHs are partially adsorbed; this adsorption may attenuate the degradation of PAHs. Particulate-phase PAHs may be removed from the air by wet and dry deposition. Some PAHs can undergo direct photolysis (>290 nm). If released to soil, Koc values in the range of 1E+03 to 1E+04 for low molecular weight (MW 152 to 178) PAHs, 1E+04 for medium molecular weight (MW 202) PAHs, and 1E+5 to 1E+6 for high molecular weight (228 to 278) PAHs, indicate that low molecular weight PAHs are expected to have slight to no mobility in soil and medium and high molecular weight PAHs are expected to be immobile in soil. Volatilization of PAHs from moist soil surfaces may be an important fate process for low and medium molecular weight PAHs, given Henry’s Law constants in the range of 1E-03 to 1E-05 atm-cu m/mole (low molecular weight PAHs) and of 1E-06 atm-cu m/mole (medium molecular weight PAHs). Volatilization of high molecular weight PAHs is not expected to be an important fate process, given Henry’s Law constants in the range of 1E-05 to 1E-08 atm-cu m/mole. However, adsorption to soil is expected to attenuate volatilization for those PAHs with Henry’s Law constants greater than 1E-03 atm-cu m/mole. PAHs are not expected to volatilize from dry soil surfaces. In general, vapor pressures of PAHs are less than 1 mm Hg, and vapor pressures of PAHs decrease with increasing molecular weight. Breakdown in soil generally takes weeks to months for PAHs with 3 rings, primarily by action of microorganisms; PAHs with 4 or more rings are generally resistant to biodegradation. If released into water, PAHs are expected to adsorb to suspended solids and sediment. In general, PAHs with higher molecular weights will adsorb more strongly than those with lower molecular weights. In aquatic environments, low molecular weight PAHs generally biodegrade relatively rapidly, while PAHs with more than 3 rings appear to be extremely stable to biodegradation. Volatilization of PAHs from water surfaces may be an important fate process for low and medium molecular weight PAHs given Henry’s Law constants in the range of 1E-03 to 1E-05 atm-cu m/mole (low molecular weight PAHs) and of 1E-06 atm-cu m/mole (medium molecular weight PAHs).

Volatilization of high molecular weight PAHs from water surfaces is not expected to be an important fate process, given Henry's Law in the range of 1E-05 to 1E-08 atm-cu m/mole. Any volatilization from water surfaces is expected to be attenuated by adsorption to suspended solids and sediment in the water column. Bioaccumulation factors for PAHs for fish and crustaceans have been reported in the range of 10 to 10,000. Compounds with BCFs greater than 1,000 have a high potential for bioaccumulation. In general, bioaccumulation is higher for higher molecular weight PAHs than for lower molecular weight PAHs, although some specific compounds (e.g., benzo(*a*)pyrene) are susceptible to metabolism in some aquatic organisms. Hydrolysis is not expected to be an important environmental fate process, since PAHs lack functional groups that hydrolyze under environmental conditions.

Monitoring data indicate that the largest exposure to PAHs to the general population is through the ingestion of foods. Exposure may also occur from drinking water and inhalation of ambient air containing exhaust from the combustion of fuels or cigarette smoke. Occupational exposure may occur through inhalation and dermal contact with PAHs.

Arsenic is a naturally occurring element and is found in a number of sulfide ores. It constitutes 5E-04% of the earth's crust. Arsenic can be released to the environment from natural sources, including volcanoes and erosion of mineral deposits. Human activities, e.g., chemical production and use, metal smelting, coal combustion, and waste disposal, result in release of arsenic, causing substantial environmental contamination (ATSDR 1993) (HSDB 2001).

Most human releases of arsenic are to land or soil, primarily from pesticides or solid wastes. Substantial amounts of arsenic are also released to air and water. Arsenic production and use of arsenic-containing products are the major sources of arsenic releases to the air from human activities. Arsenic is released to water by natural weathering processes, by discharge from industrial facilities, by leaching from landfills or soil, and by urban runoffs (ATSDR 1993).

Arsenic pollution is widespread. Human exposure to both naturally occurring and manufactured arsenic may occur through air, food, and water (Bingham et al. 2001). Arsenic is a widespread soil contaminant because of past use of arsenic-containing pesticides. Native soil concentrations of arsenic are typically in the range of 1.0-40 ppm, and in extreme states, as high as 0.1-500 ppm (Dragun 1988). Arsenic content of soils in Ohio range from 0.5 to 56 mg/kg (Cox and Colvin 1996) and the United States Geological Survey's Certificate of Analysis of the Devonian Ohio Shale estimates arsenic concentrations of 68.5 mg/kg are naturally present in bedrock shales (USGS 2004). Background concentrations of arsenic in soils at RVAAP range from 3.5 to 19.8 mg/kg.

6.7 REMEDIAL GOAL OPTIONS

To support the remedial alternative selection process, RGOs are developed for the all chemicals identified as COCs in the direct exposure pathways for this HHRA. For each exposure medium, RGOs are calculated for all COCs for that medium regardless of receptor. For example, benzo(*a*)pyrene was identified as a COC in shallow surface soil for a Resident Subsistence Farmer Adult but not for any of the representative receptors; however, shallow surface soil RGOs are calculated for benzo(*a*)pyrene for all five receptors exposed to shallow surface soil. RGOs are calculated for direct contact COCs only because the model used to estimate risk from waterfowl ingestion is extremely conservative and is not appropriate for calculating RGOs because it does not account for exposures to clean or contaminated media outside FBQ and RVAAP as described previously. RGOs are calculated using the methodology presented in RAGS Part B (EPA 1991a) while incorporating site-specific exposure parameters applicable to FBQ. RGOs are RBCs that may be considered in an FS to define the extent of contamination that must be remediated and to help cost various alternatives. RGOs are media- and chemical-specific concentrations. The RGOs presented in this document are for protection of human health and may or may not be protective of ecological receptors. The process for calculating RGOs for this HHRA is a rearrangement of the cancer risk or non-cancer hazard equations, with the goal of obtaining the concentration that will produce a specific risk or hazard level. For example, the RGO for arsenic at the cancer risk level of 10^{-5} for the Fire/Dust Suppression Worker is the concentration of arsenic that produces a risk of 10^{-5} when using the exposure parameters specific to the Fire/Dust Suppression Worker receptor.

As discussed in Section 6.5.1, the cancer risk and non-cancer hazard are calculated as

$$\text{Risk} = (\text{Intake}) \times (\text{CSF}) \qquad \textbf{(6-27)}$$

and

$$\text{Hazard} = (\text{Intake}) / (\text{RfD}). \qquad \textbf{(6-28)}$$

The pathway-specific (e.g., incidental ingestion of water) equations for intake are provided in Section 6.3.4. Note that all of the intake equations shown in Section 6.3.4 include a concentration term multiplied by several other exposure parameters.

To obtain the RGO for a specific risk level (e.g., 10^{-5}), the risk equation is rearranged so that the equation is solved for C, the concentration term. Similarly, to obtain the RGO for a specific hazard level (e.g., 1.0), the hazard equation is rearranged so that the equation is solved for the concentration term.

To demonstrate for the incidental ingestion of surface water pathway, note that by using the ingestion intake equation from Section 6.3.4.2 (Equation 6-17) and the general risk equation from Section 6.5.1, the risk from ingestion of surface water is calculated as

$$\text{Risk}_{\text{ing(water)}} = (C_w \times IR_w \times EF \times ED \times CSF) / (BW \times AT). \qquad \textbf{(6-29)}$$

To obtain the RGO at the 10^{-5} risk level for the ingestion of surface water, a value of 10^{-5} is substituted in the equation above for $\text{Risk}_{\text{ing(water)}}$, and the equation is rearranged to solve for C_w. Thus, the general RGO equation at the 10^{-5} risk level for the ingestion of surface water is calculated as:

$$\text{RGO}_{\text{ing(water)}} \text{ at } 10^{-5} = (10^{-5} \times BW \times AT) / (IR_w \times EF \times ED \times CSF). \qquad \textbf{(6-30)}$$

A similar rearrangement of the ingestion of soil hazard equation is made, producing the general RGO equation at the 1.0 hazard level for this pathway/medium:

$$\text{RGO}_{\text{ing(water)}} \text{ at } 1.0 = (1.0 \times BW \times AT \times RfD) / (IR_w \times EF \times ED). \qquad \textbf{(6-31)}$$

Thus, to obtain the ingestion of surface water RGO at the 10^{-5} risk level for the Fire/Dust Suppression Worker exposed to arsenic, the parameter values for the Fire/Dust Suppression Worker (from Table 6-8) and the chemical-specific oral CSF (from Table M-9) for arsenic are used:

$$\text{RGO}_{\text{ing(water)}} \text{ at } 10^{-5} \text{ for arsenic} = [(10^{-5})(70)(25550)] / (0.1)(15)(25)(1.5)] = 0.318 \text{ mg/L}.$$

In this example, the RGO calculated is 0.318 mg/L, which will produce a surface water ingestion risk of 10^{-5} for the Fire/Dust Suppression Worker exposed to arsenic in the surface water. This example is based on the ingestion of surface water; however, RGOs calculated for FBQ include exposure by ingestion, dermal contact, and inhalation.

Note that if a calculated RGO is not physically possible (e.g., more than the pure chemical), then the RGO is adjusted accordingly. For example, if the calculated RGO is 5.5E+06 mg/kg, then the RGO is adjusted downward to 1.0E+06 mg/kg.

For this HHRA, RGOs are calculated for each exposure route (e.g., ingestion), as well as for the total chemical risk or hazard across all appropriate exposure routes. Carcinogenic RGOs are calculated and presented in this HHRA at a target risk (TR) level of 10^{-5}. To obtain the carcinogenic RGO at another risk level, one should adjust the RGO at 10^{-5} accordingly, taking care to check the resulting concentration against the physical limits discussed above (e.g., 1.0E+06 mg/kg). For example, to obtain the RGO at the 10^{-4} risk level, one should multiply the RGO at the 10^{-5} risk level by 10 (and then check the result to ensure that the concentration is physically possible). Non-carcinogenic RGOs are calculated and presented in this HHRA for a target hazard index (THI) level of 1.0. To find the non-carcinogenic RGO at another hazard level, one should adjust the RGO at the 1.0 hazard level accordingly, taking care to check the resulting concentration against the physical limits discussed above (e.g., 1.0E+06 mg/kg). For example, to obtain the RGO at the 3.0 hazard level, one should multiply the RGO at the 1.0 hazard level by 3 (and then check the result to ensure that the concentration is physically possible).

Exposure to multiple COCs may require downward adjustment of the TR and THI used to calculate final remedial levels. The 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. The representative receptors at FBQ are the National Guard Trainee, Fire/Dust Suppression Worker, Security Guard/Maintenance Worker, and Hunter/Trapper/Fisher. The maximum number of non-carcinogenic COCs identified for any exposure media/receptor combination is 7 for ingestion of food grown in contaminated surface soil by the Resident Subsistence Farmer Child. The maximum number of carcinogenic COCs is 4 for the same receptor. The maximum number of non-carcinogenic and carcinogenic COCs for any direct contact exposure pathway is 3 non-carcinogens in groundwater and 4 carcinogens in sediment. Therefore, no downward adjustment of the TR and THI is required for any of the media or receptors evaluated.

RGOs for shallow surface soil, deep surface soil, subsurface soil, groundwater, sediment, and surface water are provided in Tables 6-17 through 6-22.

Table 6-17. RGOs for Shallow Surface Soil COCs at Fuze and Booster Quarry Landfill/Ponds

COC	Ingestion RGO		Dermal RGO		Inhalation RGO		Total RGO[a]	
	HQ = 1.0	Risk = 10^{-5}	HQ = 1.0	Risk = 10^{-5}	HQ = 1.0	Risk = 10^{-5}	HI = 1.0	Risk = 10^{-5}
Hunter/Trapper/Fisher								
Arsenic	5.8E+04	3.0E+03	2.3E+04	1.2E+03	N/A	1.0E+06	1.7E+04	8.6E+02
Benzo(*a*)pyrene	--	6.1E+02	--	5.8E+01	--	1.0E+06	--	5.3E+01
National Guard Fire Suppression Worker								
Arsenic	3.1E+04	1.9E+03	1.7E+04	1.1E+03	N/A	4.0E+05	1.1E+04	6.8E+02
Benzo(*a*)pyrene	--	3.9E+02	--	5.1E+01	--	1.0E+06	--	4.5E+01
Resident Farmer Adult								
Arsenic	2.2E+02	1.1E+01	3.2E+02	1.7E+01	N/A	5.2E+03	1.3E+02	6.7E+00
Benzo(*a*)pyrene	--	2.3E+00	--	7.9E-01	--	2.5E+04	--	5.9E-01
Resident Farmer Child								
Arsenic	2.3E+01	6.1E+00	3.6E+02	9.2E+01	N/A	1.1E+04	2.2E+01	5.7E+00
Benzo(*a*)pyrene	--	1.3E+00	--	4.4E+00	--	5.4E+04	--	9.7E-01
Security Guard/Maintenance Worker								
Arsenic	7.4E+03	4.6E+02	4.4E+02	2.8E+01	N/A	2.1E+05	4.2E+02	2.6E+01
Benzo(*a*)pyrene	--	9.4E+01	--	1.3E+00	--	1.0E+06	--	1.3E+00

[a] Total RGO is the RGO across all pathways (ingestion, dermal, and inhalation). All RGOs are in mg/kg.
COC = Chemical of concern.
HI = Hazard index.
HQ = Hazard quotient.
N/A = Not applicable (risk-based RGOs for inhalation are only quantified for volatile organic compounds).
RGO = Remedial goal option.
-- = No RGO could be quantified based on lack of approved toxicity value.

Table 6-18. RGOs for Deep Surface Soil COCs at Fuze and Booster Quarry Landfill/Ponds

COC	Ingestion RGO		Dermal RGO		Inhalation RGO		Total RGO[a]	
	HQ = 1.0	Risk = 10^{-5}	HQ = 1.0	Risk = 10^{-5}	HQ = 1.0	Risk = 10^{-5}	HI = 1.0	Risk = 10^{-5}
National Guard Trainee								
Arsenic	2.0E+03	1.2E+02	6.6E+03	4.1E+02	N/A	4.6E+01	1.5E+03	3.1E+01
Manganese	3.0E+05	--	1.0E+06	--	3.5E+02	N/A	3.5E+02	--

[a] Total RGO is the RGO across all pathways (ingestion, dermal, and inhalation). All RGOs are in mg/kg.
COC = Chemical of concern.
HI = Hazard index.
HQ = Hazard quotient.
N/A = Not applicable (risk-based RGOs for inhalation are only quantified for volatile organic compounds).
RGO = Remedial goal option.
-- = No RGO could be quantified based on lack of approved toxicity value.

Table 6-19. RGOs for Subsurface Soil COCs at Fuze and Booster Quarry Landfill/Ponds

COC	Ingestion RGO		Dermal RGO		Inhalation RGO		Total RGO[a]	
	HQ = 1.0	Risk = 10^{-5}	HQ = 1.0	Risk = 10^{-5}	HQ = 1.0	Risk = 10^{-5}	HI = 1.0	Risk = 10^{-5}
Resident Farmer Adult								
Arsenic	2.2E+02	1.1E+01	3.2E+02	1.7E+01	N/A	5.2E+03	1.3E+02	6.7E+00
Resident Farmer Child								
Arsenic	2.3E+01	6.1E+00	3.6E+02	9.2E+01	N/A	1.1E+04	2.2E+01	5.7E+00

[a] Total RGO is the RGO across all pathways (ingestion, dermal, and inhalation). All RGOs are in mg/kg.
COC = Chemical of concern.
HI = Hazard index.
HQ = Hazard quotient.
N/A = Not applicable (risk-based RGOs for inhalation are only quantified for volatile organic compounds).
RGO = Remedial goal option.

Table 6-20. RGOs for Groundwater COCs at Fuze and Booster Quarry Landfill/Ponds

COC	Ingestion RGO		Dermal RGO		Inhalation RGO		Total RGO[a]	
	HQ = 1.0	Risk = 10^{-5}	HQ = 1.0	Risk = 10^{-5}	HQ = 1.0	Risk = 10^{-5}	HI = 1.0	Risk = 10^{-5}
National Guard Trainee								
Manganese	1.5E+01	--	1.9E+02	--	N/A	N/A	1.4E+01	--
2,4,6-Trinitrotoluene	1.6E-01	3.1E-01	6.3E+01	1.2E+02	--	--	1.6E-01	3.0E-01
2,4-Dinitrotoluene	6.6E-01	1.3E-02	7.2E+01	1.5E+00	--	--	6.5E-01	1.3E-02
Trichloroethene	--	7.1E-01	--	1.9E+01	1.1E+01	2.6E-01	1.1E+01	1.9E-01
Resident Farmer Adult								
Manganese	1.7E+00	--	2.2E+01	--	N/A	N/A	1.6E+00	--
2,4,6-Trinitrotoluene	1.8E-02	2.8E-02	7.0E+00	1.1E+01	--	--	1.8E-02	2.8E-02
2,4-Dinitrotoluene	7.3E-02	1.3E-03	8.0E+00	1.4E-01	--	--	7.2E-02	1.2E-03
Trichloroethene	--	6.6E-02	--	1.7E+00	1.2E+00	2.4E-02	1.2E+00	1.8E-02
Resident Farmer Child								
Manganese	4.8E-01	--	1.0E+01	--	N/A	N/A	4.6E-01	--
2,4,6-Trinitrotoluene	5.2E-03	4.1E-02	3.4E+00	2.6E+01	--	--	5.2E-03	4.0E-02
2,4-Dinitrotoluene	2.1E-02	1.8E-03	3.8E+00	3.3E-01	--	--	2.1E-02	1.8E-03
Trichloroethene	--	9.4E-02	--	4.1E+00	5.3E-01	5.2E-02	5.3E-01	3.3E-02

[a] Total RGO is the RGO across all pathways (ingestion, dermal, and inhalation). All RGOs are in mg/L.
COC = Chemical of concern.
HI = Hazard index.
HQ = Hazard quotient.
N/A = Not applicable (risk-based RGOs for inhalation are only quantified for volatile organic compounds).
RGO = Remedial goal option.
-- = No RGO could be quantified based on lack of approved toxicity value.

Table 6-21. RGOs for Sediment COCs at Fuze and Booster Quarry Landfill/Ponds

COC	Ingestion RGO		Dermal RGO		Inhalation RGO		Total RGO[a]	
	HQ = 1.0	Risk = 10^{-5}	HQ = 1.0	Risk = 10^{-5}	HQ = 1.0	Risk = 10^{-5}	HI = 1.0	Risk = 10^{-5}
Hunter/Trapper/Fisher								
Antimony	7.7E+04	--	1.4E+05	--	N/A	N/A	5.0E+04	--
Arsenic	5.8E+04	3.0E+03	2.3E+04	1.2E+03	N/A	1.0E+06	1.7E+04	8.6E+02
Cadmium	1.9E+05	--	5.8E+04	--	N/A	1.0E+06	4.5E+04	1.0E+06
Chromium, hexavalent	5.8E+05	--	1.8E+05	--	1.0E+06	4.9E+05	1.3E+05	4.9E+05
Manganese	1.0E+06	--	1.0E+06	--	1.0E+06	N/A	1.0E+06	--
Mercury	5.8E+04	--	4.9E+04	--	N/A	N/A	2.6E+04	--
Benz(*a*)anthracene	--	6.1E+03	--	5.8E+02	--	1.0E+06	--	5.3E+02
Benzo(*a*)pyrene	--	6.1E+02	--	5.8E+01	--	1.0E+06	--	5.3E+01
Benzo(*b*)fluoranthene	--	6.1E+03	--	5.8E+02	--	1.0E+06	--	5.3E+02
National Guard Fire Suppression Worker								
Antimony	4.1E+04	--	1.0E+05	--	N/A	N/A	2.9E+04	--
Arsenic	3.1E+04	1.9E+03	1.7E+04	1.1E+03	N/A	4.0E+05	1.1E+04	6.8E+02
Cadmium	1.0E+05	--	4.3E+04	--	N/A	9.4E+05	3.0E+04	9.4E+05
Chromium, hexavalent	3.1E+05	--	1.3E+05	--	1.0E+06	1.4E+05	8.9E+04	1.4E+05
Manganese	1.0E+06	--	1.0E+06	--	1.0E+06	N/A	1.0E+06	--
Mercury	3.1E+04	--	3.6E+04	--	N/A	N/A	1.7E+04	--
Benz(*a*)anthracene	--	3.9E+03	--	5.1E+02	--	1.0E+06	--	4.5E+02
Benzo(*a*)pyrene	--	3.9E+02	--	5.1E+01	--	1.0E+06	--	4.5E+01
Benzo(*b*)fluoranthene	--	3.9E+03	--	5.1E+02	--	1.0E+06	--	4.5E+02
National Guard Trainee								
Antimony	2.6E+03	--	4.0E+04	--	N/A	N/A	2.5E+03	--
Arsenic	2.0E+03	1.2E+02	6.6E+03	4.1E+02	N/A	4.6E+01	1.5E+03	3.1E+01
Cadmium	6.6E+03	--	1.7E+04	--	N/A	1.1E+02	4.7E+03	1.1E+02
Chromium, hexavalent	2.0E+04	--	5.0E+04	--	7.0E+02	1.6E+01	6.7E+02	1.6E+01
Manganese	3.0E+05	--	1.0E+06	--	3.5E+02	N/A	3.5E+02	--
Mercury	2.0E+03	--	1.4E+04	--	N/A	N/A	1.7E+03	--
Benz(*a*)anthracene	--	2.5E+02	--	2.0E+02	--	2.2E+03	--	1.0E+02
Benzo(*a*)pyrene	--	2.5E+01	--	2.0E+01	--	2.2E+02	--	1.0E+01
Benzo(*b*)fluoranthene	--	2.5E+02	--	2.0E+02	--	2.2E+03	--	1.0E+02
Resident Farmer Adult								
Antimony	2.9E+02	--	1.9E+03	--	N/A	N/A	2.5E+02	--
Arsenic	2.2E+02	1.1E+01	3.2E+02	1.7E+01	N/A	5.2E+03	1.3E+02	6.7E+00
Cadmium	7.3E+02	--	8.0E+02	--	N/A	1.2E+04	3.8E+02	1.2E+04
Chromium, hexavalent	2.2E+03	--	2.4E+03	--	9.6E+04	1.9E+03	1.1E+03	1.9E+03
Manganese	3.4E+04	--	5.9E+04	--	4.8E+04	N/A	1.5E+04	--
Mercury	2.2E+02	--	6.7E+02	--	N/A	N/A	1.7E+02	--
Benz(a)anthracene	--	2.3E+01	--	7.9E+00	--	2.5E+05	--	5.9E+00
Benzo(a)pyrene	--	2.3E+00	--	7.9E-01	--	2.5E+04	--	5.9E-01
Benzo(b)fluoranthene	--	2.3E+01	--	7.9E+00	--	2.5E+05	--	5.9E+00

Table 6-21. RGOs for Sediment COCs at Fuze and Booster Quarry Landfill/Ponds (continued)

COC	Ingestion RGO		Dermal RGO		Inhalation RGO		Total RGO[a]	
	HQ = 1.0	Risk = 10^{-5}	HQ = 1.0	Risk = 10^{-5}	HQ = 1.0	Risk = 10^{-5}	HI = 1.0	Risk = 10^{-5}
Resident Farmer Child								
Antimony	3.1E+01	--	2.1E+03	--	N/A	N/A	3.1E+01	--
Arsenic	2.3E+01	6.1E+00	3.6E+02	9.2E+01	N/A	1.1E+04	2.2E+01	5.7E+00
Cadmium	7.8E+01	--	8.9E+02	--	N/A	2.7E+04	7.2E+01	2.7E+04
Chromium, hexavalent	2.3E+02	--	2.7E+03	--	4.1E+04	4.0E+03	2.1E+02	4.0E+03
Manganese	3.6E+03	--	6.5E+04	--	2.1E+04	N/A	2.9E+03	--
Mercury	2.3E+01	--	7.5E+02	--	N/A	N/A	2.3E+01	--
Benz(*a*)anthracene	--	1.3E+01	--	4.4E+01	--	5.4E+05	--	9.7E+00
Benzo(*a*)pyrene	--	1.3E+00	--	4.4E+00	--	5.4E+04	--	9.7E-01
Benzo(*b*)fluoranthene	--	1.3E+01	--	4.4E+01	--	5.4E+05	--	9.7E+00

[a] Total RGO is the RGO across all pathways (ingestion, dermal, and inhalation). All RGOs are in mg/kg.
COC = Chemical of concern.
HI = Hazard index.
HQ = Hazard quotient.
N/A = Not applicable (risk-based RGOs for inhalation are only quantified for volatile organic compounds).
RGO = Remedial goal option.
-- = No RGO could be quantified based on lack of approved toxicity value.

Table 6-22. RGOs for Surface Water COCs at Fuze and Booster Quarry Landfill/Ponds

COC	Ingestion RGO		Dermal RGO		Inhalation RGO		Total RGO[a]	
	HQ = 1.0	Risk = 10^{-5}	HQ = 1.0	Risk = 10^{-5}	HQ = 1.0	Risk = 10^{-5}	HI = 1.0	Risk = 10^{-5}
Hunter/Trapper/Fisher								
Arsenic	2.2E+01	1.1E+00	2.4E+01	1.2E+00	N/A	N/A	1.1E+01	5.9E-01
Manganese	3.4E+03	--	2.2E+02	--	N/A	N/A	2.1E+02	--
Bis(2-ethylhexyl)phthalate	1.5E+03	1.2E+02	1.6E+00	1.3E-01	--	--	1.6E+00	1.3E-01
National Guard Fire Suppression Worker								
Arsenic	5.1E+00	3.2E-01	2.0E+01	1.2E+00	N/A	N/A	4.1E+00	2.5E-01
Manganese	7.8E+02	--	1.9E+02	--	N/A	N/A	1.5E+02	--
Bis(2-ethylhexyl)phthalate	3.4E+02	3.4E+01	1.3E+00	1.3E-01	--	--	1.3E+00	1.3E-01
National Guard Trainee								
Arsenic	2.0E+00	1.2E-01	1.3E+00	8.0E-02	N/A	N/A	7.8E-01	4.8E-02
Manganese	3.0E+02	--	1.2E+01	--	N/A	N/A	1.1E+01	--
Bis(2-ethylhexyl)phthalate	1.3E+02	1.3E+01	8.4E-02	8.4E-03	--	--	8.4E-02	8.4E-03
Resident Farmer Adult								
Arsenic	2.2E-01	1.1E-02	8.0E-01	4.1E-02	N/A	N/A	1.7E-01	8.9E-03
Manganese	3.4E+01	--	7.4E+00	--	N/A	N/A	6.0E+00	--
Bis(2-ethylhexyl)phthalate	1.5E+01	1.2E+00	5.2E-02	4.3E-03	--	--	5.2E-02	4.3E-03
Resident Farmer Child								
Arsenic	4.7E-02	1.2E-02	4.4E-01	1.1E-01	N/A	N/A	4.2E-02	1.1E-02
Manganese	7.2E+00	--	4.1E+00	--	N/A	N/A	2.6E+00	--
Bis(2-ethylhexyl)phthalate	3.1E+00	1.3E+00	2.9E-02	1.2E-02	--	--	2.9E-02	1.2E-02

[a] Total RGO is the RGO across all pathways (ingestion, dermal, and inhalation). All RGOs are in mg/L.
COC = Chemical of concern.
HI = Hazard index.
HQ = Hazard quotient.
N/A = Not applicable (risk-based RGOs for inhalation are only quantified for volatile organic compounds).
RGO = Remedial goal option.
-- = No RGO could be quantified based on lack of approved toxicity value.

6.8 SUMMARY AND CONCLUSIONS

This HHRA was conducted to evaluate risks and hazards associated with contaminated media at the FBQ AOC at RVAAP. Risks and hazards were estimated for four representative receptors (National Guard Trainee, Fire/Dust Suppression Worker, Security Guard/Maintenance Worker, and Hunter/Trapper/Fisher) exposed to four media (surface soil, groundwater, sediment, and surface water). Risks and hazards were also calculated for potential exposure to surface soil, subsurface soil, groundwater, sediment, and surface water by a Resident Subsistence Farmer (adult and child). The following steps were used to generate conclusions regarding human health risks and hazards associated with contaminated media at FBQ:

- identification of COPCs,
- calculation of risks and hazards,
- identification of COCs, and
- calculation of RGOs.

Results are presented for all exposure scenarios, pathways, and media in Appendix M. Risk characterization results are summarized in Table 6-23 for all receptors.

Table 6-23. Summary of Human Health Risks and Hazards for Fuze and Booster Quarry Landfill/Ponds

Receptor	Total HI	Total ILCR
Groundwater – Bedrock Aquifer		
National Guard Trainee	0.35	9.0E-07
Resident Subsistence Farmer (Adult)	3.2	9.7E-06
Resident Subsistence Farmer (Child)	11	6.0E-06
Groundwater- Unconsolidated Aquifer		
National Guard Trainee	0.48	No COPC
Resident Subsistence Farmer (Adult)	4.3	No COPC
Resident Subsistence Farmer (Child)	15	No COPC
Surface Soil[a]		
National Guard Trainee	2.2	4.4E-06
Fire/Dust Suppression Worker	0.0027	2.0E-07
Security Guard/Maintenance Worker	0.067	5.5E-06
Hunter/Trapper/Fisher	0.0017	1.6E-07
Resident Subsistence Farmer (Adult)	0.22	2.0E-05
Resident Subsistence Farmer (Child)	1.2	2.3E-05
Agricultural Foodstuffs[b]		
Resident Subsistence Farmer (Adult)	27	2.7E-03
Resident Subsistence Farmer (Child)	130	2.5E-03
Subsurface Soil		
Resident Subsistence Farmer (Adult)	0.16	2.4E-05
Resident Subsistence Farmer (Child)	0.98	2.8E-05
Sediment – Drainage Ditch		
National Guard Trainee	12	7.3E-06
Fire/Dust Suppression Worker	0.0059	4.5E-07
Hunter/Trapper/Fisher	NA	NA
Resident Subsistence Farmer (Adult)	0.49	4.2E-05
Resident Subsistence Farmer (Child)	2.8	4.3E-05

Table 6-23. Summary of Human Health Risks and Hazards for Fuze and Booster Quarry Landfill/Ponds (continued)

Receptor	Total HI	Total ILCR
Sediment – Quarry Ponds		
National Guard Trainee	0.57	2.0E-05
Fire/Dust Suppression Worker	0.0092	4.3E-07
Hunter/Trapper/Fisher	0.0057	3.5E-07
Resident Subsistence Farmer (Adult)	0.95	4.0E-05
Resident Subsistence Farmer (Child)	7.1	4.1E-05
Sediment – Settling Basins		
National Guard Trainee	2.4	1.1E-07
Fire/Dust Suppression Worker	0.00096	2.4E-08
Hunter/Trapper/Fisher	NA	NA
Resident Subsistence Farmer (Adult)	0.086	1.9E-06
Resident Subsistence Farmer (Child)	0.53	1.1E-06
Surface Water – Drainage Ditch		
National Guard Trainee	0.96	No COPC
Fire/Dust Suppression Worker	0.073	No COPC
Hunter/Trapper/Fisher	NA	NA
Resident Subsistence Farmer (Adult)	1.8	No COPC
Resident Subsistence Farmer (Child)	4.2	No COPC
Surface Water – Quarry Ponds		
National Guard Trainee	0.000054	8.7E-09
Fire/Dust Suppression Worker	0.0000073	1.2E-09
Hunter/Trapper/Fisher	0.0000033	6.5E-10
Resident Subsistence Farmer (Adult)	0.00018	3.4E-08
Resident Subsistence Farmer (Child)	0.00062	2.4E-08
Surface Water – Settling Basins		
National Guard Trainee	0.24	7.3E-06
Fire/Dust Suppression Worker	0.020	7.0E-07
Hunter/Trapper/Fisher	NA	NA
Resident Subsistence Farmer (Adult)	0.49	2.1E-05
Resident Subsistence Farmer (Child)	1.2	1.2E-05
Fish – Quarry Ponds		
Hunter/Trapper/Fisher	0.00011	2.1E-08
Resident Subsistence Farmer (Adult)	0.00011	2.1E-08
Resident Subsistence Farmer (Child)	0.00051	2.0E-08
Waterfowl- Quarry Ponds		
Hunter/Trapper/Fisher	98	1.5E-03

[a]Surface soil defined as 0 to 1 ft (shallow surface soil) for all receptors except National Guard Trainee. Surface soil defined as 0 to 3 ft (deep surface soil) for the National Guard Trainee.
[b]Agricultural foodstuffs include milk, beef, and vegetables.
COC = Chemical of concern.
HI = Hazard index.
ILCR = Incremental lifetime cancer risk.
NA = Not applicable; the Hunter/Trapper/Fisher is only exposed at the Quarry Ponds because the Drainage Ditch and Settling Basins do not provide habitat for fish or waterfowl.
No COPC = No carcinogenic chemicals of potential concern (COPCs) identified for this aquifer.

Table 6-24. Human Health Chemicals of Concern for Representative Receptors and Resident Subsistence Farmer at Fuze and Booster Quarry Landfill/Ponds[a]

COC	Surface Soil		Subsurface Soil	Groundwater		Sediment			Surface Water			Fish[d]	Water-fowl
	Direct[b]	Indirect[c]		Bedrock	Unconsol-idated	Ditch	Quarry Pond	Settling Basins	Ditch	Quarry Pond[d]	Settling Basins		
Metals													
Antimony		FA, FC					FC						HTF
Arsenic	NG, SG, FA, FC	FA, FC	FA, FC			NG, FA, FC	NG, FA, FC				NG, FA, FC		HTF
Barium		FC											
Cadmium							NG						
Copper		FC											
Hexavalent Chromium							NG						
Lead[e]							FA, FC						
Manganese	NG	FA, FC		FA, FC	FA, FC	NG, FC		NG	FA, FC				
Mercury							FC						HTF
Vanadium		FC											
Zinc													HTF
Explosives													
2,4,6-Trinitrotoluene		FA, FC		FA, FC									
2,4-Dinitrotoluene				FA, FC									
2,6-Dinitrotoluene		FA, FC											
Semivolatile Organic Compounds													
Benz(*a*)anthracene						FA							HTF
Benzo(*a*)pyrene	FA	FA, FC				FA, FC	FA, FC	FA, FC					HTF
Benzo(*b*)fluoranthene						FA							HTF
Bis(2-ethylhexyl)phthalate											NG, FA, FC		
Indeno(1,2,3-*cd*)pyrene													HTF
Volatile Organic Compounds													
Trichloroethene				FA, FC									

[a]Chemicals of concern are denoted for each receptor as follows:
FA = Farmer Adult. NG = National Guard Trainee.
FC = Farmer Child. SG = National Guard Security Guard/Maintenance Worker.
HTF = Hunter/Trapper/Fisher.
[b]Direct soil exposure includes incidental soil ingestion, inhalation of volatile organic compounds and particulates, and dermal contact with soil.
[c]Indirect soil exposure includes ingestion of vegetables, meat, milk, and venison.
[d]No chemicals of concern identified.
[e]Lead is identified as a chemical of concern based on the results of blood lead modeling.

Risks and hazards were evaluated and RGOs calculated for the National Guard Trainee, Fire/Dust Suppression Worker, Security Guard/Maintenance Worker, and Hunter/Trapper/Fisher as the representative receptors. A summary of COCs for each medium and receptor evaluated is provided in Table 6-24. Results for these receptors are discussed below for each medium.

- Two surface soil COCs (arsenic and manganese) were identified for the National Guard Trainee and one (arsenic) for the Security Guard/Maintenance Worker. EPCs for both these metals are below background concentrations.

- No surface soil COCs were identified for the Hunter/Trapper/Fisher and Fire/Dust Suppression Worker.

- No groundwater COCs were identified for the National Guard Trainee. Fire/Dust Suppression Worker, Security Guard/Maintenance Worker, and Hunter/Trapper/Fisher are not exposed to groundwater.

- Two sediment COCs were identified for the National Guard Trainee at the Ditch (arsenic and manganese) and three COCs (arsenic, cadmium, and hexavalent chromium) were identified at the Quarry Ponds for this receptor.

- No sediment COCs were identified for the Fire/Dust Suppression Worker or Hunter/Trapper/Fisher.

- Two surface water COCs [arsenic and bis(2-ethylhexyl)phthalate] were identified for the National Guard Trainee at the Settling Basins. No surface water COCs were identified for this receptor at the Ditch or Quarry Ponds.

- No surface water COCs were identified for any of the applicable representative receptors at the Ditch and Quarry Ponds.

- Waterfowl concentrations were conservatively modeled for all COPCs identified in the sediment and surface water at the FBQ Quarry Ponds. The total estimated ILCR and HI for ingestion of hypothetical waterfowl exposed exclusively at the Quarry Ponds exceeded the target HI of 1.0 and target ILCR of 1.0E-06. Because of the high level of uncertainty associated with modeling tissue concentrations and the actual location of exposure of waterfowl harvested at the Quarry Ponds, RGOs are not calculated for this indirect exposure pathway.

7.0 SCREENING ECOLOGICAL RISK ASSESSMENT

An ERA defines the likelihood of harmful effects on plants and animals as a result of exposure to chemical constituents. There are two types of ERAs: screening and baseline. A screening ERA depends on available site data and is conservative in all regards. A baseline ERA requires even more site-specific exposure and effects information, including such measurements as body burden measurements and bioassays, and often uses less conservative assumptions. A screening ERA or equivalent is needed to evaluate the possible risk to plants and wildlife from current and future exposure to contamination at FBQ. A baseline ERA is not planned at this site, rather a WOE assessment.

The initial regulatory guidance for an ERA is contained in EPA's *Risk Assessment Guidance for Superfund (RAGS), Volume II, Environmental Evaluation Manual* (EPA 1989b) and in a subsequent document (EPA 1991b). Further discussion on the scientific basis for assessing ecological effects and risk is presented in *Ecological Assessments of Hazardous Waste Sites: A Field and Laboratory Reference Document* (EPA 1989c). Other early 1990s guidance is provided in the *Framework for Ecological Risk Assessment* (EPA 1992b). A second generation of guidance consists of the *Procedural Guidance for Ecological Risk Assessments at U. S. Army Exposure Units* (Wentsel et al. 1994) and in its replacement, the *Tri-Service Procedural Guidelines for Ecological Risk Assessments* (Wentsel et al. 1996). In addition, the more recently published *Ecological Risk Assessment Guidance* (EPA 1997c, 1998) supersedes *RAGS, Volume II* (EPA 1989b). This latter guidance makes the distinction between the interrelated roles of screening and baseline ERAs. Briefly, SERAs utilize conservative assumptions for exposures and effects, while a baseline ERA means increasingly unit-specific, more realistic (and generally less conservative) exposures and effects. More recently, published EPA guidance (EPA 1997c) was used because it provided the clearest information on preliminary or screening ERAs. The Army also has the RVAAP Facility-wide Ecological Risk Work Plan (USACE 2003b) to guide the work at FBQ. Additionally, Ohio EPA has guidance, and that too was used, especially for the hierarchy for ecological screening values (ESVs) and toxicity reference values (TRVs) (Ohio EPA 2003). The Ohio EPA guidance identifies four levels of ERA: Level I Scoping, Level II Screening, Level III Baseline, and Level IV Field Baseline. This screening ERA for FBQ includes the equivalent of Ohio EPA's Level I Scoping and Level II Screening ERA.

These guidance documents discuss an overall approach to considering ecological effects and to identifying sources of information necessary to perform ERAs. However, they do not provide all the details. Thus, professional knowledge and experience are important in ERAs to compensate for this lack of specific guidance and established methods. This professional experience comes from a team of risk scientists, who are representatives from RVAAP, USACE, Ohio EPA, and SAIC.

The following sections present the scope and objectives (Section 7.1); the procedural framework (Section 7.2); and the four steps to complete the screening work, hereafter referred to as the SERA, with emphasis on problem formulation (Section 7.3). The results are presented in Section 7.4. Finally, there is an uncertainties section (Section 7.5), a summary of SERA results (Section 7.6), and a recommendations section (Section 7.7).

7.1 SCOPE AND OBJECTIVES

The scope of the ERA is to characterize, in a preliminary way, the risk to plant and animal populations at FBQ, including its aquatic environment, from analytes that are present in the surface soil, subsurface soil, sediment, and surface water. This is done for current conditions. Unlike the HHRA, which focuses on individuals, the screening ERA focuses on generic groups of organisms. In the screening ERA process, individuals are addressed only if they are protected under the Endangered Species Act (ESA). For the baseline ERA, specific ecological receptors would be utilized, and these specific receptors are part of the effort of Level II in Ohio EPA guidance.

The screening ERA used site-specific analyte concentration data for surface soil, subsurface soil, sediment, and surface water from various geographical parts of FBQ. Risks to ecological receptors were evaluated by performing a multi-step screening process in which, after each step, the detected analytes in the media were either deemed to pose negligible risk and eliminated from further consideration or carried forward to the next step in the screening process to a final conclusion of being a contaminant of potential ecological concern (COPEC). COPECs are analytes whose concentrations are great enough to pose potential adverse effects to ecological receptors. The screening steps are described in detail in Section 7.3.3.

The objective of the screening ERA was to identify whether any of the detected analytes in surface soil, subsurface soil, sediment, and surface water at FBQ posed sufficient potential risk to ecological receptors to warrant the analytes being classified as COPECs. This was done for soil, sediment, and surface water and generic receptors that would be exposed to these media. Deep groundwater is not a medium of concern for ecological receptors. However, shallow groundwater could flow into the three ponds on FBQ. Groundwater is treated as surface water once it surfaces and mixes with existing surface water.

As an additional element of risk evaluation outside the screening ERA, Army guidance (USACE 2003b) directs that ERAs consider extrapolated information from Winklepeck Burning Grounds (WBG). The Army conducted ground-truthing investigations of plants and animals and how they responded to the chemically contaminated WBG versus the nearby-uncontaminated reference (SAIC 2002). The principal item of extrapolation was the plant protection levels for four chemicals. No other WOE comparisons were justified because of the large differences between WBG and FBQ site histories, topography, soil type, vegetation, and role of surface water (SAIC 2002).

7.2 PROCEDURAL FRAMEWORK

According to the *Framework for Ecological Risk Assessment* (EPA 1992b), the ERA process consists of three interrelated phases: problem formulation, analysis (composed of exposure assessment and ecological effects assessment), and risk characterization. In conducting the ERA for FBQ, these three phases were partially completed by performing four interrelated steps. Each has the following parts.

- **Problem Formulation:** Problem formulation establishes the goals, breadth, and focus of the ERA and provides a characterization (screening step) of chemical stressors (chemicals that restrict growth and reproduction or otherwise disturb the balance of ecological populations and systems) present in the various habitats at the site. The problem formulation step also includes a preliminary characterization of the components, especially the ecological receptors, in the ecosystem likely to be at risk. It can also include the selection of assessment and measurement endpoints as a basis for developing a conceptual model of stressors, components, and effects (Section 7.3).

- **Exposure Assessment:** Exposure assessment defines and evaluates the concentrations of the chemical stressors. It also describes the ecological receptors to define the route, magnitude, frequency, duration, and spatial pattern of the exposure of each receptor population to a chemical stressor (Section 7.4).

- **Effects Assessment:** Effects assessment evaluates the ecological response to chemical stressors in terms of the selected assessment and measurement endpoints. The effects assessment results in a profile of the ecological response of populations of plants and animals to the chemical concentrations or doses and to other types and units of stress to which they are exposed. Data from both field observations and controlled laboratory studies are used to assess ecological effects (Section 7.4).

- **Risk Characterization:** Risk characterization integrates exposure and effects or the response to chemical stressors on ecological receptors using exceedances of ESVs and later HQs, which are ratios of exposure concentrations to concentrations associated with an effect. The results are used to define the risk from contamination at FBQ. In the screening ERA scope, it is an exceedance of an ESV that is an equivalent of being in harm's way (Section 7.4).

7.3 PROBLEM FORMULATION FOR THE SCREENING ECOLOGICAL RISK ASSESSMENT

The first step of EPA's approach to the screening ERA process, problem formulation (data collection and evaluation), includes:

- descriptions of habitats, biota, and threatened and endangered (T&E) species (Section 7.3.1);
- selection of EUs (Section 7.3.2); and
- identification of COPECs (Section 7.3.3).

The first part of this work is required by Level I.

7.3.1 Description of Habitats, Biota, Threatened and Endangered Species, and Populations

This section provides a description of the ecological resources at FBQ. Terrestrial habitats and communities are discussed in Section 7.3.1.1. Resource management topics are presented in Sections 7.3.1.2 and 7.3.1.3. Animals are discussed in Section 7.3.1.4. Aquatic habitats are discussed in Section 7.3.1.5 and protected species are discussed in Section 7.3.1.6. All of this information shows that Level I in the Ohio EPA guidance is met. There are ecological resources present in the form of vegetation and animal life in both terrestrial and aquatic ecosystems. Thus, Level II was justified.

7.3.1.1 Terrestrial habitats and plant communities

The FBQ limit of assessment occupies a total area of about 38.8 acres (Table 7-1). This area includes forests, shrublands, grasslands, wetlands, and paved roads. The vegetated areas provide habitat for the many plants and animals at Ravenna. Information on plant communities at FBQ was gleaned from the *Plant Community Survey for the Ravenna Army Ammunition Plant* (SAIC 1999). The RVAAP plant community survey was based on a combination of color infrared and black-and-white aerial photogrammetry available from the mid-1990s and field surveys conducted in the autumn of 1998 and spring and summer of 1999. An additional field walkover of FBQ was conducted in April 2005.

Forest Formations

Forest formations at RVAAP correspond to plant communities with closed tree canopies. Forest formations occupy approximately 13,330 acres at RVAAP. Note that some areas at RVAAP contain plant communities dominated by tree species, but intermixed with patches of shrubs as a result of past disturbance. The following types of forest formations occur at the FBQ AOC.

Table 7-1. Plant Communities and Other Habitat Recorded at Fuze and Booster Quarry Landfill/Ponds

Plant Community Type	Acres	% Area
Forest Formations		
Fagus grandifolia-Acer saccharum-(*Liriodendron tulipifera*) Forest Alliance	5.6	14.4
Acer rubrum Successional Forest	0.7	1.8
Mixed Cold-Deciduous Successional Forest	4.5	11.6
Shrubland Formations		
Dry mid-successional cold-deciduous shrubland	13.4	34.5
Dry late-successional cold-deciduous shrubland	7.4	19.1
Herbaceous Formations		
Dry early successional herbaceous field	2.9	7.5
Phalaris arundinacea Seasonally Flooded Herbaceous Alliance	1.4	3.6
Other		
Open Water	2.9	7.5
Total	38.8	100.0

Fagus grandifolia - Acer saccharum - (Liriodendron tulipifera) Forest Alliance

This forest alliance describes a diverse community common to mesic, gently sloping sites throughout the east-central United States and southern Canada. At RVAAP, many of the most mature upland stands correspond to this alliance. American beech (*Fagus grandifolia*) and sugar maple (*Acer saccharum*) dominate the canopy. Other common trees include yellow-poplar (*Liriodendron tulipifera*), northern red oak (*Quercus rubra*), white ash (*Fraxinus americana*), black cherry (*Prunus serotina*), American basswood (*Tilia americana*), various hickories (*Carya* spp.), and occasionally white oak (*Quercus alba*). In some areas, American beech is absent from the canopy, possibly as a result of the length of time of forest development since the last period of disturbance (i.e., there has been insufficient time for the species to invade the site and become established). Where beech does occur, it is frequently present only in the understory or as young saplings. Shrub and herbaceous species are generally sparse probably as a result of heavy browsing by deer. Spicebush (*Lindera benzoin*), American hornbeam (*Carpinus caroliniana*), and eastern hop-hornbeam (*Ostrya virginiana*) were frequently observed in the understory. Mayapple (*Podophyllum peltatum*) and New York fern (*Thelypteris noveboracensis*) were frequently observed in the herbaceous layer. This community is located in the central portion of FBQ. This forest type makes up about 5.6 acres or 14.4% of the FBQ AOC limit of assessment (Table 7-1).

Acer rubrum successional forest

This transitional forest community is very common at RVAAP. It is characterized by a high abundance of red maple (*Acer rubrum*) often in nearly pure stands. Green ash (*Fraxinus pennsylvanica*), white ash (*Fraxinus americana*), black cherry (*Prunus serotina*), and sugar maple (*Acer saccharum*) often are present, but never dominant. In some cases, the canopy is very dense and little to no ground cover is present. In other cases the canopy is somewhat open and old-field species such as blackberry (*Rubus allegheniensis*), goldenrod (*Solidago* spp.), dogbane (*Apocynum cannabinum*), and self-heal or heal-all (*Prunella vulgaris*) form a dense herbaceous layer. In general, stand age is fairly even. This community is located in the southeast corner of FBQ. This forest type makes up about 0.7 acres or 1.8% of the FBQ AOC limit of assessment (Table 7-1).

Mixed Cold-Deciduous successional forest

This transitional forest community is fairly abundant at RVAAP and is indicative of a late stage of recovery following significant disturbance (e.g., clear-cutting). A mixture of pioneer species forms the somewhat open canopy. Common species include white ash (*Fraxinus americana*), wild black cherry (*Prunus serotina*), red maple (*Acer rubrum*), black locust (*Robinia pseudoacacia*), quaking aspen (*Populus tremuloides*), and bigtooth aspen (*Populus grandidentata*). Generally, thick shrub and herbaceous layers are present characterized by old-field species such as gray dogwood (*Cornus racemosa*), northern arrowwood (*Viburnum recognitum*, syn. *dentatum*), blackberry (*Rubus allegheniensis*), hawthorn (*Crataegus* spp.), goldenrod (*Solidago* spp.), sheep sorrel (*Rumex acetosella*), and fescue grasses (*Festuca* spp., mostly *Festuca arundinacea*). This community is located in the north-central portion of FBQ. This forest type makes up about 4.5 acres or 11.5% of the FBQ AOC limit of assessment (Table 7-1).

Shrubland Formations

Shrubland formations at RVAAP correspond to plant communities where the dominant life form is shrub. The term shrub corresponds to both true shrub species and young tree species (seedlings and saplings) less than 20 ft tall. For example, successional areas at RVAAP that contain young trees or young trees mixed with shrubs were classified as shrubland if the majority of the vegetation did not exceed 20 ft in height. Note that many areas at RVAAP that were classified as shrubland are successional areas comprised mostly of young trees mixed with shrubs (i.e., mature old fields). Without disturbance, many of these areas will probably develop into young forest communities within approximately 5 to 15 years. The following two shrubland formations occur at FBQ.

Dry mid-successional cold-deciduous shrubland

The dry mid-successional cold-deciduous shrubland community describes a plant grouping at RVAAP that is frequently encountered in previously disturbed areas (e.g., former agricultural fields) that have had sufficient recovery time for invasion by shrub species. It is commonly referred to as an “Old Field Community”. This community is present throughout RVAAP covering large (> 10 acres) as well smaller areas (< 1 acre). It is characterized by shrub species covering more than 50% of the area with relatively few large trees (> 20 ft in height). Common shrub species include gray dogwood (*Cornus racemosa*), northern arrowwood (*Viburnum recognitum*), blackberry (*Rubus allegheniensis*), hawthorn (*Crataegus* spp.), and multiflora rose (*Rosa multiflora*). Typical pioneer tree species include red maple (*Acer rubrum*), wild black cherry (*Prunus serotina*), white ash (*Fraxinus americana*), and black locust (*Robinia pseudoacacia*). A dense herbaceous community is present with common species such as goldenrod (*Solidago* spp.), dogbane (*Apocynum cannabinum*), self-heal or heal-all (*Prunella vulgaris*), yarrow (*Achillea millefolium*), strawberry (*Fragaria virginiana*), black-eyed Susan (*Rudbeckia hirta*), sheep sorrel (*Rumex acetosella*), and fescue grasses (*Festuca* spp., mostly *Festuca arundinacea*). This community is located along the eastern portion of FBQ around the quarry ponds and in the northwest corner. This shrubland formation makes up about 13.4 acres or 34.5% of the FBQ AOC limit of assessment (Table 7-1).

Dry late-successional cold-deciduous shrubland

This community is more advanced stage of the “Old Field Community” (see dry mid-successional cold-deciduous shrubland). At this stage, young pioneer trees, generally less than 20 ft in height, are dominant. Common species include red maple (*Acer rubrum*), wild black cherry (*Prunus serotina*), white ash (*Fraxinus americana*), and black locust (*Robinia pseudoacacia*). Shrub and herbaceous species are still present although to a lesser extent than in younger stages of the “Old Field Community.” This community is located in the central portion of FBQ. This shrubland formation makes up about 7.4 acres or 19.1% of the FBQ AOC limit of assessment (Table 7-1).

Herbaceous Formations

Herbaceous formations at RVAAP correspond to plant communities where the dominant life form is herbaceous (non-woody). Herbaceous formations occupy approximately 3,400 acres at RVAAP. The following two types of herbaceous vegetation formations occur at the FBQ AOC limit of assessment.

Dry early successional herbaceous field

This community describes a frequent plant grouping at RVAAP that is present in recently disturbed areas that have not had sufficient recovery time for significant invasion by shrub species. It is characterized by a dense herbaceous community with common species including goldenrod (*Solidago* spp.), clasping-leaf dogbane (*Apocynum cannabinum*), self-heal or heal-all (*Prunella vulgaris*), yarrow (*Achillea millefolium*), strawberry (*Fragaria virginiana*), black-eyed Susan (*Rudbeckia hirta*), sheep sorrel (*Rumex acetosella*), and fescue grasses (*Festuca* spp., mostly *Festuca arundinacea*). Young shrubs frequently are present, but cover less than 50% of the area. Trees are rare. Common shrub species include gray dogwood (*Cornus racemosa*), northern arrowwood (*Viburnum recognitum*), blackberry (*Rubus allegheniensis*), and multiflora rose (*Rosa multiflora*). This community is located in the south-central and southeast corner of FBQ. This herbaceous formation makes up about 2.9 acres or 7.4% of the FBQ AOC (Table 7-1).

Phalaris arundinacea Seasonally Flooded Herbaceous Alliance

According to TNC (1997) this alliance occurs as a natural community in the northeastern United States, but its presence as a natural community elsewhere is uncertain. The alliance is dominated by reed canary grass (*Phalaris arundinacea*), which is a highly invasive species. At RVAAP, the alliance frequently occurs as a reed canary grass monoculture, but also occurs in combination with giant-reed (*Phragmites australis*), sweetflag (*Acorus calamus*), cattails (*Typha* spp.), rice cut-grass (*Leersia oryzoides*), and sedges (*Carex* spp.). This alliance is found most often in depressional areas and swales in previously cleared fields. As its name implies, this alliance can be located in wetland areas that may be jurisdictional. This community is located in the southwest corner of FBQ. This herbaceous formation makes up about 1.4 acres or 3.6% of the FBQ AOC (Table 7-1).

Other Landscape Features

Other landscape features at FBQ include the three quarry ponds (oriented in a north to south row). The 2.9-acre area covered by the ponds is about 7.5% of the FBQ AOC limit of assessment. The upper two ponds are connected via a spillway. The bottom pond is not connected to the upper two ponds. The bottom pond receives a great deal more runoff than the upper ponds and the bottom pond drains via an underground culvert to the drainage ditch.

7.3.1.2 Forestry resources and management

FBQ supports 10.8 acres of forest. Approximately 5.2 acres are deciduous successional forest indicative of a late stage of recovery following a significant disturbance such as clear cutting (SAIC 1999). Approximately 5.6 acres are more mature beech-maple forests.

FBQ is within Forest Management Compartment 3 of the ten compartments designated within RVAAP. Each compartment is further subdivided into cutting units with the cutting unit boundaries reflecting topographic features (e.g., creeks and roads) rather than forest types. FBQ is located within cutting unit M. Of Compartment 3’s total 329 acres, 34 acres is sawtimber, 108 acres is poletimber, and 98 acres are in timber stands considered to be of adequate regeneration. Areas of inadequate forest regeneration and non-forested areas total 89 acres with Compartment 3. No specific timber stand improvement prescriptions are currently in place for Forest Compartment 3. In August 1999, sawtimber volume was estimated at 104,100 board ft. Compartment 3 is not currently scheduled to be harvested, but would be ready for harvest as early as 2013 (Morgan 2005).

7.3.1.3 Special management considerations

Special Interest Areas and Sensitive Areas

As a result of state and federal interagency consultation and the flora and fauna inventories conducted at RTLS/RVAAP, and in accordance with AR 200-3, some "Special Interest Areas" have been established. Special Interest Areas include communities that host state-listed species, are representative of historic ecosystems, and/or are otherwise noteworthy (OHARNG 2001).

Several types of plant communities are considered noteworthy on RVAAP. Noteworthy forested communities include beech-sugar maple forest, oak-maple swamp forest, mixed swamp forest, oak-maple-tuliptree forest, oak-hickory forest, mixed floodplain forest, and successional woods. Noteworthy wetland communities include floating-leaved marsh, submergent marsh, emergent marsh, cattail marsh, sedge-grass meadow, mixed shrub swamp, buttonbush swamp, shrub bog, wet fields, ponds, and disturbed wetlands (OHARNG 2001, Morgan 2005).

Ohio Department of Natural Resources (ODNR) and the U. S. Fish and Wildlife Service did not identify any sensitive habitats on or near FBQ during their natural heritage data searches (Morgan 2005).

Jurisdictional Wetlands

There have been multiple wetland delineations performed in recent years to support National Environmental Policy Act (NEPA) requirements of specific project proposals, including delineations on over 2,500 acres of RTLS during 2003 and 2004. All of these maps and delineations are on file in the RTLS Environmental Office. No wetland delineations have been performed on RVAAP (Morgan 2005). However, it is highly probable that jurisdictional wetlands would be found within FBQ if a jurisdictional delineation were to be performed (Morgan 2005). The quarry ponds may contain wetland fringe habitat and the southwest corner of FBQ containing the *Phalaris arundinacea Seasonally Flooded Herbaceous Alliance* may be a wetland. During a site-walkover at FBQ, water, vegetation, and perhaps hyrdic soils that maintain one or more acres of this type of habitat was noted in the southwestern portion of FBQ. However, the exact quantity, quality, and category of the potential wetlands habitat has not been determined by a method such as the Ohio Rapid Assessment Method for Wetlands.

A jurisdictional wetland refers to a habitat that has a combination of soil/sediment, hydrology (surface water and/or shallow groundwater), and vegetation that meets several criteria from the government for each element of the combination. For example, soil/sediment needs to considered "hydric" meaning that it is frequently saturated, surface water and/or very shallow groundwater needs to be present for several consecutive weeks during the growing season, and water-tolerant plant species must cover at least 50% of the area.

7.3.1.4 Animal populations

The plant communities at RVAAP provide diverse habitats that support many species of animals. Results of 1992 and 1993 ODNR biological surveys (ODNR 1997) included 27 mammals, 154 birds, 12 reptiles and 19 amphibians, 47 fish (including 6 hybrids), 4 crayfish, 17 mussels and clams, 11 aquatic snails, 26 terrestrial snails, 37 damselflies and dragonflies, 58 butterflies, and 485 moths. Several game species, such as deer, are managed through hunts scheduled during the fall months. The FBQ area has been included in the deer hunts for years and is still hunted today. It is part of hunting area 32A and those assigned to this area may hunt there or anywhere else within 32A (Morgan 2005).

The plant communities within the FBQ AOC also provide varied habitats that support several species of animals. About 81% (31.6 acres) of FBQ is covered by young forests and late-stage successional habitat, including shrublands. This habitat is located in the central and northern portions of FBQ. Common bird species that use this habitat with its somewhat open canopy include the song sparrow (*Melospiza melodia*), common yellowthroat (*Geothylpis trichas*), gray catbird (*Dumetella carolinensis*), rufous-sided towhee (*Pipilo erythrophthalmus*), and American goldfinch (*Carduelis tristis*). Common large mammals include white-tailed deer (*Odocoileus virginianus*), raccoon (*Procyon lotor*), and woodchuck (*Marmota monax*), while eastern cottontail (*Sylvilagus floridanus*), white-footed mouse (*Peromyscus leucopus*), short-tailed shrew (*Blarina brevicauda*), and meadow vole (*Microtus pennsylvanicus*) are common small mammals (ODNR 1997).

The southern portion of FBQ contains herbaceous fields including the *Phalaris arundinacea* wet grassland in the southwest corner. Many of the same species listed above would also occupy the more open herbaceous fields. Eastern bluebirds (*Sialia sialis*), field sparrows (*Spizella pusilla*), eastern kingbirds (*Tyrannus tyrannus*), and eastern meadowlarks (*Sturnella magna*) are more common in these open areas.

The 2.9 acres of open water in the quarry or large pond habitat support wetland birds such as the red-winged blackbird (*Agelaius phoeniceus*), great blue herons (*Ardea herodias*), tree swallows (*Tachycineta bicolor*), eastern phoebes (*Sayornis phoebe*), wood ducks (*Aix sponsa*), and mallards (*Anas platyrhynchos*). Waterfowl are not expected to be present at the small basins nor the FBQ drainage. Muskrats (*Ondatra zibethicus*), common water snakes (*Nerodia sipedon*), green frogs (*Rana clamitans*), bullfrogs (*Rana catesbeiana*), and painted turtles (*Chrysemys picta*) are also likely inhabitants of the large pond habitat. Three species of fish including largemouth bass (*Micropterus salmoides*) have been collected from these ponds (USACE 2005).

7.3.1.5 Aquatic habitats

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 basins totaling 1.23 acres are located in the southwest portion of FBQ. These basins are associated with the past use of the area for ammunition production. The drainages are generally dry except during precipitation events.

Habitat evaluations rated the ponds as fair, although aquatic vegetation is sparse along much of the shoreline (USACE 2005). 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 slightly exceeding several water quality standards, does not appear to impact the biological community. Sediment sampling results indicated moderate contamination, with lead and zinc measured above the *Probable Effect Concentration*.

7.3.1.6 T&E species

The relative isolation and protection of habitat at RVAAP has created an important area of refuge for a number of plant and animal species considered rare by the state of Ohio. To date, 74 state-listed species are confirmed to be on the RVAAP property. None of these are known to exist within FBQ (Morgan 2005). See Table 7-2 for a list of T&E species at RTLS/RVAAP.

Table 7-2. Ravenna Training and Logistics Site Ravenna Army Ammunition Plant, Rare Species List (May 2005)

I. Species confirmed to be on the RTLS/RVAAP property by biological inventories and confirmed sightings

A. State Endangered

1. American bittern, *Botaurus lentiginosus* (migrant)
2. Northern harrier, *Circus cyaneus*
3. Yellow-bellied Sapsucker, *Sphyrapicus varius*
4. Golden-winged warbler, *Vermivora chrysoptera*
5. Osprey, *Pandion haliaetus* (migrant)
6. Trumpeter swan, *Cygnus buccinator* (migrant)
7. Mountain Brook Lamprey, *Ichthyomyzon greeleyi*
8. Graceful Underwing, *Catocala gracilis*
9. Ovate Spikerush, *Eleocharis ovata* (Blunt spike-rush)
10. Tufted Moisture-loving Moss, *Philonotis fontana* var. *caespitosa*
11. Bobcat, *Felis rufus*

B. State Threatened

1. Barn owl, *Tyto alba*
2. Dark-eyed junco, *Junco hyemalis* (migrant)
3. Hermit thrush, *Catharus guttatus* (migrant)
4. Least bittern, *Ixobrychus exilis*
5. Lest flycatcher, *Empidonax minimus*
6. *Psilotreta indecisa* (caddisfly)
7. Simple willow-herb, *Epilobium strictum*
8. Woodland Horsetail, *Equisetum sylvaticum*

C. State Potentially Threatened Plants

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

D. State Species of Concern

1. Pygmy shrew, *Sorex hovi*
2. Star-nosed mole, *Condylura cristata*
3. Woodland jumping mouse, *Napaeozapus insignis*
4. Sharp-shinned hawk, *Accipiter striatus*
5. Marsh wren, *Cistothorus palustris*
6. Henslow's sparrow, *Ammodramus henslowii*
7. Cerulean warbler, *Dendroica cerulea*
8. Prothonotary warbler, *Protonotaria citrea*
9. Bobolink, *Dolichonyx oryzivorus*
10. Northern bobwhite, *Colinus virginianus*
11. Common moorhen, *Gallinula chloropus*
12. Great egret, *Casmerodius albus*
13. Sora, *Porzana carolina*
14. Virginia Rail, *Rallus limicola*
15. Creek heelsplitter, *Lasmigona compressa*

Table 7-2. Ravenna Training and Logistics Site, Ravenna Army Ammunition Plant, Rare Species List (May 2005) (continued)

16. Eastern box turtle, *Terrapene carolina*
17. Four-toed Salamander, *Hemidactylium scutatum*
18. *Stenonema ithica* (mayfly)
19. *Apamea mixta* (moth)
20. *Brachylomia algens* (moth)
E. State Special Interest
1. Canada warbler, *Wilsonia canadensis*
2. Little blue heron, *Egretta caerula*
3. Magnolia warbler, *Dendroica magnolia*
4. Northern waterthrush, *Seiurus noveboracensis*
5. Winter wren, *Troglodytes troglodytes*
6. Back-throated blue warbler, *Dendroica caerulescens*
7. Brown creeper, *Certhia americana*
8. Mourning warbler, *Oporornis philadelphia*
9. Pine siskin, *Carduelis pinus*
10. Purple finch, *Carpodacus purpureus*
11. Red-breasted nuthatch, *Sitta canadensis*
12. Golden-crowned kinglet, *Regulus satrapa*
13. Blackburnian warbler, *Dendroica fusca*
14. Blue grosbeak, *Guiraca caerulea*
15. Common snipe, *Gallinago gallinago*
16. American wigeon, *Anas americana*
17. Gadwall, *Anas strepera*
18. Green-winged teal, *Anas crecca*
19. Northern shoveler, *Anas clypeata*
20. Redhead duck, *Aythya americana*
21. Ruddy duck, *Oxyura jamaicensis*
23. *Pohlia elongata* var. *elongata* (No Common Name, Bryophyte)
F. Rare Plant Communities/Significant Natural Areas
1. The area known as the northern woods contains Beech-sugar maple forest, oak-maple swamp forest, mixed swamp forest, oak-maple-tulip forest, oak-hickory forest, mixed floodplain forest, and successional woods, floating-leaved marsh, submergent marsh, emergent marsh, cat-tail marsh, sedge-grass meadow, mixed shrub swamp, buttonbush swamp, shrub bog, wet fields, ponds, and disturbed wetlands. This area is approximately 1,500 acres and includes a Pin Oak-Swamp White Oak-Red Maple-(Northern Pin Oak) Flatwoods Forest. This community is ranked as a G2 community. This means that it is “imperiled globally because rarity (6 to 20 occurrences or few remaining individuals) or because of some factor(s) making it very vulnerable to extinction throughout its range.” According to Dr. Barbara Andreas, who did the RTLS plant communities inventory, the best examples of this community in NE Ohio are at RTLS. This area also contains good examples of Beech-Maple Forests (G4?).
2. The Wadsworth Glenn contains the following communities: Hemlock-White Pine-Northern Hardwood Forest (G3/G4), oak-hickory forest, mixed floodplain forest, floating-leaved marsh, submergent marsh, emergent marsh, cat-tail marsh, and ponds. This area is approximately 90 acres.
3. The Group 3 woods is approximately 700 acres and contains mixed swamp forest, beech-sugar maple forest, oak-maple-tuliptree forest, red maple woods, successional woods, cat-tail marsh, and disturbed habitats.
4. The B&O Wye Road area contains Sphagnum thicket, oak-maple swamp forest, mixed swamp forest, dry fields, buttonbush swamp, wet meadows, cat-tail marsh, a pond, and seeps. This area consists of approximately 145 acres and is on the southeastern perimeter in Portage County on the Portage and Trumbull County line.
5. The South Patrol Road swamp forest is about 120 acres and contains mixed swamp forest, oak-maple swamp forest, beech-maple forest, buttonbush swamp, and open swamps.

Table 7-2. Ravenna Training and Logistics Site, Ravenna Army Ammunition Plant, Rare Species List (May 2005) (continued)

G. Other Biological Items of Interest
1. Turkey Vulture Roosts - Turkey Vultures roost and breed throughout the RVAAP, primarily on and around earth-covered magazine headwalls and abandoned buildings. 2. Great Blue Heron - Up to three heron rookeries have been identified at the RVAAP in a given year. The rookeries are normally small and are abandoned for better areas from time to time.

Note that there are currently no federally listed species or critical habitat on the RTLS/RVAAP property. Thus, there are no known legally protected species to require special consideration.
RTLS = Ravenna Training and Logistics Site.
RVAAP = Ravenna Army Ammunition Plant.

Federal

There are no federally listed plants or animals currently known to occur at RVAAP. Site-wide bat surveys were performed in 1999 and 2004 (ODNR 1999, ES&I 2005). Bat species captured included little brown bats, big brown bats, northern long-eared bats, red bats, and hoary bats, and eastern pipistrelle. Although the federally listed endangered Indiana bat (*Myotis sodalis*) has been documented nearby, the Indiana bat was not identified during any surveys and does not occur on RVAAP or at FBQ (OHARNG 2001).

Several species listed as under Federal Observation (formerly Federal Candidate Species, Category 2) occur on RVAAP. These species include the Cerulean Warbler (*Dendroica cerulea*), henslow's Sparrow (*Ammodramus henslowii*), and butternut trees (*Juglans cinerea*) (ODNR 1997). None of these species has been documented at FBQ (Morgan 2005).

State

State-listed endangered species include six birds [American bittern (*Botaurus lentiginosus)* (migrant), Northern harrier (*Circus cyaneus*), Yellow-bellied Sapsucker (*Sphyrapicus varius*), Golden-winged warbler (*Vermivora chrysoptera*), Osprey (*Pandion haliaetus)* (migrant), and Trumpeter swan (*Cygnus buccinator*) (migrant)], a lamprey [Mountain Brook Lamprey (*Ichthyomyzon greeleyi*)], a butterfly [Graceful Underwing (*Catocala gracilis*)], two plants [Ovate Spikerush (*Eleocharis ovata*) (Blunt spike-rush) and Tufted Moisture-loving Moss (*Philonotis fontana* var. *caespitosa*)], and one mammal [Bobcat (*Felis rufus*)]. None of these species has been documented at FBQ (Morgan 2005).

State-listed threatened species include five birds [Barn owl (*Tyto alba*), Dark-eyed junco (*Junco hyemalis*) (migrant), Hermit thrush (*Catharus guttatus*) (migrant), Least bittern (*Ixobrychus exilis*), and Least flycatcher (*Empidonax minimus*)], one insect [*Psilotreta indecisa* (caddisfly)] and two plants [Simple willow-herb (*Epilobium strictum*) and Woodland Horsetail (*Equisetum sylvaticum*)]. None of these species has been documented at FBQ (Morgan 2005).

Portage County has more rare species, especially plants, than any other county in Ohio. This is reflected in the number of species occurring on RVAAP that are listed as State Potentially Threatened. These species include four tree species [Gray Birch (*Betula populifolia*), Butternut (*Juglans cinerea*), Arbor Vitae (*Thuja occidentalis*), and American Chestnut (*Castanea dentate*)], two woody species [Northern rose azalea (*Rhododendron nudiflorum* var. *roseum*) and Hobblebush (*Viburnum alnifolium*)], and seven herbaceous species [Pale sedge (*Carex pallescens*), Long Beech Fern (*Phegopteris connectilis*), Straw sedge (*Carex straminea*), Water avens (*Geum rivale*), Tall St. John's wort (*Hypercium majus*), Swamp oats (*Sphenopholis pensylvanica*), and Shining ladies'-tresses (*Spiranthes lucida*). None of these species has been documented at FBQ (Morgan 2005).

Species that are state-listed as of Special Concern [listed by either Ohio Department of Wildlife or the Heritage Program (Heritage)] include three mammals [Pygmy shrew (*Sorex hovi*), Star-nosed mole (*Condylura cristata*), and Woodland jumping mouse (*Napaeozapus insignis*)], eleven birds [Sharp-shinned hawk (*Accipiter striatus*), Marsh wren (*Cistothorus palustris*), Henslow's sparrow (*Ammodramus henslowii*), Cerulean warbler (*Dendroica cerulean*), Prothonotary warbler (*Protonotaria citrea*), Bobolink (*Dolichonyx oryzivorus*), Northern bobwhite (*Colinus virginianus*), Common moorhen (*Gallinula chloropus*), Great egret (*Casmerodius albus*), Sora (*Porzana Carolina*), and Virginia Rail (*Rallus limicola*)], one freshwater mussel [Creek heelsplitter (*Lasmigona compressa*)], one reptile [Eastern box turtle (*Terrapene Carolina*)], one amphibian [Four-toed Salamander (*Hemidactylium scutatum*)], and three insects [*Stenonema ithica* (mayfly), *Apamea mixta* (moth), and *Brachylomia algens* (moth)]. None of these species has been documented at FBQ (Morgan 2005).

Species that are state listed as Special Interest include 21 birds [Canada warbler (*Wilsonia Canadensis*), Little blue heron (*Egretta caerula*), Magnolia warbler (*Dendroica magnolia*), Northern waterthrush (*Seiurus noveboracensis*), Winter wren (*Troglodytes troglodytes*), Back-throated blue warbler (*Dendroica caerulescens*), Brown creeper (*Certhia Americana*), Mourning warbler (*Oporornis Philadelphia*), Pine siskin (*Carduelis pinus*), Purple finch (*Carpodacus purpureus*), Red-breasted nuthatch (*Sitta canadensis*), Golden-crowned kinglet (*Regulus satrapa*), Blackburnian warbler (*Dendroica fusca*), Blue grosbeak (*Guiraca caerulea*), Common snipe (*Gallinago gallinago*), American wigeon (*Anas Americana*), Gadwall (*Anas strepera*), Green-winged teal (*Anas crecca*), Northern shoveler (*Anas clypeata*), Redhead duck (*Aythya americana*), and Ruddy duck (*Oxyura jamaicensis*)] and one plant [*Pohlia elongata* var. *elongata* (No Common Name, Bryophyte)]. None of these species has been documented at FBQ (Morgan 2005).

7.3.2 Selection of Exposure Units

From the ecological assessment viewpoint, an EU is the area where ecological receptors potentially are exposed to the site constituents. Thus, the EU is defined on the basis of the historical use of various processes. Although some ecological receptors are likely to gather food, seek shelter, reproduce, and move around, spatial boundaries of the ecological EUs are the same as the spatial boundaries of aggregates defined for nature and extent, fate and transport, and the HHRA. These proposed EUs for FBQ are as follows:

Terrestrial EUs:

- Surface soil (0 to 1 ft BGS),
- Subsurface soil (1 to 3 ft BGS).

Sediment EUs:

- Large ponds
- Drainage ditch
- Small basins.

Surface water EUs:

- Large ponds
- Drainage ditch
- Small basins

The distinction between EUs is based on location and history of the units. Each of the EUs is spatially separated. The exact history of waste applications and spills at each EU is uncertain. This uncertainty regarding waste applications and spills provides further justification for the distinction between the EUs.

7.3.3 Identification of Constituents of Potential Ecological Concern

COPECs were identified by using methods described for Level II Screening in Ohio EPA's *Ecological Risk Assessment Guidance Document* (Ohio EPA 2003). Identification of COPECs entailed a multi-step process that began with the detected chemicals of interest (COIs) that were identified in the Level I Scoping and included a data evaluation, media evaluation, and media screening as part of the Level II Screen. These three processes are described below in sections 7.3.3.1, 7.3.3.2, and 7.3.3.3, respectively.

7.3.3.1 Data evaluation

The data evaluation of COIs entailed two components: a frequency of detection analysis and an evaluation of common laboratory contaminants. Summary statistics, including frequency of detection, for surface soil [0-1 ft below ground surface (BGS)], subsurface soil (1-3 ft BGS), sediment, and surface water are presented in Appendix Tables N-1 through N-4, respectively. The purpose of the frequency of detection analysis was to eliminate from further consideration any COIs that were detected in 5% or less of the samples for a given medium. However, COIs that were present in multiple media, or deemed to be persistent, bioaccumulative, and toxic (PBT) were not eliminated, even if they failed the frequency of detection evaluation. PBT compounds included four inorganics (cadmium, lead, mercury, and zinc) because of their bioaccumulative potential, as well as any organic compound whose log octanol-water (K_{ow}) partitioning coefficient is greater than or equal to 3.0. Appendix Table N-5 lists the Log K_{ow} values for organic compounds. The data evaluations for surface and subsurface soil, sediment, and surface water are presented in Appendix Tables N-6 through N-13.

Common laboratory contaminants included acetone, 2-butanone (methyl ethyl ketone), carbon disulfide, methylene chloride, toluene, and phthalate esters. If blanks contained detectable concentrations of these contaminants, then the sample results would be considered positive results if the sample concentrations exceeded 10-fold the maximum amount detected in any blank.

7.3.3.2 Media evaluation

The media evaluation was performed after the frequency of detection and common laboratory contaminant evaluation, using the COIs that were not eliminated during those two steps. The purpose of the media evaluation was to determine whether site-related chemicals have impacted media associated with the site. The evaluation methods were media-specific, and included comparison against background concentrations for all media and comparison against Ohio-specific sediment reference values (SRVs) for sediment. Ohio EPA (2003) specifies SRVs to be used for sediments from lentic (standing water) surface water bodies. Because water in the Fuze and Booster Quarry is mostly lentic, Ohio-specific SRVs were used with the approval of Ohio EPA for acceptable background values whenever available. The SRVs were derived by Ohio EPA (Ohio EPA 2003) to be used in lieu of or in addition to on-site sediment background values.

For the media evaluation, maximum detected concentrations (MDCs) of COIs in soil, sediment, and surface water were compared to selected background concentrations and eliminated from further consideration in the Level II Screen if the maximum concentrations were less than background values (or SRVs) and the COIs were not PBT compounds. If the MDCs of COIs exceeded background values or SRVs, and/or the COIs were PBT compounds, the COIs were deemed COPECs and were carried forward to the media screening step.

The media evaluation results for surface and subsurface soil, sediment, and surface water are also presented along with the Data Evaluation results in Appendix Tables N-6 through N-13.

7.3.3.3 Media screening

The media-screening step proceeded after the data/media evaluations, using the inputted COPECs identified in those two steps because a decision was made to proceed with the ERA process instead of selecting a removal action. The media screening process was media-specific (Ohio EPA 2003). For example, MDCs of the COPECs for surface soil and sediment were compared against media-specific ESVs recommended by Ohio EPA (Ohio EPA 2003). The ESVs are conservative toxicological benchmarks that represent concentrations, which if not exceeded, should cause no adverse effects to most ecological receptors exposed to the media. For surface water, average concentrations of COPECs that were identified during the data and media evaluations were compared against Ohio Administrative Code (OAC) water quality criteria (WQC) pursuant to OAC 3745-1 and an updated summary (per December 30, 2002) of criteria posted on the Ohio EPA website (http://www.epa.state.oh.us/dws/wqc/criteria.html). Each COPEC was considered separately. During the media screening, each COPEC was again considered in regards to whether it was a PBT compound. The soil and sediment ESVs, as well as the OAC WQC that were used for the media screening, are presented in Appendix Tables N-14 through N-16, respectively.

For the media screening, any inputted soil or sediment COPEC that was not a PBT compound and whose MDC did not exceed the ESV was not retained as a COPEC and was eliminated from further consideration in the Level II Screen. For surface water, any inputted COPEC that was not a PBT compound and whose average concentration did not exceed the OAC WQC was also eliminated from further consideration. If no COPECs were retained in any medium, that medium was eliminated from further ecological risk evaluation (Ohio EPA 2003). However, any inputted COPECs whose concentrations exceeded ESVs or OAC WQC, or that did not have ESVs or OAC WQC, and/or were PBT compounds, were retained as COPECs.

The sources and screening hierarchy of soil and sediment screening benchmarks were specified by Ohio EPA (2003) as follows.

Soil Screening Hierarchy

For soils, the MDC of each COPEC was compared to soil screening values. The hierarchy of sources of soil screening values, in order of preference, (Ohio EPA 2003) was as follows:

- Efroymson, R.A., G.W. Suter II, B.E. Sample, and D.S. Jones, 1997a. *Preliminary Remediation Goals for Ecological Endpoints.* ES/ER/TM-162/R2.

- Efroymson, R.A., M.E. Will, and G.W. Suter II, 1997b. *Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Soil and Litter Invertebrates and Heterotrophic Process: 1997 Revision*. ES/ER/TM-126/R2.

- Efroymson, R.A., M.E. Will, G.W. Suter II, and A.C. Wooten, 1997c. *Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Terrestrial Plants: 1997 Revision*. ES/ER/TM-85/R3.

- The fourth stated source is *Ecological Data Quality Levels (EDQL), U. S. EPA, Region 5, Final Technical Approach for Developing EDQLs for RCRA Appendix IX Constituents and Other Significant Contaminants of Concern, 1999* (EPA 1999). However, that reference has been superceded by *Region 5 Corrective Action, Ecological Screening Levels (2003)* (EPA 2003).

Sediment Screening Hierarchy

For sediments, the stream must have an Aquatic Life Habitat Use Designation. If there is full attainment of biological criteria for that designation, sediment is dismissed from further evaluation. If there is not full attainment of biological criteria, the MDCs of COPECs are to be compared to sediment screening values. The hierarchy for sediment screening values (Ohio EPA 2003), in order of preference, was as follows:

- Consensus-based threshold effects concentrations values (MacDonald, Ingersoll, and Berger 2000).
- *Ecological Data Quality Levels (EDQL), U. S. EPA, Region 5, Final Technical Approach for Developing EDQLs for RCRA Appendix IX Constituents and Other Significant Contaminants of Concern, 1999* (EPA 1999). However, this reference has been superceded by *Region 5 Corrective Action, Ecological Screening Levels (2003)* (EPA 2003).

Surface Water Hierarchy

For surface water, one uses the chemical criteria pursuant to OAC 3745-1 for the Erie Ontario Lake Plain ecoregion (Ohio EPA 2002). The guidance (Ohio EPA 2003) specifies that samples averaged over a 30-day period are to be compared to "outside mixing zone average" (OMZA) criteria for human health, aquatic life, and wildlife. Single ambient samples are not to exceed the "outside mixing zone maximum" (OMZM) criteria. Multiple water measurements were available for the Large Ponds and Small Basins (see Appendix Table N-4) so the OMZA WQC were used for the Level II Screen for those two locations. However, only a single water measurement was available for the Drainage Ditch, so the OMZM WQC were used for that location. In addition, biological criteria for the aquatic life habitat designation, warm-water habitat, pursuant to AOC 3745-1-07 for the Lake Erie basin ecoregion, must be met.

7.4 RESULTS AND DISCUSSION

This section presents the findings or results of the data/media evaluation and media screenings comparisons of various media concentrations (e.g., maximum or average concentrations) and various effects measurements (e.g., ESVs). These comparisons are done at each of the EUs and their applicable media to identify COPECs, as well as chemicals that can be eliminated from the Level II Screen. In addition, the results and discussion section contains the preliminary CSM, site-specific receptors, and other information pertaining to Level III.

7.4.1 Data/Media Evaluation Results

Tables showing the results of the data/media evaluation to initially identify COPECs for surface soil, subsurface soil, sediment, and surface water are presented in Appendix Tables N-6 through N-13. A summary of these results of the data/media evaluation screening is provided below.

Surface Soil. Forty-five detected COIs, including 23 inorganics (includes total and hexavalent chromium), 9 explosives, 1 pesticide, 8 SVOCs, and 4 VOCs were inputted to the data/media evaluation for the FBQ surface soil (Appendix Table N-6). One inorganic (silver) and two explosives (2,6-DNT and RDX) were eliminated from being COPECs due to a frequency of detection less than 5% and not being PBT compounds. In addition, aluminum was eliminated from being a COPEC due to its MDC being below site background and not being a PBT compound. Thus, 41 of the 45 detected COIs were deemed to be COPECs because they met one or more of the following criteria: they were PBT compounds and/or their frequency of detection exceeded 5%, and/or their MDC exceeded the background value (or there was not a reported background value). The COPECs were carried forward to the media screening step, which is discussed in Section 7.4.2.

Subsurface Soil. Twenty-seven detected COIs, including 22 inorganics (includes total and hexavalent chromium), 2 explosives, and 3 VOCs were inputted to the data/media evaluation for the FBQ subsurface soil (Appendix Table N-7). Six inorganic COIs were eliminated from being COPECs due to their MDC being less than background and not being a PBT compound. Thus, only 21 of the 27 detected COIs were deemed to be COPECs because they met one or more of the following criteria: they were PBT compounds and/or their frequency of detection exceeded 5%, and/or their MDC exceeded the background value (or there was not a reported background value). The COPECs were carried forward to the media screening step, which is discussed in Section 7.4.2.

Sediment. For the Large Ponds, 56 detected COIs, including 23 inorganics (includes total and hexavalent chromium), 7 explosives, 6 pesticides/PCBs, 15 SVOCs, and 5 VOCs were inputted to the data/media evaluation for sediment (Appendix Table N-8). Four inorganic COIs (aluminum, manganese, potassium, and vanadium) were eliminated from being COPECs because their MDCs did not exceed the Ohio EPA SRVs and they were not PBT compounds. Thus, 52 of the 56 inputted COIs for the Large Ponds sediment were deemed to be COPECs because they met one or more of the following criteria: they were PBT compounds and/or their frequency of detection exceeded 5%, and/or their MDC exceeded the SRV or background value (or there was not a reported SRV or background value). The COPECs were carried forward to the media screening, which is discussed in Section 7.4.2.

For the Drainage Ditch, 51 detected COIs, including 23 inorganics (includes total and hexavalent chromium), 4 explosives, 3 pesticides/PCBs, 17 SVOCs, and 4 VOCs were inputted to the data/media evaluation for sediment (Appendix Table N-9). Seven inorganic COIs (aluminum, calcium, chromium, magnesium, nickel, potassium, and vanadium) were eliminated from being COPECs because their MDCs did not exceed the Ohio EPA SRVs and they were not PBT compounds. Thus, 44 of the 51 inputted COIs for the Drainage Ditch sediment were deemed to be COPECs because they met one or more of the following criteria: they were PBT compounds and/or their frequency of detection exceeded 5%, and/or their MDC exceeded the SRV or background value (or there was not a reported SRV or background value). The COPECs were carried forward to the media screening, which is discussed in Section 7.4.2.

For the Small Basins, 51 detected COIs, including 21 inorganics (includes total and hexavalent chromium), 6 explosives, 10 pesticides/PCBs, 12 SVOCs, and 2 VOCs were inputted to the data/media evaluation for sediment (Appendix Table N-10). Six inorganic COIs [aluminum, arsenic, calcium, chromium (hexavalent), magnesium, and potassium] were eliminated from being COPECs because their MDCs did not exceed the Ohio EPA SRVs and they were not PBT compounds. Thus, 45 of the 51 inputted COIs for the Small Basins sediment were deemed to be COPECs because they met one or more of the following criteria: they were PBT compounds and/or their frequency of detection exceeded 5%, and/or their MDC exceeded the SRV or background value (or there was not a reported SRV or background value). The COPECs were carried forward to the media screening, which is discussed in Section 7.4.2.

Surface Water. For the Large Ponds, 12 detected COIs, including 9 inorganics, 1 explosive (nitrocellulose), 1 SVOC [bis(2-ethylhexyl)phthalate], and 1 VOC (methylene chloride) were inputted to the data/media evaluation for surface water (Appendix Table N-11). Six of the inorganic COIs (copper, iron, magnesium, manganese, potassium, and sodium) were eliminated from being COPECs because their MDCs did not exceed the site background concentration and they were not PBT compounds. Thus, 6 of the 12 inputted COIs for the Large Ponds surface water were deemed to be COPECs because they met one or more of the following criteria: they were PBT compounds and/or their frequency of detection exceeded 5%, and/or their MDC exceeded the background value (or there was not a reported background value). The COPECs were carried forward to the media screening, which is discussed in Section 7.4.2.

For the Drainage Ditch, 16 detected COIs, including 13 inorganics, 1 explosive (nitrocellulose), 1 SVOC [bis(2-ethylhexyl)phthalate], and 1 VOC (carbon disulfide) were inputted to the data/media evaluation for sediment (Appendix Table N-12). Six of the inorganic COIs (aluminum, calcium, copper, magnesium, potassium, and sodium) were eliminated from being COPECs because their MDCs did not exceed the site background concentration and they were not PBT compounds. Thus, 10 of the 16 inputted COIs for the Drainage Ditch surface water were deemed to be COPECs because they met one or more of the following criteria: they were PBT compounds and/or their frequency of detection exceeded 5%, and/or their MDC exceeded the background value (or there was not a reported background value). The COPECs were carried forward to the media screening, which is discussed in Section 7.4.2.

For the Small Basins, 29 detected COIs, including 18 inorganics (includes total and hexavalent chromium), 1 miscellaneous anion (perchlorate), 3 explosives, 3 SVOCs, and 4 VOCs were inputted to the data/media evaluation for sediment (Appendix Table N-13). Three of the inorganic COIs (calcium, magnesium, and sodium) were eliminated from being COPECs because their MDCs did not exceed the site background concentration and they were not PBT compounds. Thus, 26 of the 29 inputted COIs for the Small Basins surface water were deemed to be COPECs because they met one or more of the following criteria: they were PBT compounds and/or their frequency of detection exceeded 5%, and/or their MDC exceeded the background value (or there was not a reported background value). The COPECs were carried forward to the media screening, which is discussed in Section 7.4.2.

7.4.2 Media Screening Results

Tables providing the screening values and chemical criteria for these comparisons are found in Appendix Tables N-14 through N-16. Tables showing the results of the media screening for surface soil, subsurface soil, sediment, and surface water are presented in Appendix Tables N-17 through N-24, respectively. Summary results of the COIs eliminated during the data/media evaluation and media screening, as well as retained COPECs following the media screening are presented in Tables 7-3 through 7-18 and are discussed below.

7.4.2.1 Surface soil media screening

The media screening for surface soil is shown in Appendix Table N-17. A summary of surface soil COIs that were eliminated from the Level II Screen are presented in Table 7-3. COPECs that were retained following the media screening are presented in Table 7-4.

Forty-one COPECs were inputted into the media screening from the data/media evaluation, including 21 inorganics (chromium counted twice to include total and hexavalent), 7 explosives, 1 pesticide, 8 SVOCs, and 4 VOCs (Appendix Table N-17). Seven of the inputted COPECs were not retained because their maximum detects were below their ESVs and they were not PBT compounds (Table 7-3). The 7 eliminated COPECs included 1 inorganic (beryllium), two explosives (2,4-DNT and nitrobenzene), and all four VOCs (acetone, carbon disulfide, methylene chloride, and tetrachloroethene). Thus, 34 COPECs were retained, which included 20 inorganics, 1 pesticide, 5 explosives, and 8 SVOCs.

Of the 34 retained COPECs, 14 had maximum detects that exceeded their ESV and were not PBT compounds (12 inorganics and 2 explosives), 10 were COPECs solely due to being PBT compounds (one inorganic, one pesticide, and 8 SVOCs), and 7 had no ESVs, (4 inorganics and 3 explosives) (Table 7-4). Three of the retained COPECs (lead, mercury, and zinc) had maximum detects that exceeded the ESV and were also PBT compounds.

Table 7-3. Summary of Fuze and Booster Surface Soil (0 to 1 ft BGS) Chemicals Qualifying for Elimination From the Ecological Risk Assessment and the Rationale for Elimination

		Rationale for Elimination			
		Data/Media Evaluation			Media Screening
Surface Soil COI	CAS Registry Number	Elimination Because Frequency of Detection was < 5% and not a PBT Compound[a]	Elimination Because COI is a Common Laboratory Contaminant[a]	Elimination Because COI Concentration was Less Than Background and not a PBT Compound[a]	Elimination Because COI Maximum Detected Concentration Was < the ESV and not a PBT Compound[b]
Inorganics					
Aluminum	7429-90-5			X	
Antimony	7440-36-0				
Arsenic	7440-38-2				
Barium	7440-39-3				
Beryllium	7440-41-7				X
Cadmium	7440-43-9				
Calcium	7440-70-2				
Chromium	7440-47-3				
Chromium, hexavalent	18540-29-9				
Cobalt	7440-48-4				
Copper	7440-50-8				
Iron	7439-89-6				
Lead	7439-92-1				
Magnesium	7439-95-4				
Manganese	7439-96-5				
Mercury	7487-94-6				
Nickel	7440-02-0				
Potassium	7440-09-7				
Selenium	7782-49-2				
Silver	7440-22-4	X			
Sodium	7440-23-5				
Vanadium	7440-62-2				
Zinc	7440-66-6				
Organics-Explosives					
1,3,5-Trinitrobenzene	99-35-4				
2,4,6-Trinitrotoluene	118-96-7				
2,4-Dinitrotoluene	121-14-2				X
2,6-Dinitrotoluene	606-20-2	X			
2-Amino-4,6-Dinitrotoluene	35572-78-2				
4-Amino-2,6-Dinitrotoluene	19406-51-0				
Nitrobenzene	98-95-3				X
Nitrocellulose	9004-70-0				
RDX	121-82-4	X			
Organics-Pesticides/PCBs					
4,4'-DDE	72-55-9				
Organics-Semivolatiles					
Benzo(*a*)anthracene	56-55-3				
Benzo(*a*)pyrene	50-32-8				
Benzo(*b*)fluoranthene	205-99-2				
Benzo(*k*)fluoranthene	207-08-9				
Chrysene	218-01-9				
Di-n-buthylphthalate	84-74-2				
Fluoranthene	206-44-0				
Pyrene	129-00-0				

Table 7-3. Summary of Fuze and Booster Quarry Landfill/Ponds Surface Soil (0 to 1 ft BGS) Chemicals Qualifying for Elimination From the Ecological Risk Assessment and the Rationale for Elimination (continued)

		Rationale for Elimination			
		Data/Media Evaluation			Media Screening
Surface Soil COI	CAS Registry Number	Elimination Because Frequency of Detection was < 5% and not a PBT Compound[a]	Elimination Because COI is a Common Laboratory Contaminant[a]	Elimination Because COI Concentration was Less Than Background and not a PBT Compound[a]	Elimination Because COI Maximum Detected Concentration Was < the ESV and not a *PBT Compound*[b]
Organics-Volatiles					
Acetone	67-64-1				X
Carbon Disulfide	75-15-0				X
Methylene Chloride	75-09-2				X
Tetrachloroethene	127-48-4				X

[a]See Appendix Table N-6.
PBT = Persistent, bioaccumulative, and toxic compound (inorganics include cadmium, lead, mercury, and zinc; organics include Log Kow of at least 3.0).
[b]See Appendix Table N-17.
BGS = Below ground surface.
CAS = Chemical Abstract Service.
COI = Contaminant of interest.
ESV = Ecological screening value.
X = the chemical is justified for elimination because of this condition.

Table 7-4. Summary of Surface Soil (0 to 1 ft BGS) COPECs at Fuze and Booster Quarry Landfill/Ponds and the Rationale(s) Why They Are COPECs

Surface Soil COPECs After Media Screening	CAS Registry Number	Rationale for Selection[a]		
		Maximum Detect > ESV	PBT Compound	No ESV
Inorganics				
Antimony	7440-36-0	X		
Arsenic	7440-38-2	X		
Barium	7440-39-3	X		
Cadmium	7440-43-9		X	
Calcium	7440-70-2			X
Chromium	7440-47-3	X		
Chromium, hexavalent	18540-29-9	X		
Cobalt	7440-48-4	X		
Copper	7440-50-8	X		
Iron	7439-89-6	X		
Lead	7439-92-1	X	X	
Magnesium	7439-95-4			X
Manganese	7439-95-4	X		
Mercury	7439-97-6	X	X	
Nickel	7440-02-0	X		
Potassium	7440-09-7			X
Selenium	7782-49-2	X		
Sodium	7440-23-5			X
Vanadium	7440-62-2	X		
Zinc	7440-66-6	X	X	
Organics-Explosives				
1,3,5-Trinitrobenzene	99-35-4	X		
2,4,6-Trinitrotoluene	118-96-7	X		
2-Amino-4,6-Dinitrotoluene	35572-78-2			X
4-Amino-2,6-Dinitrotoluene	19406-51-0			X
Nitrocellulose	9004-70-4			X
Organics-Pesticides				
4,4'-DDE	72-55-9		X	
Organics-Semivolatiles				
Benzo(*a*)anthracene	56-55-3		X	
Benzo(*a*)pyrene	50-32-8		X	
Benzo(*b*)fluoranthene	205-99-2		X	
Benzo(*k*)fluoranthene	207-08-9		X	
Chrysene	218-01-9		X	
Di-n-buthylphthalate	84-74-2		X	
Fluoranthene	206-44-0		X	
Pyrene	129-00-0		X	

[a] See Appendix Table N-17.
BGS = Below ground surface.
CAS = Chemical Abstract Service.
COPEC = Chemical of potential ecological concern.
ESV = Ecological screening value.
PBT = Persistent, bioaccumulative, and toxic compound (inorganics include cadmium, lead, mercury, and zinc; organics include Log Kow of at least 3.0).
X = Chemical is a COPEC due to criterion in this column.

Table 7-5. Summary of Fuze and Booster Quarry Landfill/Ponds Subsurface Soil (1 to 3 ft BGS) Chemicals Qualifying for Elimination From the Ecological Risk Assessment and the Rationale for Elimination

		Rationale for Elimination			
		Data/Media Evaluation			Media Screening
Subsurface Soil COI	CAS Registry Number	Elimination Because Frequency of Detection was < 5% and not a PBT Compound[a]	Elimination Because COI is a Common Laboratory Contaminant[a]	Elimination Because COI Concentration was Less Than Background and not a PBT Compound[a]	Elimination Because COI Maximum Detected Concentration Was < the ESV and not a PBT Compound[b]
Inorganics					
Aluminum	7429-90-5				
Antimony	7440-36-0				X
Arsenic	7440-38-2				
Barium	7440-39-3				X
Beryllium	7440-41-7				X
Cadmium	7440-43-9				
Calcium	7440-70-2			X	
Chromium	7440-47-3				
Chromium, hexavalent	18540-29-9				
Cobalt	7440-48-4			X	
Copper	7440-50-8			X	
Iron	7439-89-6				
Lead	7439-92-1				
Magnesium	7439-95-4				
Manganese	7439-96-5			X	
Mercury	7487-94-6				
Nickel	7440-02-0			X	
Potassium	7440-09-7			X	
Selenium	7782-49-2				
Sodium	7440-23-5				
Vanadium	7440-62-2				
Zinc	7440-66-6				
Organics-Explosives					
Nitrobenzene	98-95-3				X
Nitrocellulose	9004-70-0				
Organics-Volatiles					
Carbon Disulfide	75-15-0				
Methylene Chloride	75-09-2				X
Trichloroethene	79-01-6				X

[a]See Appendix Table N-7.
[b]See Appendix Table N-18.
BGS = Below ground surface.
CAS = Chemical Abstract Service.
COI = Contaminant of interest.
ESV = Ecological screening value.
PBT = Persistent, bioaccumulative, and toxic compound (inorganics include cadmium, lead, mercury, and zinc; organics include Log Kow of at least 3.0).
X = Chemical is justified for elimination because of this condition.

Table 7-6. Summary of Subsurface Soil (1 to 3 ft BGS) COPECs at Fuze and Booster Quarry Landfill/Ponds, and the Rationale(s) Why They Are COPECs

Subsurface Soil COPECs After Media Screening	CAS Registry Number	Rationale for Selection[a]		
		Maximum Detect > ESV	PBT Compound	No ESV
Inorganics				
Aluminum	7429-90-5	X		
Arsenic	7440-38-2	X		
Cadmium	7440-43-9		X	
Chromium	7440-47-3	X		
Chromium, hexavalent	18540-29-9	X		
Iron	7439-89-6	X		
Lead	7439-92-1	X	X	
Magnesium	7439-95-4	X		X
Mercury	7439-97-6	X	X	
Selenium	7782-49-2	X		
Sodium	7440-23-5			X
Vanadium	7440-62-2	X		
Zinc	7440-66-6	X	X	
Organics-Explosives				
Nitrocellulose	9004-70-4			X
Organics-Volatiles				
Carbon Disulfide	75-15-0	X		

[a] See Appendix Table N-18.
BGS = Below ground surface.
CAS = Chemical Abstract Service.
COPEC = Chemical of potential ecological concern.
ESV = Ecological screening value.
PBT = Persistent, bioaccumulative, and toxic compound (inorganics include cadmium, lead, mercury, and zinc; organics include Log Kow of at least 3.0).
X = Chemical is a COPEC due to criterion in this column.

Table 7-7. Summary of Fuze and Booster Large Quarry Landfill/Ponds Sediment Chemicals Qualifying for Elimination From the Ecological Risk Assessment and the Rationale for Elimination

		Rationale for Elimination			
		Data/Media Evaluation			Media Screening
Sediment COI	CAS Registry Number	Elimination Because Frequency of Detection was < 5% and not a PBT Compound[a]	Elimination Because COI is a Common Laboratory Contaminant[a]	Elimination Because COI Concentration was Less Than SRV or Background and not a PBT Compound[a]	Elimination Because COI Maximum Detected Concentration Was < the ESV and not a PBT Compound[b]
Inorganics					
Aluminum	7429-90-5			X	
Antimony	7440-36-0				
Arsenic	7440-38-2				
Barium	7440-39-3				
Beryllium	7440-41-7				
Cadmium	7440-43-9				
Calcium	7440-70-2				
Chromium	7440-47-3				
Chromium, hexavalent	18540-29-9				X
Cobalt	7440-48-4				X
Copper	7440-50-8				
Iron	7439-89-6				
Lead	7439-92-1				
Magnesium	7439-95-4				
Manganese	7439-96-5			X	
Mercury	7487-94-6				
Nickel	7440-02-0				
Selenium	7782492				
Silver	7440-22-4				
Sodium	7440-23-5				
Vanadium	7440-62-2			X	
Zinc	7440-66-6				
Organics-Explosives					
2,4,6-Trinitrotoluene	118-96-7				
2-Amino-4,6-Dinitrotoluene	35572-78-2				
4-Amino-2,6-Dinitrotoluene	19406-51-0				
HMX	2691-41-0				
Nitrobenzene	98-95-3				X
Nitrocellulose	9004-70-0				
Nitroglycerin	55-63-0				
Organics-Pesticides/PCBs					
4,4'-DDD	72-54-8				
4,4'-DDE	72-55-9				
Dieldrin	60-57-1				
Endrin	72-20-8				
Endrin aldehyde	7421-93-4				
Methoxychlor	72-43-5				
Organics-Semivolatiles					
2-Methylnaphthalene	91-57-6				
Anthracene	120-12-7				

Table 7-7. Summary of Fuze and Booster Large Quarry Landfill/Ponds Sediment Chemicals Qualifying for Elimination From the Ecological Risk Assessment and the Rationale for Elimination (continued)

		Rationale for Elimination			
		Data/Media Evaluation			Media Screening
Sediment COI	CAS Registry Number	Elimination Because Frequency of Detection was < 5% and not a PBT Compound[a]	Elimination Because COI is a Common Laboratory Contaminant[a]	Elimination Because COI Concentration was Less Than SRV or Background and not a PBT Compound[a]	Elimination Because COI Maximum Detected Concentration Was < the ESV and not a PBT Compound[b]
Benzo(*a*)anthracene	56-55-3				
Benzo(*a*)pyrene	50-32-8				
Benzo(*b*)fluoranthene	205-99-2				
Benzo(*ghi*)perylene	191-24-2				
Benzo(*k*)fluoranthene	207-08-9				
Bis(2-ethylhexyl)phthalate	117-81-7				
Carbazole	86-74-8				
Chrysene	218-01-9				
Fluoranthene	206-44-0				
Indeno(1,2,3-*cd*)pyrene	193-39-5				
Naphthalene	91-20-3				
Phenanthrene	85-01-8				
Pyrene	129-00-0				
Organics-Volatiles					
2-Butanone	78-93-3				
Acetone	67-64-1				
Carbon Disulfide	75-15-0				X
Methylene Chloride	75-09-2				X
Toluene	108-88-3				X

[a]See Appendix Table N-8.
[b]See Appendix Table N-19.
CAS = Chemical Abstract Service.
COI = Contaminant of interest.
ESV = Ecological screening value.
PBT = persistent, bioaccumulative, and toxic compound (inorganics include cadmium, lead, mercury, and zinc; organics include Log Kow of at least 3.0).
PCB = Polychlorinated biphenyl.
SRV = Sediment reference value (Ohio EPA 2003).
X = Chemical is justified for elimination because of this condition.

Table 7-8. Summary of Sediment COPECs at Large Ponds at Fuze and Booster Quarry Landfill/Ponds and the Rationale(s) Why They Are COPECs

Sediment COPECs After Media Screening	CAS Registry Number	Rationale for Selection[a]		
		Maximum Detect > ESV	PBT Compound	No ESV
Inorganics				
Antimony	7440-36-0			X
Arsenic	7440-38-2	X		
Barium	7440-39-3			X
Beryllium	7440-41-7			X
Cadmium	7440-43-9	X	X	
Calcium	7440-70-2			X
Chromium	7440-47-3	X		
Copper	7440-50-8	X		
Iron	7439-89-6			X
Lead	7439-92-1	X	X	
Magnesium	7439-95-4			X
Mercury	7439-97-6	X	X	
Nickel	7440-02-0	X		
Selenium	7782-49-2			X
Silver	7440-22-4	X		
Sodium	7440-23-5			X
Zinc	7440-66-6	X	X	
Organics-Explosives				
2,4,6-Trinitrotoluene	118-96-7			X
2-Amino-4,6-Dinitrotoluene	35572-78-2			X
4-Amino-2,6-Dinitrotoluene	19406-51-0			X
HMX	2691-41-0			X
Nitrocellulose	9004-70-4			X
Nitroglycerin	55-63-0			X
Organics-Pesticides				
4,4'-DDD	72-45-8		X	
4,4'-DDE	72-55-9		X	
Dieldrin	60-57-1		X	
Endrin	72-20-8		X	
Endrin aldehyde	7421-93-4		X	
Methoxychlor	72-43-5		X	
Organics-Semivolatiles				
2-Methylnaphthalene	91-57-6	X		
Anthracene	120-12-7	X	X	
Benzo(*a*)anthracene	56-55-3	X	X	
Benzo(*a*)pyrene	50-32-8	X	X	
Benzo(*b*)fluoranthene	205-99-2		X	
Benzo(*ghi*)perylene	191-24-2	X	X	
Benzo(*k*)fluoranthene	207-08-9	X	X	
Bis(2-ethylhexyl)phthalate	117-81-7		X	
Carbazole	86-74-8		X	X
Chrysene	218-01-9	X	X	
Fluoranthene	206-44-0	X	X	
Indeno(1,2,3-*cd*)pyrene	193-39-5	X	X	

Table 7-8. Summary of Sediment COPECs at Large Ponds at Fuze and Booster Quarry Landfill/Ponds and the Rationale(s) Why They Are COPECs (continued)

Sediment COPECs After Media Screening	CAS Registry Number	Rationale for Selection[a]		
		Maximum Detect > ESV	PBT Compound	No ESV
Naphthalene	91-20-3	X	X	
Phenanthrene	85-01-8	X	X	
Pyrene	129-00-0	X	X	
Organics-Volatiles				
2-Butanone	78-93-3	X		
Acetone	67-64-1	X		

[a]See Appendix Table N-19.
CAS = Chemical Abstract Service.
COPEC = Chemical of potential ecological concern.
ESV = Ecological screening value.
PBT = Persistent, bioaccumulative, and toxic compound (inorganics include cadmium, lead, mercury, and zinc; organics include Log Kow of at least 3.0).
X = Chemical is a COPEC per meeting criteria in this category.

Table 7-9. Summary of Fuze and Booster Quarry Landfill/Ponds Drainage Ditch Sediment Chemicals Qualifying for Elimination From the Ecological Risk Assessment and the Rationale for Elimination

		Rationale for Elimination			
		Data/Media Evaluation			Media Screening
Sediment COI	CAS Registry Number	Elimination Because Frequency of Detection was < 5% and not a PBT Compound[a]	Elimination Because COI is a Common Laboratory Contaminant[a]	Elimination Because COI Concentration was Less Than SRV or Background and not a PBT Compound[a]	Elimination Because COI Maximum Detected Concentration Was < the ESV and not a PBT Compound[b]
Inorganics					
Aluminum	7429-90-5			X	
Antimony	7440-36-0				
Arsenic	7440-38-2				
Barium	7440-39-3				
Beryllium	7440-41-7				
Cadmium	7440-43-9				
Calcium	7440-70-2			X	
Chromium	7440-47-3			X	
Chromium, hexavalent	18540-29-9				X
Cobalt	7440-48-4				X
Copper	7440-50-8				
Iron	7439-89-6				
Lead	7439-92-1				
Magnesium	7439-95-4			X	
Manganese	7439-96-5				
Mercury	7487-94-6				
Nickel	7440-02-0			X	
Selenium	7782492				
Silver	7440-22-4				
Sodium	7440-23-5				
Vanadium	7440-62-2			X	
Zinc	7440-66-6				
Organics-Explosives					
2,4,6-Trinitrotoluene	118-96-7				
3-Nitrotoluene	99-08-1				
Nitrobenzene	98-95-3				X
Nitrocellulose	9004-70-0				
Organics-Pesticides/PCBs					
4,4'-DDD	72-54-8				
4,4'-DDE	72-55-9				
Methoxychlor	72-43-5				
Organics-Semivolatiles					
2-Methylnaphthalene	91-57-6				
Acenaphthylene	208-96-8				
Anthracene	120-12-7				
Benzo(*a*)anthracene	56-55-3				
Benzo(*a*)pyrene	50-32-8				
Benzo(*b*)fluoranthene	205-99-2				
Benzo(*ghi*)perylene	191-24-2				

Table 7-9. Summary of Fuze and Booster Quarry Landfill/Ponds Drainage Ditch Sediment Chemicals Qualifying for Elimination From the Ecological Risk Assessment and the Rationale for Elimination (continued)

		Rationale for Elimination			
		Data/Media Evaluation			Media Screening
Sediment COI	CAS Registry Number	Elimination Because Frequency of Detection was < 5% and not a PBT Compound[a]	Elimination Because COI is a Common Laboratory Contaminant[a]	Elimination Because COI Concentration was Less Than SRV or Background and not a PBT Compound[a]	Elimination Because COI Maximum Detected Concentration Was < the ESV and not a PBT Compound[b]
Benzo(*k*)fluoranthene	207-08-9				
Carbazole	86-74-8				
Chrysene	218-01-9				
Dibenzofuran	132-64-9				
Fluoranthene	206-44-0				
Fluorene	86-73-7				
Indeno(1,2,3-*cd*)pyrene	193-39-5				
Naphthalene	91-20-3				
Phenanthrene	85-01-8				
Pyrene	129-00-0				
Organics-Volatiles					
2-Butanone	78-93-3				X
Carbon Disulfide	75-15-0				X
Toluene	108-88-3				X
Trichloroethene	79-01-6				X

[a]See Appendix Table N-9.
[b]See Appendix Table N-20.
CAS = Chemical Abstract Service.
COI = Contaminant of interest.
ESV = Ecological screening value.
PBT = Persistent, bioaccumulative, and toxic compound (inorganics include cadmium, lead, mercury, and zinc; organics include Log Kow of at least 3.0).
PCB = Polychlorinated biphenyl.
SRV = Sediment reference value (Ohio EPA 2003).
X = Chemical is justified for elimination because of this condition.

Table 7-10. Summary of Sediment COPECs at the Drainage Ditch at Fuze and Booster Quarry Landfill/Ponds and the Rationale(s) Why They Are COPECs

Sediment COPECs After Media Screening	CAS Registry Number	Rationale for Selection[a]		
		Maximum Detect > ESV	PBT Compound	No ESV
Inorganics				
Antimony	7440-36-0			X
Arsenic	7440-38-2	X		
Barium	7440-39-3			X
Beryllium	7440-41-7			X
Cadmium	7440-43-9	X	X	
Copper	7440-50-8	X		
Iron	7439-89-6			X
Lead	7439-92-1	X	X	
Manganese	7439-96-5			X
Mercury	7439-97-6	X	X	
Selenium	7782-49-2			X
Silver	7440-22-4	X		
Sodium	7440-23-5			X
Zinc	7440-66-6	X	X	
Organics-Explosives				
2,4,6-Trinitrotoluene	118-96-7			X
3-Nitrotoluene	99-08-1			X
Nitrocellulose	9004-70-4			X
Organics-Pesticides				
4,4'-DDD	72-45-8	X	X	
4,4'-DDE	72-55-9		X	
Methoxychlor	72-43-5		X	
Organics-Semivolatiles				
2-Methylnaphthalene	91-57-6	X		
Acenaphthylene	208-96-8	X	X	
Anthracene	120-12-7	X	X	
Benzo(*a*)anthracene	56-55-3	X	X	
Benzo(*a*)pyrene	50-32-8	X	X	
Benzo(*b*)fluoranthene	205-99-2		X	
Benzo(*ghi*)perylene	191-24-2	X	X	
Benzo(*k*)fluoranthene	207-08-9	X	X	
Carbazole	86-74-8		X	X
Chrysene	218-01-9	X	X	
Dibenzofuran	132-64-9		X	
Fluoranthene	206-44-0	X	X	
Fluorene	86-73-7	X	X	
Indeno(1,2,3-*cd*)pyrene	193-39-5	X	X	
Naphthalene	91-20-3	X	X	
Phenanthrene	85-01-8	X	X	
Pyrene	129-00-0	X	X	

[a]See Appendix Table N-20.
CAS = Chemical Abstract Service.
COPEC = Chemical of potential ecological concern.
ESV = Ecological screening value.
PBT = Persistent, bioaccumulative, and toxic compound (inorganics include cadmium, lead, mercury, and zinc; organics include Log Kow of at least 3.0).
X = Chemical is a COPEC per meeting criteria in this category.

Table 7-11. Summary of Fuze and Booster Quarry Landfill/Ponds Small Basins Sediment Chemicals Qualifying for Elimination From the Ecological Risk Assessment and the Rationale for Elimination

Sediment COI	CAS Registry Number	Rationale for Elimination			
		Data/Media Evaluation			Media Screening
		Elimination Because Frequency of Detection was < 5% and not a PBT Compound[a]	Elimination Because COI is a Common Laboratory Contaminant[a]	Elimination Because COI Concentration was Less Than SRV or Background and not a PBT Compound[a]	Elimination Because COI Maximum Detected Concentration Was < the ESV and not a PBT Compound[b]
Inorganics					
Aluminum	7429-90-5			X	
Arsenic	7440-38-2			X	
Barium	7440-39-3				
Beryllium	7440-41-7				
Cadmium	7440-43-9				
Calcium	7440-70-2			X	
Chromium	7440-47-3				
Chromium, hexavalent	18540-29-9			X	
Cobalt	7440-48-4				X
Copper	7440-50-8				
Iron	7439-89-6				
Lead	7439-92-1				
Magnesium	7439-95-4			X	
Manganese	7439-96-5				
Mercury	7487-94-6				
Nickel	7440-02-0				
Potassium	7440-09-7			X	
Selenium	7782492				
Sodium	7440-23-5				
Vanadium	7440-62-2				
Zinc	7440-66-6				
Organics-Explosives					
1,3,5-Trinitrobenzene	99-35-4				
1,3-Dinitrobenzene	99-65-0				
2,6-Dinitrotoluene	606-20-2				
3-Nitrotoluene	99-08-1				
HMX	2691-41-0				
Nitrocellulose	9004-70-0				
Organics-Pesticides/PCBs					
4,4'-DDD	72-54-8				
4,4'-DDE	72-55-9				
4,4'-DDT	50-29-3				
Dieldrin	60-57-1				
Endosulfan I	959-98-8				
Endrin	72-20-8				
Heptachlor epoxide	1024-57-3				
Lindane	58-89-9				
Methoxychlor	72-43-5				
beta-BHC	319-85-7				

Table 7-11. Summary of Fuze and Booster Quarry Landfill/Ponds Small Basins Sediment Chemicals Qualifying for Elimination From the Ecological Risk Assessment and the Rationale for Elimination (continued)

Sediment COI	CAS Registry Number	Rationale for Elimination			
		Data/Media Evaluation			Media Screening
		Elimination Because Frequency of Detection was < 5% and not a PBT Compound[a]	Elimination Because COI is a Common Laboratory Contaminant[a]	Elimination Because COI Concentration was Less Than SRV or Background and not a PBT Compound[a]	Elimination Because COI Maximum Detected Concentration Was < the ESV and not a PBT Compound[b]
Organics-Semivolatiles					
2-Methylnaphthalene	91-57-6				
4-Methylphenol	91-57-6				
Benzo(*a*)anthracene	56-55-3				
Benzo(*a*)pyrene	50-32-8				
Benzo(*b*)fluoranthene	205-99-2				
Bis(2-ethylhexyl)phthalate	117-81-7				
Chrysene	218-01-9				
Fluoranthene	206-44-0				
Indeno(1,2,3-*cd*)pyrene	193-39-5				
Naphthalene	91-20-3				
Phenanthrene	85-01-8				
Pyrene	129-00-0				
Organics-Volatiles					
Acetone	67-64-1				
Toluene	108-88-3				X

[a]See Appendix Table N-10.
[b]See Appendix Table N-24.
CAS = Chemical Abstract Service.
COI = Contaminant of interest.
ESV = Ecological screening value.
PBT = Persistent, bioaccumulative, and toxic compound (inorganics include cadmium, lead, mercury, and zinc; organics include Log Kow of at least 3.0).
PCB = Polychlorinated biphenyl.
SRV = Sediment reference value (Ohio EPA 2003).
X = Chemical is justified for elimination because of this condition.

Table 7-12. Summary of Sediment COPECs at Small Basins at Fuze and Booster Quarry Landfill/Ponds and the Rationale(s) Why They Are COPECs

Sediment COPECs After Media Screening	CAS Registry Number	Rationale for Selection[a]		
		Maximum Detect > ESV	PBT Compound	No ESV
Inorganics				
Barium	7440-39-3			X
Beryllium	7440-41-7			X
Cadmium	7440-43-9		X	
Chromium	7440-47-3	X		
Copper	7440-50-8	X		
Iron	7439-89-6			X
Lead	7439-92-1	X	X	
Manganese	7439-95-4			X
Mercury	7439-97-6	X	X	
Nickel	7440-02-0	X		
Selenium	7782-49-2			X
Sodium	7440-23-5			X
Vanadium	7440-62-2			X
Zinc	7440-66-6	X	X	
Organics-Explosives				
1,3,5--Trinitrobenzene	99-35-4			X
1,3-Dinitrobenzene	99-65-3	X		
2,6-Dinitrotoluene	606-20-2	X		
3-Nitrotoluene	99-08-1			X
HMX	2691-41-0			X
Nitrocellulose	9004-70-4			X
Organics-Pesticides				
4,4'-DDD	72-45-8		X	
4,4'-DDE	72-55-9		X	
4,4'-DDT	50-29-3		X	
Dieldrin	60-57-1		X	
Endosulfan I	959-98-9		X	
Heptachlor epoxide	1024-57-3		X	
Lindane	58-89-9		X	
Methoxychlor	72-43-5		X	
beta-BHC	319-85-7		X	
Organics-Semivolatiles				
2-Methylnaphthalene	91-57-6	X		
4-Methylphenol	106-44-5			X
Benzo(*a*)anthracene	56-55-3	X	X	
Benzo(*a*)pyrene	50-32-8		X	
Benzo(*b*)fluoranthene	205-99-2		X	
Bis(2-ethylhexyl)phthalate	117-81-7		X	
Chrysene	218-01-9		X	
Fluoranthene	206-44-0		X	
Indeno(1,2,3-*cd*)pyrene	193-39-5		X	
Naphthalene	91-20-3		X	

Table 7-12. Summary of Sediment COPECs at Small Basins at Fuze and Booster Quarry Landfill/Ponds and the Rationale(s) Why They Are COPECs (continued)

Sediment COPECs After Media Screening	CAS Registry Number	Rationale for Selection[a]		
		Maximum Detect > ESV	PBT Compound	No ESV
Phenanthrene	85-01-8		X	
Pyrene	129-00-0	X	X	
Organics-Volatiles				
Acetone	67-64-1	X		

[a]See Appendix Table N-21.
CAS = Chemical Abstract Service.
COPEC = Chemical of potential ecological concern.
ESV = Ecological screening value.
PBT = Persistent, bioaccumulative, and toxic compound (inorganics include cadmium, lead, mercury, and zinc; organics include Log Kow of at least 3.0).
X = Chemical is a COPEC per meeting criteria in this category.

Table 7-13. Summary of Fuze and Booster Quarry Landfill/Ponds Large Ponds Surface Water Chemicals Qualifying for Elimination From the Ecological Risk Assessment and the Rationale for Elimination

		Rationale for Elimination			
		Data/Media Evaluation			Media Screening
Surface Water COI	CAS Registry Number	Elimination Because Frequency of Detection was < 5% and not a PBT Compound[a]	Elimination Because COI is a Common Laboratory Contaminant[a]	Elimination Because COI Concentration was Less Than Background and not a PBT Compound[a]	Elimination Because COI Average Detected Concentration Was < the OAC WQC and was not a PBT Compound[b]
Inorganics					
Barium	7440-39-3				X
Calcium	7440-70-2				
Copper	7440-50-8			X	
Iron	7439-89-6			X	
Magnesium	7439-95-4			X	
Manganese	7439-96-5			X	
Potassium	7440-09-7			X	
Sodium	7440-23-5			X	
Zinc	7440-66-6				
Organics-Explosives					
Nitrocellulose	9004-70-0				
Organics-Semivolatiles					
Bis(2-ethylhexyl)phthalate	117-81-7				
Organics-Volatiles					
Methylene Chloride	75-09-2				X

[a]See Appendix Table N-11.
[b](See Appendix Table N-22).
CAS = Chemical Abstract Service.
COI = Contaminant of interest.
OAC = Ohio Administrative Code [For Lake Erie Basin in Chapters 3745-1 and 3745-2, Ohio EPA, Division of Surface Water]
PBT = Persistent, bioaccumulative, and toxic compound (inorganics include cadmium, lead, mercury, and zinc; organics include Log Kow of at least 3.0).
WQC = Water quality criteria, Outside Mixing Zone Average because multiple water measurements were available.
X = Chemical is justified for elimination because of this condition.

Table 7-14. Summary of Surface Water COPECs at Large Ponds at Fuze and Booster Quarry, Ravenna, and the Rationale(s) Why They Are COPECs

Surface Water COPECs After Media Screening	CAS Registry Number	Rationale for Selection[a]		
		Average Detect > OAC WQC	PBT Compound	No OAC WQC
Inorganics				
Calcium	7440-70-2			X
Zinc	7440-66-6		X	
Organics-Explosives				
Nitrocellulose	9004-70-4			X
Organics-Semivolatiles				
Bis(2-ethylhexyl)phthalate	117-81-7		X	

[a]See Appendix Table N-22.
CAS = Chemical Abstract Service.
COPEC = Chemical of potential ecological concern.
OAC = Ohio Administrative Code (For Lake Erie Basin in Chapters 3745-1 and 3745-2, Ohio EPA, Division of Surface Water).
PBT = Persistent, bioaccumulative, and toxic compound (inorganics include cadmium, lead, mercury, and zinc; organics include Log Kow of at least 3.0).
WQC = Water quality criteria, Outside Mixing Zone Average because multiple water measurements were available.
X = Chemical is a COPEC per meeting criteria in this category.

Table 7-15. Summary of Fuze and Booster Quarry Landfill/Ponds Drainage Ditch Surface Water Chemicals Qualifying for Elimination From the Ecological Risk Assessment and the Rationale for Elimination

		Rationale for Elimination			
		Data/Media Evaluation			Media Screening
Surface Water COI	**CAS Registry Number**	**Elimination Because Frequency of Detection was < 5% and not a PBT Compound[a]**	**Elimination Because COI is a Common Laboratory Contaminant[a]**	**Elimination Because COI Concentration was Less Than Background and not a PBT Compound[a]**	**Elimination Because COI Average Detected Concentration Was < the OAC WQC and was not a PBT Compound[b]**
Inorganics					
Aluminum	7429-90-5			X	
Barium	7440-39-3				X
Calcium	7440-70-2			X	
Chromium	7440-47-3				X
Cobalt	7440-48-4				X
Copper	7440-50-8			X	
Iron	7439-89-6				
Magnesium	7439-95-4			X	
Manganese	7439-96-5				
Potassium	7440-09-7			X	
Sodium	7440-23-5			X	
Vanadium	7440-62-2				X
Zinc	7440-66-6				
Organics-Explosives					
Nitrocellulose	9004-70-0				
Organics-Semivolatiles					
Bis(2-ethylhexyl)phthalate	117-81-7				
Organics-Volatiles					
Carbon Disulfide	75-15-0				X

[a]See Appendix Table N-12.
[b]See Appendix Table N-23.
CAS = Chemical Abstract Service.
COI = Contaminant of interest.
OAC = Ohio Administrative Code (For Lake Erie Basin in Chapters 3745-1 and 3745-2, Ohio EPA, Division of Surface Water).
PBT = Persistent, bioaccumulative, and toxic compound (inorganics include cadmium, lead, mercury, and zinc; organics include Log Kow of at least 3.0).
WQC = Water quality criteria, Outside Mixing Zone Maximum because only a single water measurement was available.
X = Chemical is justified for elimination because of this condition.

Table 7-16. Summary of Surface Water COPECs at Drainage Ditch at Fuze and Booster Quarry Landfill/Ponds and the Rationale(s) Why They Are COPECs

Surface Water COPECs After Media Screening	CAS Registry Number	Rationale for Selection[a]		
		Average detect > OAC WQC	PBT Compound	No OAC WQC
Inorganics				
Barium	7440-39-3	X		
Iron	7439-89-6			X
Manganese	7439-95-4			X
Zinc	7440-66-6		X	
Organics-Explosives				
Nitrocellulose	9004-70-4			X
Organics-Semivolatiles				
Bis(2-ethylhexyl)phthalate	117-81-7		X	

[a]See Appendix Table N-23
CAS = Chemical Abstract Service.
COPEC = Chemical of potential ecological concern.
OAC = Ohio Administrative Code (For Lake Erie Basin in Chapters 3745-1 and 3745-2, Ohio EPA, Division of Surface Water).
PBT = Persistent, bioaccumulative, and toxic compound (inorganics include cadmium, lead, mercury, and zinc; organics include Log Kow of at least 3.0).
WQC = Water quality criteria, Outside Mixing Zone Maximum because only a single water measurement was available.
X = Chemical is a COPEC per meeting criteria in this category.

Table 7-17. Summary of Fuze and Booster Quarry Landfill/Ponds Small Basins Surface Water Chemicals Qualifying for Elimination From the Ecological Risk Assessment and the Rationale for Elimination

Surface Water COI	CAS Registry Number	Rationale for Elimination			
		Data/Media Evaluation			Media Screening
		Elimination Because Frequency of Detection was < 5% and not a PBT Compound[a]	Elimination Because COI is a Common Laboratory Contaminant[a]	Elimination Because COI Concentration was Less Than Background and not a PBT Compound[a]	Elimination Because COI Average Detected Concentration Was < the OAC WQC and was not a PBT Compound[b]
Inorganics					
Aluminum	7429-90-5				
Arsenic	7440-38-2				
Barium	7440-39-3				
Beryllium	7440-41-7				
Calcium	7440-70-2			X	
Chromium	7440-47-3				
Chromium, hexavalent	18540-29-9				
Cobalt	7440-48-4				
Copper	7440-50-8				
Iron	7439-89-6				
Lead	7439-92-1				
Magnesium	7439-95-4			X	
Manganese	7439-96-5				
Nickel	7440-02-0				
Potassium	7440-09-7				
Sodium	7440-23-5			X	
Vanadium	7440-62-2				
Zinc	7440-66-6				
Anions-Miscellaneous					
Perchlorate	7601-90-3				
Organics-Explosives					
2-Amino-4,6-Dinitrotoluene	35572-78-2				X
4-Amino-2,6-Dinitrotoluene	19406-51-0				X
Nitrocellulose	9004-70-0				
Organics-Semivolatiles					
4-Methylphenol	91-57-6				X
Bis(2-ethylhexyl)phthalate	117-81-7				
Phenol	108-95-2				X
Organics-Volatiles					
2-Butanone	78-93-3				X
Carbon Disulfide	75-15-0				X
Styrene	100-42-5				X
Toluene	108-88-3				X

[a]See Appendix Table N-13.
[b]See Appendix Table N-24.
CAS = Chemical Abstract Service.
COI = Contaminant of interest.
OAC = Ohio Administrative Code (For Lake Erie Basin in Chapters 3745-1 and 3745-2, Ohio EPA, Division of Surface Water).
PBT = Persistent, bioaccumulative, and toxic compound (inorganics include cadmium, lead, mercury, and zinc; organics include Log Kow of at least 3.0).
WQC = Water quality criteria, Outside Mixing Zone Average because multiple water measurements were available.
X = Chemical is justified for elimination because of this condition.

Table 7-18. Summary of Surface Water COPECs at Small Basins at Fuze and Booster Quarry Landfill/Ponds and the Rationale(s) Why They Are COPECs

Surface Water COPECs After Media Screening	CAS Registry Number	Rationale for Selection[a]		
		Average Detect > OAC WQC	PBT Compound	No OAC WQC
Inorganics				
Aluminum	7429-90-2			X
Chromium, hexavalent	18540-29-9	X		
Iron	7439-89-6			X
Lead	7439-92-1		X	
Manganese	7439-96-5			X
Potassium	7440-09-7			X
Zinc	7440-66-6		X	
Anions-Miscellaneous				
Perchlorate	7601-90-3			X
Organics-Explosives				
Nitrocellulose	9004-70-4			X
Organics-Semivolatiles				
Bis(2-ethylhexyl)phthalate	117-81-7		X	

[a]See Appendix Table N-24.
CAS = Chemical Abstract Service.
COPEC = Chemical of potential ecological concern.
OAC = Ohio Administrative Code (For Lake Erie Basin in Chapters 3745-1 and 3745-2, Ohio EPA, Division of Surface Water).
PBT = Persistent, bioaccumulative, and toxic compound (inorganics include cadmium, lead, mercury, and zinc; organics include Log Kow of at least 3.0).
WQC = Water quality criteria, Outside Mixing Zone Average because multiple water measurements were available.
X = Chemical is a COPEC per meeting criteria in this category.

7.4.2.2 Subsurface soil media screening

The media screening for subsurface soil is shown in Appendix Table N-18. A summary of subsurface soil COIs that were eliminated from the Level II Screen is presented in Table 7-5. COPECs that were retained following the media screening are presented in Table 7-6.

Twenty-one COPECs were inputted into the media screening from the data/media evaluation, including 16 inorganics (chromium counted twice to include total and hexavalent), 2 explosives, and 3 VOCs (Appendix Table N-18). Six of the inputted COPECs (including three inorganics, one explosive, and two VOCs) were eliminated from the Level II Screen because their maximum detects were below their ESVs and they were not PBT compounds (Table 7-5). The six eliminated COPECs included antimony, barium, beryllium, nitrobenzene, methylene chloride, and TCE). Thus, 15 COPECs were retained, which included 13 inorganics, 1 explosive, and 1 VOC.

Of the 15 retained COPECs, 8 had maximum detects that exceeded their ESV and were not PBT compounds (7 inorganics and 1 explosive), one inorganic was a COPEC solely due to being a PBT compound, and 3 had no ESVs (magnesium, sodium, and nitrocellulose) (Table 7-6). Three of the retained COPECs (lead, mercury, and zinc) had maximum detects that exceeded the ESV and were also PBT compounds.

7.4.2.3 Sediment media screening

Large Ponds. The media screening for the Large Ponds sediment is shown in Appendix Table N-19. A summary of sediment COIs eliminated from the Level II Screen is presented in Table 7-19. COPECs that were retained following the media screening are presented in Table 7-8.

Fifty-two sediment COPECs were inputted into the media screening from the data/media evaluation, including 19 inorganics (chromium counted twice to include total and hexavalent), 7 explosives, 6 pesticides/PCBs, 15 SVOCs, and 5 VOCs (Appendix Table N-19). Six of the inputted COPECs were eliminated from the Level II Screen because their maximum detects were below their ESVs and they were not PBT compounds (Table 7-19). The six eliminated COPECs included two inorganics (hexavalent chromium and cobalt), one explosive (nitrobenzene), and three VOCs (carbon disulfide, methylene chloride, and toluene). Thus, 46 COPECs were retained, which included 17 inorganics, 6 explosives, 6 pesticides/PCBs, 15 SVOCs, and 2 VOCs.

Of the 46 retained COPECs, 8 had maximum detects 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) (Table 7-8). Fifteen of the retained COPECs (cadmium, lead, mercury, zinc, and 11 SVOCs) had maximum detects 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.

Drainage Ditch. The media screening for the Drainage Ditch sediment is shown in Appendix Table N-20. A summary of sediment COIs eliminated from the Level II Screen is presented in Table 7-9. COPECs that were retained following the media screening are presented in Table 7-10.

Forty-four sediment COPECs were inputted into the media screening from the data/media evaluation, including 16 inorganics, 4 explosives, 3 pesticides/PCBs, 17 SVOCs, and 4 VOCs (Appendix Table N-20). Seven of the inputted COPECs were eliminated from the Level II Screen because their maximum detects were below their ESVs and they were not PBT compounds (Table 7-9). The 7 eliminated COPECs included

Table 7-19. Management Goals, Ecological Assessment Endpoints, Measures of Effect, and Decision Rules Identified for Fuze and Booster Quarry Landfill/Ponds During the Level II Screening

Management Goals	Assessment Endpoint	Measures of Effect	Decision Rule
Management Goal 1: The protection of terrestrial populations, communities, and ecosystems	Assessment Endpoint 1: Growth, survival, and reproduction of plant and soil invertebrate communities Receptors: plants and earthworms	Measures of Effect 1: Plant and earthworm soil toxicity benchmarks and measured RME concentrations of constituents in soil	Decision Rule for Assessment Endpoint 1: If HQs, defined as the ratios of COPEC RME concentrations in surface soil to TRV benchmarks for adverse effects on plants and soil invertebrates, are less than or equal to 1, then Assessment Endpoint 1 has been met and plants and soil-dwelling invertebrates are not at risk. If the HQs are >1, a SMDP has been reached, at which it will be necessary to decide what is needed: no further action, risk management of ecological resources, monitoring of the environment, remediation of any site-usage-related COPECs and applicable media, or further investigation such as a Level III and Level IV Field Baseline
	Assessment Endpoint 2: Growth, survival, and reproduction of herbivorous mammal populations Receptor: cottontail rabbits	Measures of Effect 2: Estimates of receptor home range area, body weights, feeding rates, and dietary composition based on published measurements of endpoint species or similar species; modeled COPEC concentrations in food chain based on measured RME concentrations in physical media; chronic dietary NOAELs applicable to wildlife receptors based on measured responses of similar species in laboratory studies	Decision Rule for Assessment Endpoint 2: If HQs, based on ratios of estimated exposure concentrations predicted from COPEC RME concentrations in surface soil to dietary limits corresponding to NOAEL TRV benchmarks for adverse effects on herbivorous mammals are less than or equal to 1, Assessment Endpoint 2 is met, and the receptors are not at risk. If the HQs are >1, a SMDP has been reached, at which it will be necessary to decide what is needed: no further action, risk management of ecological resources, monitoring of the environment, remediation of any site-usage-related COPECs in applicable media, or further investigation such as a Level III and Level IV Field Baseline

Table 7-19. Management Goals, Ecological Assessment Endpoints, Measures of Effect, and Decision Rules Identified for Fuze and Booster Quarry Landfill/Ponds During the Level II Screening (continued)

Management Goals	Assessment Endpoint	Measures of Effect	Decision Rule
Management Goal 1: The protection of terrestrial populations, communities, and ecosystems (continued)	Assessment Endpoint 3: Growth, survival, and reproduction of worm-eating and insectivorous mammal and bird populations Receptors: shrews and/or robins	Measures of Effect 3: Estimates of receptor home range area, body weights, feeding rates, and dietary composition based on published measurements of endpoint species or similar species; modeled COPEC concentrations in food chain based on measured RME concentrations in physical media; chronic dietary NOAELs applicable to wildlife receptors based on measured responses of similar species in laboratory studies	Decision Rule for Assessment Endpoint 3: If HQs based on ratios of estimated exposure concentrations predicted from COPEC RME concentrations in surface soil to dietary limits corresponding to NOAEL TRV benchmarks for adverse effects on worm-eating and insectivorous mammals and birds is less than or equal to 1, then Assessment Endpoint 3 is met, and these receptors are not at risk. If the HQs are >1, a SMDP has been reached, at which it will be necessary to decide what is needed: no further action, risk management of ecological resources, monitoring of the environment, remediation of any site-usage-related COPECs in applicable media, or further investigation such as a Level III and Level IV Field Baseline
	Assessment Endpoint 4: Growth, survival, and reproduction of carnivorous mammal and bird populations Receptors: red fox and red-tailed hawk	Measures of Effect 4: Estimates of receptor home range area, body weights, feeding rates, and dietary composition based on published measurements of endpoint species or similar species; modeled COPEC concentrations for PBT compounds in food chain based on measured RME concentrations in physical media; chronic dietary NOAELs applicable to wildlife receptors based on measured responses of similar species in laboratory studies	Decision Rule for Assessment Endpoint 4: If HQs based on ratios of estimated exposure concentrations predicted from COPEC RME concentrations in surface soil to dietary limits corresponding to NOAEL TRV benchmarks for adverse effects on carnivorous mammals and birds are less than or equal to 1, then Assessment Endpoint 4 is met, and the receptors are not at risk. If the HQs are >1, a SMDP has been reached, at which it will be necessary to decide what is needed: no further action, risk management of ecological resources, monitoring of the environment, remediation of any site-usage-related COPECs in applicable media, or further investigation such as a Level III and Level IV Field Baseline

Table 7-19. Management Goals, Ecological Assessment Endpoints, Measures of Effect, and Decision Rules Identified for Fuze and Booster Quarry Landfill/Ponds During the Level II Screening (continued)

Management Goals	Assessment Endpoint	Measures of Effect	Decision Rule
Management Goal 2: The protection of aquatic populations, communities, and ecosystems	Assessment Endpoint 5: Survival, reproduction, and diversity of benthic invertebrate communities Receptor: benthic invertebrates	Measures of Effect 5: Measured RME concentration of contaminants in sediment and sediment toxicity thresholds, e.g., consensus-based TECs, EPA Region 5 ESLs, and Ohio EPA sediment reference values	Decision Rule for Assessment Endpoint 5: If HQs based on ratios of COPEC RME concentrations in sediment-to-sediment toxicity benchmarks are less than or equal to1, then Assessment Endpoint 5 is met and sediment-dwelling organisms are not at risk. If the HQs are > 1, a SMDP has been reached, at which it will be necessary to decide what is needed: no further action, risk management of ecological resources, monitoring of the environment, remediation of any site-usage-related COPECs in applicable media, or further investigation such as a Level III and Level IV Field Baseline
	Assessment Endpoint 6: Growth, survival, and reproduction of aquatic biota (including fish, plants, invertebrates) Receptor: aquatic biota	Measures of Effect 6: Measured RME concentrations of contaminants in surface water and Ohio EPA Chemical-Specific Water Quality Criteria found in OAC 3745 (If multiple samples, use OMZA; otherwise, OMZM)	Decision Rule for Assessment Endpoint 6: If HQs based on ratios of COPEC RME concentrations in surface water to aquatic biota toxicity benchmarks are less than or equal to 1, then Assessment Endpoint 6 is met and the receptors are not at risk. If the HQs are > 1, a SMDP has been reached, at which it will be necessary to decide what is needed: no further action, risk management of ecological resources, monitoring of the environment, remediation of any site-usage-related COPECs in applicable media, or further investigation such as a Level III and Level IV Field Baseline

Table 7-19. Management Goals, Ecological Assessment Endpoints, Measures of Effect, and Decision Rules Identified for Fuze and Booster Quarry Landfill/Ponds During the Level II Screening (continued)

Management Goals	Assessment Endpoint	Measures of Effect	Decision Rule
Management Goal 2: The protection of aquatic populations, communities, and ecosystems (continued)	Assessment Endpoint 7: Growth, survival, and reproduction of aquatic herbivores that ingest aquatic plants, surface water, and sediment Receptors: muskrats and/or mallards	Measures of Effect 7: Estimates of receptor home range area, body weights, feeding rates, and dietary composition based on published measurements of endpoint species or similar species; modeled COPEC concentrations in food chain based on measured RME concentrations in physical media; chronic dietary NOAELs applicable to wildlife receptors based on measured responses of similar species in laboratory studies	Decision Rule 7: If HQs based on ratios of COPEC RME concentrations in surface water and sediment to dietary limits corresponding to NOAEL TRV benchmarks for adverse effects on aquatic herbivorous mammals and birds are less than or equal to 1, then Assessment Endpoint 7 is met and the receptors are not at risk. If the HQs are > 1, a SMDP has been reached, at which it will be necessary to decide what is needed: no further action, risk management of ecological receptors, monitoring of the environment, remediation of any site-usage-related COPECs in applicable media, or further investigation such as a Level III and Level IV Field Baseline
	Assessment Endpoint 8: Growth, survival, and reproduction of riparian carnivorous mammal and bird communities that feed on aquatic organisms Receptors: mink and herons	Measures of Effect 8: Estimates of receptor home range area, body weights, feeding rates, and dietary composition based on published measurements of endpoint species or similar species; modeled COPEC concentrations for PBT compounds in food chain based on measured RME concentrations in physical media; chronic dietary NOAELs applicable to wildlife receptors based on measured responses of similar species in laboratory studies	Decision Rule 8: If HQs based on ratios of estimated exposure concentrations predicted from COPEC RME concentrations in surface water to dietary limits corresponding to NOAEL TRV benchmarks for adverse effects on riparian carnivores is less than or equal to 1, then Assessment Endpoint 8 has been met and these receptor populations are not at risk. If the HQs are > 1, a SMDP has been reached, at which it will be necessary to decide what is needed: no further action, risk management of ecological receptors, monitoring of the environment, remediation of any site-usage-related COPECs in applicable media, or further investigation such as a Level III and Level IV Field Baseline

COPEC = Constituent of potential concern.
EPA = U. S. Environmental Protection Agency.
ESL = Ecological screening level.
HQ = Hazard quotient.
NOAEL = No observed adverse effects level.
OAC = Ohio Administrative Code.
Ohio EPA = Ohio Environmental Protection Agency.
PBT = Persistent, bioaccumulative, and toxic compound.
RME = Reasonable maximum exposure.
SMDP = Scientific management decision point.
TEC =Threshold effect concentration.
TRV = Toxicity reference value.

two inorganics (hexavalent chromium and cobalt), one explosive (nitrobenzene), and all 4 VOCs (2-butanone, carbon disulfide, toluene, and TCE). Thus, 37 COPECs were retained, which included 14 inorganics, 3 explosives, 3 pesticides/PCBs, and 17 SVOCs.

Of the 37 retained COPECs, 4 had maximum detects that exceeded their ESV and were not PBT compounds (3 inorganics and 1 SVOC), 4 were COPECs solely due to being PBT compounds (2 pesticides and 2 SVOCs), and 10 had no ESVs (7 inorganics and 3 explosives) (Table 7-10). Eighteen of the retained COPECs (cadmium, lead, mercury, zinc, 4,4′-DDD, and 13 SVOCs) had maximum detects 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.

Small Basins. The media screening for the Small Basin sediment is shown in Appendix Table N-21. A summary of sediment COIs eliminated from the Level II Screen is presented in Table 7-11. COPECs that were retained following the media screening are presented in Table 7-12.

Forty-five sediment COPECs were inputted into the media screening from the data/media evaluation, including 15 inorganics, 6 explosives, 10 pesticides/PCBs, 12 SVOCs, and 2 VOCs (Appendix Table N-21). Two of the inputted COPECs were eliminated from the Level II Screen because their maximum detects were below their ESVs and they were not PBT compounds (Table 7-11). The 2 eliminated COPECs included one inorganic (cobalt) and 1 VOC (toluene). Thus, 43 COPECs were retained, which included 14 inorganics, 6 explosives, 10 pesticides/PCBs, 12 SVOCs, and one VOC.

Of the 43 retained COPECs, 7 had maximum detects that exceeded their ESV and were not PBT compounds (3 inorganics, 2 explosives, 1 SVOC, and 1 VOC), 19 were COPECs solely due to being PBT compounds (1 inorganic, all 10 pesticides, and 8 SVOCs), and 12 had no ESVs (7 inorganics, 4 explosives, and 1 SVOC) (Table 7-12). Five of the retained COPECs (lead, mercury, zinc, and 2 SVOCs) had maximum detects that exceeded the ESV and were also PBT compounds.

7.4.2.4 Surface water media screening

Large Ponds. The media screening for the Large Ponds surface water is shown in Appendix Table N-22. A summary of surface water COIs that were eliminated from the Level II Screen are presented in Table 7-13. COPECs that were retained following the media screening are presented in Table 7-14.

Six surface water COPECs were inputted into the media screening from the data/media evaluation, including three inorganics, one explosive, one SVOC, and one VOC (Appendix Table N-22). Two of the inputted COPECs (barium and methylene chloride) were not retained because their maximum detects were below their OAC WQC and they were not PBT compounds (Table 7-13). Thus, four COPECs were retained, which included two inorganics, one explosive, and one SVOC.

Of the four retained COPECs, two were COPECs solely due to being PBT compounds [zinc and bis(2-ethylhexyl)phthalate] whereas the other two had no OAC WQC (calcium and nitrocellulose) (Table 7-14).

Drainage Ditch. The media screening for the Drainage Ditch surface water is shown in Appendix Table N-23. A summary of surface water COIs that were eliminated from the Level II Screen are presented in Table 7-15. COPECs that were retained following the media screening are presented in Table 7-16.

Ten surface water COPECs were inputted into the media screening from the data/media evaluation, including seven inorganics, one explosive, one SVOC, and one VOC (Appendix Table N-23). Five of the inputted COPECs (barium, chromium, cobalt, vanadium, and methylene chloride) were eliminated from the Level II Screen because their maximum detects were below their OAC WQC and they were not PBT compounds (Table 7-15). Thus, five COPECs were retained, which included three inorganics, one explosive, and one SVOC.

Of the five retained COPECs, zinc and one SVOC [bis(2-ethylhexyl)phthalate] were the only COPECs based solely on being PBT compounds, whereas two inorganics (iron and manganese) and one explosive (nitrocellulose) were COPECs due to not having OAC WQCs (Table 7-16).

Small Basin. The media screening for the Small Basin surface water is shown in Appendix Table N-24. A summary of surface water COIs that were eliminated from the Level II Screen are presented in Table-7-17. COPECs that were retained following the media screening are presented in Table 7-18.

Twenty-six surface water COPECs were inputted into the media screening from the data/media evaluation, including 15 inorganics (chromium counted twice to include total and hexavalent), 1 miscellaneous anion (perchlorate), 3 explosives, 3 SVOCs, and 4 VOCs (Appendix Table N-24). Sixteen of the inputted COPECs (eight inorganics, two explosives, two SVOCs, and all four VOCs) were eliminated from the Level II Screen because their maximum detects were below their OAC WQC and they were not PBT compounds (Table 7-17). Thus, ten COPECs were retained, which included seven inorganics, one miscellaneous anion, one explosive, and one SVOC.

Of the ten retained COPECs, only one inorganic (hexavalent chromium) had an average concentration that exceeded the OAC WQC (Table 7-18). Lead, zinc, and one SVOC [bis(2-ethylhexyl)phthalate] were the only COPECs based solely on being PBT compounds, whereas four inorganics (aluminum, iron, manganese, and potassium), perchlorate, and one explosive (nitrocellulose) were COPECs due to not having OAC WQCs (Table 7-17).

7.4.2.5 Conclusion and extension of the screening ERA

Ohio EPA guidance (Ohio EPA 2003) states “For a site to present a potential for hazard, it must exhibit the following three conditions: (a) contain COPECs in media at detectable and biologically significant concentrations, (b) provide exposure pathways linking COPECs to ecological receptors, and (c) have endpoint species that either utilize the site, are not observed to utilize the site but habitat is such that the endpoints species should be present, are present nearby, or can potentially come into contact with site-related COPECs.” This Level II screen has shown that these three conditions can be met at the Fuze and Booster Quarry site.

The Level II report “identifies site-specific receptors, relevant and complete exposure pathways and other pertinent information for conducting a Level III ERA if a SMDP was chosen to continue the ecological assessment in a Level III ERA” (Ohio EPA 2003). The SMDP was made before the Level II evaluation that if the conditions for potential for hazard were demonstrated at the Fuze and Booster Quarry site, the preliminary information for a Level III ERA would be included in the SERA report. The following sections present ecological CSMs (Section 7.4.3), selection of site-specific ecological receptor species (Section 7.4.4), relevant and complete exposure pathways (Section 7.4.5), and candidate ecological assessment endpoints and measures (Section 7.4.6).

7.4.2.6 Future risk to ecological receptors

The current risks for the terrestrial plants and animals at the FBQ EUs are assumed to be the same or similar to future risks because most of the soil COPEC concentrations are not expected to change dramatically over time, assuming there are no disturbances to the soil. For example, most inorganic

COPECs like the heavy metals are fairly immobile in the soil and do not undergo biodegradation or transformation processes. Although some organic COPECs can undergo biodegradation or transformations, these processes tend to be fairly slow for the types of COPECs at FBQ (e.g., pesticides, PAHs, and PCBs). Ecological succession could result in a change of specific vegetation composition, but the relatively small size of the terrestrial EUs at FBQ should minimize changes in the types of ecological receptors. Thus, because the future concentrations of COPECs, as well as the future types of ecological receptors, are not expected to change dramatically from the current conditions, future risk is expected to be similar to the current risk indicated.

Future risk in the aquatic habitats is more likely to change due to yearly inputs of new sediment and changes in sedimentation, which could affect sediment and surface water COPEC concentrations. Thus, future risk for sediment and surface water could vary accordingly. If new inputs of sediment are clean (i.e., free of COPECs), future risk would decrease because the contaminated sediments would be covered or at least "diluted" with clean sediment. Conversely, if future inputs of sediment are also contaminated with COPECs, risks to ecological receptors could stay the same or even increase, depending on the contaminant concentrations.

7.4.3 Ecological Soil Conceptual Site Models

Ecological CSMs depict and describe the known and expected relationships among the stressors, pathways, and assessment endpoints that are considered in the risk assessment, along with a rationale for their inclusion. Two ecological CSMs are presented for this Level II Screen. One ecological CSM is associated with the media screening of the Level II Screen (Figure 7-1). The other ecological CSM (Figure 7-2) represents the Level III Baseline. The ecological CSMs for the FBQ site were developed using the available site-specific information and professional judgment. The contamination mechanism, source media, transport mechanisms, exposure media, exposure routes, and ecological receptors for the ecological CSMs are described below.

7.4.3.1 Contamination source

The contamination source includes releases from historic site operations. Chapter 2.0 describes the types of historical operations that took place at the site.

7.4.3.2 Source media

The source medium is soil. For the screening level ERA, surface soil is defined as 0 to 1 ft BGS. Subsurface soil is defined as 1 to 3 ft BGS. Contaminants released from historic site operations went directly into the surrounding soil, making soil the source medium.

7.4.3.3 Transport mechanisms

Transport mechanisms at the site include volatilization into the air, biota uptake, erosion to surface water and sediment, and leaching to groundwater. Biota uptake is a transport mechanism because some of the site contaminants are known to accumulate in biota, and those biota are free to move around. The deposition of eroded soils containing site contaminants into surface water and sediment is also a valid transport mechanism for both ecological CSMs.

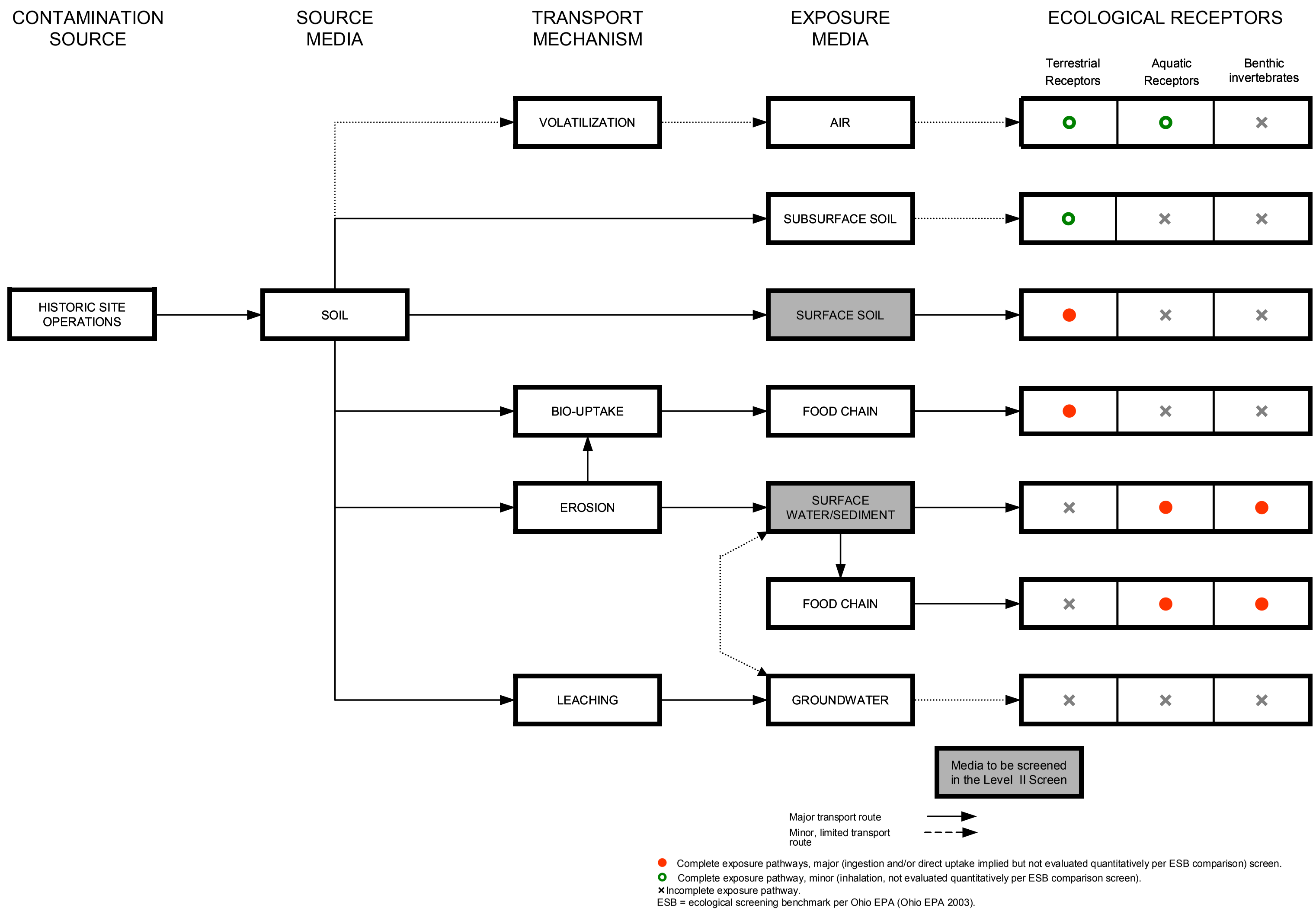


Figure 7-1. Conceptual Site Model for Level II Screen – Pathways for Ecological Exposure at the Fuze & Booster Quarry

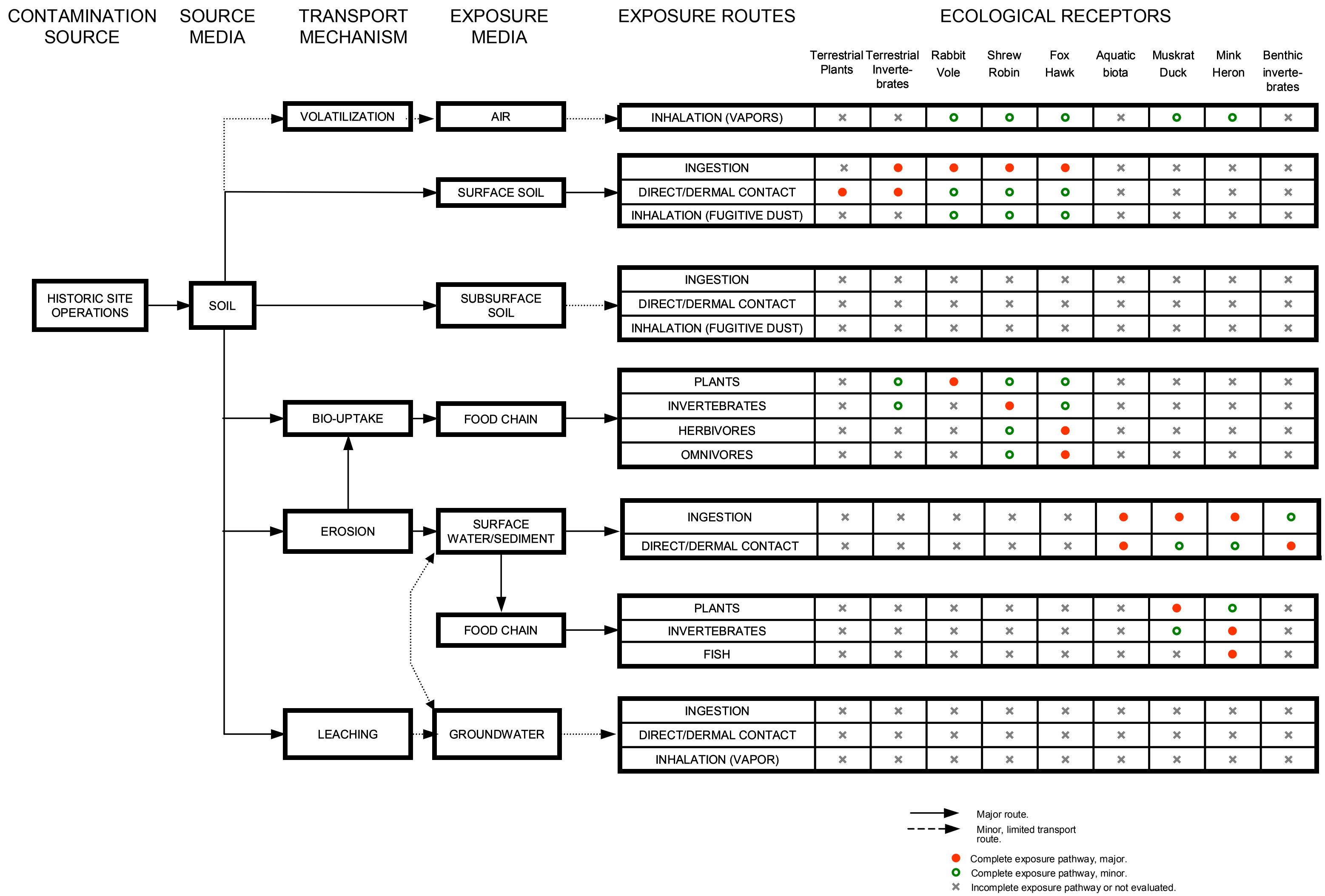


Figure 7-2. Conceptual Site Model for Level III Screen – Pathways for Ecological Exposure at the Fuze & Booster Quarry

7.4.3.4 Exposure media

Sufficient time (over 10 years) has elapsed for contaminants in the source media to have migrated to potential exposure media, resulting in possible exposure of plants and animals that come in contact with these media. Potential exposure media include air, surface and subsurface soil, food chain, surface water, and sediment. Groundwater is not considered an exposure medium because ecological receptors are unlikely to contact groundwater at a depth of greater than 5 ft BGS. Groundwater could outcrop into surface water as a seep or spring, but is not considered an exposure medium until it does so. Soil, surface water, sediment, and food chain are the principal exposure media for the FBQ site.

7.4.3.5 Exposure routes

Exposure routes are functions of the characteristics of the media in which the sources occur, and how both the released chemicals and receptors interact with those media. For example, chemicals in surface water may be dissolved or suspended as particulates and be very mobile, whereas those same constituents in soil may be much more stationary. The ecology of the receptors is important because it dictates their home range, whether the organism is mobile or immobile, local or migratory, burrowing or above ground, plant eating, animal eating, or omnivorous.

For the Level II Screen, specific exposure routes were not identified because the screen is not receptor specific and only focuses on comparison of MDCs of chemicals in the exposure media against published ecological toxicological benchmark concentrations derived for those media. However, the Level III Baseline ecological CSM (Figure 7-2) would identify specific exposure routes and indicates whether the exposure routes from the exposure media to the ecological receptors are major or minor. Major exposure routes would be evaluated quantitatively, whereas minor routes are evaluated qualitatively. The Level III Baseline ecological CSM (Figure 7-2) shows a major exposure route of soil to terrestrial plants and animals and an incomplete exposure route of upper groundwater to terrestrial and aquatic plants and animals. Groundwater is assumed not to be directly contacted by ecological receptors.

The major exposure routes for chemical toxicity from surface and subsurface soil include ingestion (for terrestrial invertebrates, rabbits, shrews, foxes, and hawks) and direct contact (for terrestrial plants and invertebrates). The ingestion exposure route for rabbits, shrews, robins, foxes, and hawks includes soil, as well as plant and/or animal food (i.e., food chain), that were exposed to the surface soil. Minor exposure routes for surface soil include direct contact and inhalation of fugitive dust (for rabbits, shrews, foxes, and hawks). The major exposure routes for surface water include ingestion (for aquatic biota, muskrats, ducks, mink, and herons) and direct contact (for aquatic biota and benthic invertebrates). Minor exposure pathways for surface water and sediment include direct contact and inhalation (for muskrats, ducks, mink, and herons). The major exposure routes for sediment include ingestion (for aquatic biota, muskrats, ducks, mink, and herons) and direct contact (for aquatic biota and benthic invertebrates). The ingestion exposure routes for aquatic biota (including vertebrate mammals and birds) include sediment and surface water (as applicable), as well as plant and/or animal food (food chain) that were exposed to the sediment or surface water.

Exposure to groundwater is an incomplete pathway for all terrestrial and aquatic ecological receptors because groundwater is likely too deep beneath ground level for there to be direct exposure to any of the receptors. If the groundwater outcrops via seeps or springs into wetlands or drainage ditches, it becomes part of the surface water and would be evaluated in the surface water pathway.

7.4.3.6 Ecological receptors

For the Level II Screen, specific ecological receptors were not identified, but terrestrial and aquatic biota were each considered as a whole. However, for the Level III Baseline, terrestrial and aquatic ecological receptors, as well as riparian receptors, are identified in the ecological CSM (Figure 7-2). The terrestrial receptors include plants, terrestrial invertebrates (earthworms), rabbits, shrews, foxes, and hawks. The aquatic receptors include benthic invertebrates and aquatic biota. Aquatic herbivore receptors are represented by the muskrat and the mallard duck. The riparian carnivores include mink and herons. These receptors are discussed in more detail in Section 7.4.4.

7.4.4 Selection of Site-specific Ecological Receptor Species

The selection of ecological receptors for the site-specific analysis screen was based on plant and animal species that do or could occur in the terrestrial and aquatic habitats at the site. Three criteria were used to identify the site-specific receptors.

1. **Ecological Relevance.** The receptor has or represents a role in an important function such as energy fixation (e.g., plants), nutrient cycling (e.g., earthworms), and population regulation (e.g., hawks). Receptor species were chosen to include representatives of all applicable trophic levels identified by the ecological CSM for the site. These species were selected to be predictive of assessment endpoints (including protected species/species of special concern and recreational species).

2. **Susceptibility.** The receptor is known to be sensitive to the chemicals detected at the site, and given their food and habitat preferences, their exposure is expected to be high. The species have a likely potential for exposure based upon their residency status, home range size, sedentary nature of the organism, habitat compatibility, exposure to contaminated media, exposure route, and/or exposure mechanism compatibility. Ecological receptor species were also selected based on the availability of toxicological effects and exposure information.

3. **Management Goals.** Valuable roles in erosion control (e.g., plants), societal values [e.g., trapping for fur (mink) and small game hunting (rabbits)], and regulatory protection [e.g., Migratory Bird Act (hawks, mallards, and herons) and Migratory Bird Hunting Stamp Act (mallards)]. The ecosystem functions of the ecological receptor species (foodweb interactions, keystone species, vital to ecosystem function, dominant species, or tolerant/intolerant species) were considered during the selection process.

At FBQ, the following types of ecological receptors are likely to be present: terrestrial plants, terrestrial invertebrates, cottontail rabbits (*Sylvilagus floridanus*), short-tailed shrews (*Blarina brevicauda*), red foxes (*Vulpes vulpes*), red-tailed hawks (*Buteo jamaicensis*), sediment-dwelling biota, aquatic biota, muskrats (*Ondatra zibenthicus*), mallard ducks (*Anas platyrhynchos*), mink (*Mustella vison*), and great blue herons (*Ardea herodias*). Each of these receptors is described in Section 7.4.4.1 (for terrestrial exposures) or 7.4.4.2 (for aquatic and riparian exposures).

7.4.4.1 Terrestrial exposure classes and receptors

Terrestrial exposures, receptors, and justification for their selection for the site-specific analysis screen are presented below.

Terrestrial Vegetation Exposure to Soil

Terrestrial vegetation exposure to soil is applicable to the FBQ site. Terrestrial plants have ecological relevance because they represent the base of the food web and are the primary producers that turn energy from the sun into organic material (plants) that provides food for many animals. There is sufficient habitat present for them at the site. In addition, plants are important in providing shelter and nesting materials to many animals, thus, plants are a major component of habitat. Plants provide natural cover and stability to soil and stream banks, thereby reducing soil erosion.

Terrestrial plants are susceptible to toxicity from chemicals. Plants have roots that are in direct contact with surface soil, which provides them with direct exposure to contaminants in the soil. They also can have exposure to contaminants via direct contact on the leaves. There are published toxicity benchmarks for plants (Efroymson et al. 1997c), and there are management goals for plants because of their importance in erosion control. Thus, there is sufficient justification to warrant plants as a receptor for the FBQ site.

Terrestrial Invertebrate Exposure to Soil

Terrestrial invertebrate exposure to soil is applicable to soils for the FBQ site. Earthworms represent the receptor for the terrestrial invertebrate class, and there is sufficient habitat present for them on-site. Earthworms have ecological relevance because they are important for decomposition of detritus and for energy and nutrient cycling in soil (Efroymson 1997b). Earthworms are probably the most important of the terrestrial invertebrates for promoting soil fertility because they process much soil.

Earthworms are susceptible to exposure to, and toxicity from, COPECs in soil. Earthworms are nearly always in contact with soil and ingest soil, which results in constant exposure. Earthworms are sensitive to various chemicals. Toxicity benchmarks are available for earthworms (Efroymson et al. 1997b). Although management goals for earthworms are not immediately obvious, the important role of earthworms in soil fertility cannot be overlooked. Thus, there is sufficient justification to warrant earthworms as a receptor for the FBQ site.

Mammalian Herbivore Exposure to Soil

Mammalian herbivore exposure to soil is applicable to the FBQ site. Cottontail rabbits represent mammalian herbivore receptors, and there is suitable habitat present for them at the site. This species has ecological relevance by consuming vegetation, which helps in the regulation of plant populations and in the dispersion of some plant seeds. Small herbivorous mammals such as cottontail rabbits are components of the diet of terrestrial top predators.

Cottontail rabbits are susceptible to exposure to, and toxicity from, COPCs in soil and vegetation. Herbivorous mammals are exposed primarily through ingestion of plant material and incidental ingestion of contaminated surface soil containing chemicals. Exposures by inhalation of COPCs in air or on suspended particulates, as well as exposures by direct contact with soil, were assumed to be negligible. Dietary toxicity benchmarks are available for many COPCs for mammals (Sample et al. 1996), and there are management goals for rabbits because they are an upland small game species protected under Ohio hunting regulations. Thus, there is sufficient justification to warrant cottontail rabbits as receptors for the FBQ site.

Insectivorous Mammal and Bird Exposure to Soil

Insectivorous mammal and bird exposure to soil is applicable to the FBQ site. Short-tailed shrews and American robins represent the receptors for the insectivorous mammal and bird terrestrial exposure class, respectively. There is sufficient, suitable habitat present at the site for these receptors. Both species have ecological relevance because they help to control aboveground invertebrate community size by consuming large numbers of invertebrates. Shrews and robins are a prey item for terrestrial top predators.

Both short-tailed shrews and American robins are susceptible to exposure to, and toxicity from, COPCs in soil, as well as contaminants in vegetation and terrestrial invertebrate. Insectivorous mammals such as short-tailed shrews and birds such as American robins are primarily exposed by ingestion of contaminated prey (e.g., earthworms, insect larvae, and slugs), as well as ingestion of soil. In addition, shrews ingest a small amount of leafy vegetation, and the robin's diet consists of 50% each of seeds and fruit. Dietary toxicity benchmarks are available for mammals and birds (Sample et al. 1996). Both species are recommended as receptors because there can be different toxicological sensitivity between mammals and birds exposed to the same contaminants. There are management goals for robins because they are federally protected under the Migratory Bird Treaty Act of 1993, as amended. There are no specific management goals for shrews at the site. Based on the management goals for robins, plus the susceptibility to contamination and ecological relevance for both species, there is sufficient justification to warrant shrews and robins as receptors for the FBQ site.

Terrestrial Top Predators

Exposure of terrestrial top predators is applicable to the FBQ site. Red foxes and red-tailed hawks represent the mammal and bird receptors for the terrestrial top predator exposure class, respectively, and there is a limited amount of suitable habitat present for them at the site. Both species have ecological relevance because as representatives of the top of the food chain for the site terrestrial EU, they control populations of prey animals such as small mammals and birds.

Both red foxes and red-tailed hawks are susceptible to exposure to, and toxicity from, COPECs in soil, vegetation, and/or animal prey. Terrestrial top predators feed on small mammals and birds that may accumulate constituents in their tissues following exposure at the site. There is a potential difference in toxicological sensitivity between mammals and birds exposed to the same COPCs so it is prudent to examine a species from each taxon (Mammalia and Aves, respectively). Red foxes are primarily carnivorous but consume some plant material. The red-tailed hawk consumes only animal prey. The foxes may incidentally consume soil.

There are management goals for both species. Laws (Ohio trapping season regulations for foxes, and federal protection of raptors under the Migratory Bird Treaty Act) also protect these species. In addition, both species are susceptible to contamination and have ecological relevance as top predators in the terrestrial ecosystem. Thus, there is sufficient justification to warrant these two species as receptors for the FBQ site.

7.4.4.2 Aquatic and riparian exposure receptors

The aquatic exposures, receptors, and justification for why they are relevant for the FBQ site are presented below.

Exposure of Aquatic Biota to Water

Exposure of aquatic biota to water is applicable to the three ponds at the FBQ site. Aquatic biota (e.g., aquatic plants, invertebrates, and fish) represent the ecological receptors for the aquatic biota exposure class, and there is habitat for them at this site. Aquatic biota have ecological relevance because they represent the range of living organisms in the aquatic ecosystem and they provide food for various predators.

Aquatic biota are susceptible to exposure to, and toxicity from, COPECs in surface water. The exposure concentration for aquatic biota is assumed to be equal to the measured environmental concentration because the biota have constant contact with water and the aquatic toxicity benchmarks that are used are expected to protect aquatic life from all exposure pathways, including ingestion of surface water, contaminated plants, and animals. Toxicity benchmarks are available for aquatic biota (Suter and Tsao 1996), but Ohio State WQC for surface water must also be met.

There are management goals for aquatic biota in laws that specify Ohio water quality standards to support designated uses (e.g., survival and propagation of aquatic life) for waters of the state. In addition, aquatic biota are susceptible to contamination by virtue of continual exposure in water, and they have ecological relevance for biota within the aquatic and terrestrial ecosystems. Thus, there is sufficient justification to warrant aquatic biota as a receptor for the FBQ site.

Exposure of Sediment-Dwelling Biota to Sediment

Sediment-dwelling biota exposure to sediment is applicable to the site-specific analysis. Benthic invertebrates such as aquatic insect larvae, like caddisflies (Trichoptera), mayflies (Ephemeroptera), and midges (Chironomidae), as well as non-insects such as crayfish (Decapoda), snails (Gastropoda), and clams and bivalves (Pelycypoda), represent the receptors for the sediment-dwelling biota aquatic exposure class. These biota have ecological relevance because they provide food for many aquatic species and also for some terrestrial mammals and birds such as raccoons, mallards, and herons.

Benthic invertebrates are susceptible to exposure to, and toxicity from, COPECs in sediment. These biota have direct contact with sediment and sediment pore water. Toxicity benchmarks are available for benthic invertebrates (Jones, Suter, and Hull 1997).

There are management goals for sediment-dwelling biota because the condition of these biological communities is linked to assessment of Ohio water quality use attainment in streams. These biota are susceptible to contamination by virtue of continual exposure in sediment, and they have ecological relevance as a major food source for aquatic biota. Thus, there is sufficient justification to warrant sediment-dwelling biota as a receptor for a Level III Baseline or subsequent WOE assessment in an FS.

Herbivore Exposure to Water, Sediment, and the Aquatic/Sediment Food Web

Aquatic herbivores, like muskrats and mallard ducks, are exposed to water and sediment so these exposures are applicable to the FBQ site. There is also suitable habitat for them at the site. Muskrats eat aquatic vegetation. Mallard ducks are surface-feeding ducks that obtain much of their food by dabbling in shallow water and filtering through soft mud with their beaks. Their food consists mostly of seeds of aquatic plants, as well as aquatic invertebrates (EPA 1993). Animal matter accounts for approximately 67 to 90% of the diet for breeding female ducks during the spring and summer, but decrease to less than 10% of the diet during the winter. Mallards have ecological relevance as important components of the aquatic food web. As aquatic herbivores, muskrats and mallards help maintain the size and composition of the aquatic vegetation community.

Muskrats and mallards are susceptible to exposure to, and toxicity from, COPECs in surface water and aquatic vegetation. The potential for exposure to contaminants is high because they consume aquatic and sediment-dwelling plants that can accumulate high concentrations of some chemicals from water. In addition, these species can have further exposure via ingestion of contaminants in surface water that they use for a drinking water source and incidentally ingested sediment. Since there is a potential difference in the toxicological sensitivity of mammals and birds exposed to the same COPECs, one mammal and one bird were examined for exposure to water, sediment, and the aquatic food chain. Dietary toxicity benchmarks for many inorganic and some organic substances are available for mammals and birds (Sample et al. 1996).

There are management goals for muskrats and mallards. For example, there are Ohio trapping season regulations for muskrats, and mallards are federally protected under the Migratory Bird Treaty Act of 1993, as amended. Mallard ducks are also federally protected as a game species under the Migratory Bird Hunting and Conservation Stamp Act of 1934, as amended. Both species are susceptible to COPECs, especially via ingestion exposure, and they have ecological relevance. Thus, there is sufficient justification to warrant these receptors for the FBQ site.

Riparian Carnivores

Exposure of predators to aquatic biota is applicable to the FBQ site because PBT chemicals are present at the site. There is also suitable habitat for these receptors at the site. Exposure evaluation for piscivores (fish-eating predators) is required by Ohio EPA (2003) when a PBT compound or a COPEC with no screening benchmark is found in surface water or sediment. Mink and great blue herons are riparian carnivores chosen to represent mammalian and bird receptors for the fish-eating predator exposure class, respectively. Riparian carnivores feed predominantly in and along the banks of streams. Both species have ecological relevance because as piscivorous riparian carnivores, they are important components of the aquatic food web representing the top predators. As top predators, they help limit the population size for some aquatic and some sediment-dwelling biota communities.

Both species are susceptible to exposure to, and toxicity from, COPECs in surface water, aquatic biota, and sediment-dwelling biota. The potential for exposure to COPECs is high for these two species because they consume fish, which can accumulate high concentrations of some chemicals from water. In addition, both species can have further exposure via ingestion of COPECs in surface water that is used for a drinking water source. Dietary toxicity benchmarks are available for mammals and birds (Sample et al. 1996). There can be differences in toxicological sensitivity between mammals and birds exposed to the same COPEC, so both species are appropriate.

There are management goals for both species because regulations protect both species. For example, mink are regulated by Ohio trapping regulations because they are fur-bearing mammals. Great blue herons are federally protected under the Migratory Bird Treaty Act of 1993, as amended. Both species are susceptible to contamination, especially via ingestion exposure routes, and they have ecological relevance as predators. Thus, there is sufficient justification to warrant these two receptors for the FBQ site.

7.4.4.3 Relevant and complete exposure pathways

Relevant and complete exposure pathways for the ecological receptors at FBQ were described in Section 7.4.3 on the ecological CSMs. As previously discussed, there are relevant and complete exposure pathways for various ecological receptors including terrestrial vegetation and invertebrates, aquatic and sediment-dwelling biota, and terrestrial and aquatic herbivores, insectivores, and carnivores. Thus, these types of receptors could be exposed to COPECs in abiotic media at the FBQ site.

7.4.4.4 Candidate ecological assessment endpoints and measures

The protection of ecological resources, such as habitats and species of plants and animals, is a principal motivation for conducting screening level ERAs. Key aspects of ecological protection are presented as management goals, which are general goals established by legislation or agency policy and based on societal concern for the protection of certain environmental resources. For example, environmental protection is mandated by a variety of legislation and governmental agency policies (e.g., CERCLA and NEPA). Other legislation includes the ESA (16 *U. S. Code* 1531-1544, 1993, as amended) and the Migratory Bird Treaty Act (16 *U. S. Code* 703-711, 1993, as amended). To evaluate whether a management goal has been met, assessment endpoints, measures of effects, and decision rules were formulated. The management goals, assessment endpoints, measures of effects, and decision rules are discussed below.

There are two management goals for FBQ. However, the assessment endpoints differ between the general screen and the site-specific analysis screen. The management goals for the screening level ERA are:

- Management Goal 1: Protect terrestrial plant and animal populations from adverse effects due to the release or potential release of chemical substances associated with past site activities.

- Management Goal 2: Protect aquatic plant and animal populations and communities from adverse effects due to the release or potential release of chemical substances associated with past site activities.

Ecological assessment endpoints are selected to determine whether these management goals are met at the unit. An ecological assessment endpoint is a characteristic of an ecological component that may be affected by exposure to a stressor (e.g., COPEC). Assessment endpoints are “explicit expressions of the actual environmental value that is to be protected” (EPA 1992b). Assessment endpoints often reflect environmental values that are protected by law, provide critical resources, or provide an ecological function that would be significantly impaired if the resource was altered. Unlike the human health risk assessment process, which focuses on individual receptors, the screening level ERA focuses on populations or groups of interbreeding non-human, non-domesticated receptors. Accordingly, assessment endpoints generally refer to characteristics of populations and communities. In the screening level ERA process, risks to individuals are assessed only if they are protected under the ESA or other species-specific legislation, or if the species is a candidate for listing as a T&E species.

Given the diversity of the biological world and the multiple values placed on it by society, there is no universally applicable list of assessment endpoints. Therefore, Ohio EPA’s *Ecological Risk Assessment Guidance Document* (Ohio EPA 2003) was used to select assessment endpoints.

For the Level II Screen, the assessment endpoints are any potential adverse effects on ecological receptors, where receptors are defined as any plant or animal population, communities, habitats, and sensitive environments (Ohio EPA 2003). Although the assessment endpoints for the Level II Screen are associated with Management Goals 1 and 2, specific receptors are not identified with the assessment endpoints.

For a Level III Baseline and subsequent WOE assessment in an FS, the assessment endpoints would be more specific and stated in terms of types of specific ecological receptors associated with each of the two management goals. Eight assessment endpoints have been defined for the Level III Baseline (Table 7-19). Assessment endpoints 1, 2, 3, and 4 entail the growth, survival, and reproduction of terrestrial receptors such as vegetation and terrestrial invertebrates, herbivorous mammals, worm-eating/insectivorous mammals and birds, and carnivorous top predator mammals and birds, respectively. Assessment endpoints 1 through 4 are associated with Management Goal 1, protection of terrestrial populations and communities. Assessment endpoint 5 deals with the growth, survival, and reproduction of sediment-dwelling biota, which is associated with Management Goal 2, protection of aquatic populations and communities. Assessment endpoints 6, 7, and 8 are also associated with Management Goal 2, and deal with the growth, survival, and reproduction of aquatic biota, aquatic herbivores, and riparian carnivores, respectively.

Table 7-19 shows the management goals for terrestrial and aquatic resources, attendant assessment endpoints, measures of effect, and decision rule by assessment endpoint number. Furthermore, the table provides definitions of Assessment Endpoints 1, 2, 3, and 4 (terrestrial receptors) and 5, 6, 7, and 8 (aquatic receptors). As stated, the assessment endpoint table includes a column about the conditions for making a decision depending on whether the HQ is less than or more than 1. If the HQ is greater than 1, the SMDP options from Ohio EPA/Army Corps guidance are provided: no further action, risk management, monitoring, remediation, or further investigation, such are Level III Baseline and Level IV Field Baseline. These are the logical options, and the options fitted to the FBQ circumstances are provided in Section 7.5.

The assessment endpoints would be evaluated through the use of “measures” (formerly named measurement endpoints). EPA defines measures as ecological characteristics used to quantify and predict change in the assessment endpoints. They consist of measures of receptor and population characteristics, measures of exposure, and measures of effect. For example, measures of receptor characteristics include parameters such as home range, food intake rate, and dietary composition. Measures of exposure include attributes of the environment such as contaminant concentrations in soil, sediment, surface water, and biota. The measures of effect for the Level II Screen consist of the MDCs of each contaminant for soil or sediment (average concentrations for surface water), ESV benchmarks for COIs in soil and sediment, as well as the Ohio state WQC for surface water (see Section 7.3.3).

Appropriate measures of exposure relating to the assessment endpoints for the Level II and Level III ERAs include measured concentrations of chemicals in surface soil, sediment, and surface water. Additional measures of exposure for a Level III Baseline would include predicted concentrations of chemicals in vegetation and various receptor animals such as rabbits, shrews, and aquatic biota based on measured soil, sediment, and surface water concentrations. The measures for the site-specific analysis screen and their relationship to their corresponding assessment endpoints are summarized in Table 7-19.

In the Level II Screen, MDCs in soil or sediment at each EU were compared to default soil or sediment concentrations that are expected not to cause harm to ecological populations. Average concentrations in surface water were compared to Ohio State WQC. The Level II screen used Ohio EPA (2003) published guidelines for selection of screening values for soil and sediment, and OAC WQC for surface water.

COPECs that remained after the Level II Screen could be subject to a Level III Baseline analysis or WOE evaluation in an FS with exposures that are more representative of the exposures expected for the representative receptors. Level III Baseline analysis would include evaluation of exposure of a variety of receptors to the RME concentrations of COPECs at each EU, using default dietary and uptake factors. The representative ecological receptors may not all be present at each EU. However, all representative receptors would be evaluated at this step.

For a Level III Baseline, the decision rules for COPECs came from Ohio EPA’s guidance for chemicals (Ohio EPA 2003) and the Army’s guidance (USACE 2003b). Briefly, for COPECs, the first decision rule is based on the ratio (hazard quotient, HQ) of the ambient exposure or exposure point concentration (EPC) (numerator) of a given chemical to the ecological effects or toxicity reference value (denominator) of the same chemical. A ratio of 1 or smaller means that ecological risk is negligible while a ratio of greater than 1 means that ecological risk from that individual chemical is possible and that additional investigation should follow to confirm or refute this prediction. In addition, a sum of all the HQs (that is, the HI) for given groups of chemicals (e.g., all inorganics, all organics, or all chemicals with a common mode of action) of 1 or less means that there is no concern, while a sum greater than 1 indicates that there may be a concern for that group of chemicals and that further investigation is needed. The second decision rule is that if "no other observed significant adverse effects on the health or viability of the local individuals or populations of species are identified" (Ohio EPA 2003) and the HI does not exceed 1, "the site is highly unlikely to present significant risks to endpoint species" (Ohio EPA 2003). The most likely outcomes for a Level III Baseline are: (1) no significant risks to endpoint species so no further analysis is needed, (2) conduct field baseline assessment to quantify adverse effects to populations of representative species (Level IV) that were shown to be potentially impacted based on hazard calculations in a baseline ERA, or (3) remedial action taken without further study.

7.5 UNCERTAINTIES FOR THE ECOLOGICAL RISK ASSESSMENT

Uncertainties in the FBQ screening ERA are discussed briefly in this section by the four interrelated steps of the EPA approach to an ERA: problem formulation, exposure assessment, effects assessment, and risk characterization.

7.5.1 Uncertainties in Problem Formulation

Environmental concentrations of analytes in the soil, sediment, and surface water at FBQ were based on a limited number of samples. A degree of uncertainty exists about the actual spatial distribution of constituents. Exposure concentrations could be overestimated or underestimated, depending on how the actual data distribution differs from the measured data distribution. Also, one or more chemicals could be a laboratory contaminant. Because the MDC was used, the estimates of risk from COPECs are conservative (i.e., protective). Using maximum concentrations decreases the likelihood of underestimating the risk posed by each COPEC and increases the likelihood of overestimating the risk.

The full distribution and abundance of organisms comprising the ecological receptors at FBQ has not been quantified by field studies. The lack of quantitative data introduces uncertainties concerning whether, and to what extent, the risk characterization based on the selected receptor species underestimates or overestimates the risk to organisms that were not used in the risk computations but that occur at FBQ. On-site reconnaissance has established the nature and quality of habitat and has confirmed the presence of vegetation types and of active, visible animal species. Observations made during this reconnaissance justify assumptions about the presence of unobserved organisms that are essential to normal ecosystem functioning, such as soil-dwelling worms and arthropods and herbivorous insects. This area falls within the acceptable range of each species. Note that the extrapolations of no ecological effects at WBG (SAIC 2002) may moderate this type of uncertainty and show risk findings at FBQ to be an overestimate of risk. However, there are many differences (much water, site histories, soil, and so forth) that preclude outright extrapolation from WBG to FBQ.

It is possible that one (or more) unobserved species at FBQ is more sensitive than the ecological receptors for which toxicity data are available for use in the screening ERA. It does not necessarily follow that these unevaluated, more sensitive species are at significantly greater risk than the species estimated in this ERA because exposure concentrations for ecological receptors in this screening ERA could be greater than those for more sensitive receptors due to different dietary regimes.

7.5.2 Uncertainties in Exposure Assessment

The actual movement of analytes from the FBQ constituent source media to ecological receptors has not been measured for this screening ERA. This introduces uncertainties about the actual modes and pathways of exposure, bioavailability of constituents, and the actual exposure concentrations of these analytes to the ecological receptors. Actual exposure concentrations can differ from the measured environmental concentrations as a result of physical and chemical processes during transport from source to receptor and as a result of biomagnification through the food web. Actual exposure concentrations in physical media are sometimes less than the total measured concentrations because a portion of the total constituent is not bioavailable to the receptors. These processes have not been evaluated quantitatively in this screening ERA. Thus, the exposures could be overestimated based on the total measured concentration.

BAFs for soil and sediment to biota, and BAFs for surface water to biota, used for the PBT evaluation, are not available for some analytes. Instead, default values were used. It is not known whether this substitution overestimates or underestimates exposure. However, the default values are thought to be conservative, so it is likely that exposures will not be underestimated.

Literature-derived factors to assume dietary intake and bioaccumulation of elements may not reflect actual diets and bioaccumulation at the site. However, the literature values are assumed to be sufficiently similar to site-specific values that exposures neither will be underestimated nor overestimated.

Exposure concentrations are likely to be overestimated because of conservative exposure factors. Exposure factors include published BAFs, irrespective of species and environmental conditions. In particular, it should be noted that, while the largest BAFs may overestimate bioaccumulation at FBQ by at least one order of magnitude for some COPECs, very high bioaccumulation, as well as biomagnification, are well documented for other constituents, although not necessarily all those likely detected.

Finally, the exposure of plants and animals to constituents below detection limits was not considered in the screening ERA. In addition, the exposure of ecological receptors to tentatively identified compounds is not considered, which could result in an underestimation of exposure.

7.5.3 Uncertainties in Effects Assessment

The preferred ESV for the three media were based on concentrations assumed to have no observed effects or NOAELs for various organisms. This screening ERA provides findings for COPEC-specific ESVs. An evaluation of risk from COPEC mixtures cannot be conducted without additional data and evaluation of alternative models of COPEC interaction.

There are no available ESVs for some analytes, especially organics, for each of the three media. This contributes to uncertainty associated with likely overestimates of risk. Sometimes, lack of ESVs based on soil-plant studies caused use of ESVs based on hydroponic studies; hydroponic studies are inferior to soil-plant studies and this contributed additional uncertainty.

7.5.4 Uncertainties in Risk Characterization

The uncertainties described above ultimately produce uncertainty in the quantification of current and future risks to terrestrial and aquatic animals at FBQ. Five additional areas of uncertainty in the risk characterization exist: off-site risk, cumulative risk, future risk, background risk, and extrapolation risk.

7.5.4.1 Off-site Risk

The risks to off-site receptors cannot be characterized without benefit of clearly identified pathways (especially any surface water pathways) as well as constituent tracer studies and off-site plant and animal and habitat surveys. Off-site receptors can be exposed to constituents via physical and organismal transport processes, but evaluating the magnitude of this exposure would require additional studies. It is unlikely that off-site receptors would have lower toxicity thresholds for constituents than the thresholds used for on-site receptors. In addition, there is little reason to expect that constituents migrating off-site would be concentrated above measured concentrations at sites at the FBQ unless a constituent bioconcentrates in organisms that move extensively on and off the site. In general, the risk to most off-site receptors is likely to be overestimated rather than underestimated by the risk estimate for on-site receptors.

7.5.4.2 Cumulative risk

The screening ERA estimates the risk to populations of ecological receptors from individual constituents. Yet, in nature, receptors are exposed simultaneously to mixtures of chemicals. Generally, the methods used are sufficiently conservative resulting in individual risks that are overestimated. Nevertheless, cumulative risk is possible when several living plants and animals are affected simultaneously. Harmful effects in ecosystems (including effects on individual organisms) may cascade throughout the system and have indirect effects on the ability of a population to persist in the area even though individual organisms are not sensitive to the given constituents in isolation. Therefore, the ecological risk characterization for sites at the FBQ may underestimate actual risks to plants and animals from cumulative risks.

7.5.4.3 Future risk

A third area of uncertainty in the ecological risk characterization is the future risk to the plants and animals from contamination at the FBQ. The screening ERA characterizes the current risk based on chronic exposure to measured concentrations of toxicants with the potential to persist in the environment for extended periods of time. Risk quotients for animals estimate the risk to animal species that would be natural parts of future successional stages at these areas. Nevertheless, possible mechanisms exist that could significantly increase (e.g., erosion, a leaching to surface water or groundwater) or decrease (e.g., enhanced microbial degradation) the risk to future plants and animals at the sites.

7.5.4.4 Background risk

Another source of uncertainty is ecological risk relative to background conditions. Although only inorganics with concentrations above background were examined in the ecological COPEC screening, some ecological COPECs are above background only by a small amount, such that concentrations at a particular exposure location can be actually less than the background concentration. The conservative approach to comparing site concentrations to background likely overestimates the risk from ecological COPECs compared to background.

7.5.4.5 Extrapolation risk

Yet another source of uncertainty revolves around the extrapolations of WBG plant protection levels to FBQ. No one AOC and no one EU is exactly like the others. Differences in concentrations and chemical mixtures introduce variation into extrapolations.

7.5.4.6 Summary of uncertainties

The most important uncertainties in the FBQ screening ERA are those surrounding the estimates of the constituent concentrations to which ecological receptors are actually exposed (exposure concentrations) and the concentrations that present an acceptable level of risk of harmful effects (ESVs). These uncertainties arise from multiple sources, but especially from the lack of site-specific data on constituent transport and transformation processes, bioavailability of contaminants, organism toxicity, and the response of plant and animal populations to stressors in their environments. Despite these uncertainties, the available site-concentration data and published exposure and effects information are believed to provide a sufficiently credible picture of ecological risk that management decisions can be made with confidence.

7.6 SUMMARY OF THE LEVEL II SCREEN

The FBQ site 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 site. The presence of suitable habitat and observed receptors at the site warrants a screening ERA. Thus, Ohio EPA protocol (Level I) was met and Level II was needed.

A Level II screening ERA was performed for FBQ soils, sediment, and surface water using Ohio EPA and Army guidance methods. The Level II Screen consisted of a media-specific data and media evaluation of detected COIs, as well as a media-specific media screening. The data and media evaluation was conducted to identify whether the chemicals could be initially eliminated from further consideration due to low frequency of detection (data evaluation) and whether the chemicals were site related and have impacted the site [media evaluation that included comparison of detected concentrations against background (and SRVs for sediment) and identification of PBT compounds]. Any input COIs that were not eliminated during the data and media evaluation were carried forward to the media screening. The media screening entailed comparing concentrations of COPECs against ESVs (for soil and sediment) and OAC WQC for surface water. Chemicals whose concentrations exceeded or lacked the ESVs or OAC WQC, as well as chemicals that were PBT compounds, were retained as COPECs while all other chemicals were eliminated from further action.

For surface soil, 45 detected COIs were inputted into the data and media evaluations, wherein 4 were eliminated due to low frequency of detection and not being PBT compounds, so 41 were identified as COPECs and carried forward to the media screening. Of the 41 COPECs inputted into the media screening, 7 were eliminated because their concentrations did not exceed their ESVs and they were not PBT compounds, so 34 chemicals were retained as COPECs for surface soil.

For subsurface soil, 27 detected COIs were inputted into the data and media evaluations, wherein 6 were eliminated due to either low frequency of detection or MDC being less than background and not being PBT compounds, so 21 were identified as COPECs and carried forward to the media screening. Of the 21 COPECs inputted into the media screening, 6 were eliminated because their concentrations did not exceed their ESVs and they were not PBT compounds, so 15 chemicals were retained as COPECs for subsurface soil.

For sediment, and specifically the Large Ponds, 56 detected COIs were inputted into the data and media evaluations, wherein 4 were eliminated due to either low frequency of detection or MDCs being less than the Ohio EPA SRVs or background and they were not PBT compounds. Thus, 52 of the 56 detected COIs were identified as COPECs and carried forward to the media screening. Of the 52 COPECs inputted into the media screening, only 6 were eliminated because their concentrations did not exceed their ESVs and they were not PBT compounds, so 46 chemicals were retained as COPECs for sediment. For the Drainage Ditch, we started with 51 detected COIs and ended with 37 COPECs. For the Small Basins, the numbers were also 51 (starting) and 43 (ending).

For surface water, and specifically the Large Ponds, 12 detected COIs were inputted into the data and media evaluations, wherein 6 were eliminated due to MDCs being less than background and not being a PBT compound. Thus, 6 of the 12 detected COIs were identified as COPECs and carried forward to the media screening. Of the 6 COPECs inputted into the media screening, 2 were eliminated because their concentrations did not exceed their OAC WQC and they were not PBT compounds, so 4 chemicals were retained as COPECs for surface water. For the Drainage Ditch, we started with 16 detected COIs and ended with 5 COPECs. For the Small Basins, the numbers were 29 (starting) and 10 (ending).

Thus, based on the presence of several COPECs in soil, sediment, and surface water, as well as the presence of ecological receptors and exposure pathways to those COPECs at the FBQ site, a recommendation is made to move to a SMDP whose outcome is further evaluation by conducting a WOE assessment in an FS.

7.7 RECOMMENDATIONS

There is sufficient information from the Level II and Facility-wide Biological and Water Quality Study 2003, all at FBQ, to clarify that there are valuable wetland/aquatic ecological resources that are experiencing some ecological risk. There is no need for more studies, rather a strategy of how to best use that information. That strategy, in terms of likely outcomes, is explained next.

The most likely outcomes associated with the SMDP for the ERA, as mentioned in the assessment endpoint table, are listed below.

1. Risk management of the ecological resources, although they are limited and include aquatic resources in the ponds and terrestrial habitat otherwise.

2. Remediation of some of the source material if land use (assumed to be restricted access because of Ohio Guard needs) and other evidence, such as site-related usage COPECs, really warrant it.

3. Conduct of more investigation, such as a Level III Baseline, to further define COPECs when this would truly yield needed information to make a significantly better decision about the present and future role of ecological resources at FBQ.

Note that other logical outcomes, mentioned in Table 7-19, are not recommended:

4. No further action because of the presence of ecological risk.

5. Monitoring because of the need to make other decisions (1, 2, or 3) prior to this.

A WOE approach to the COPECs involved at FBQ would assist in defining the best outcome or decision. The WOE would use such topics as: (a) military land use, (b) aquatic habitat assessment at FBQ, (c) useful findings of the ecological screening level work, (d) degree of correlation of site usage or suspected usage COPECs (from Step 4 of the RVAAP facility-wide ecological risk work plan), (e) surface water quality and biological measurements (from the study of the same name at RVAAP), (f) negative consequences of source removal likely be more damaging to the habitat than status quo or current conditions, and (g) other, including the need or lack of need for ecological RGOs. The WOE will be part of the FS.

7.8 FINAL SUMMARY

The screens in Level II systematically removed chemicals from further consideration. However, some chemicals remain as COPECs at the conclusion of the ERA. For example, surface soil started with 45 detected COIs and ended with 34 COPECs; most of these are inorganics. Subsurface soil started with 27 detected COIs and ended with 15 COPECs; some are arsenic, lead, and zinc. For sediment, the process started with 56 detected COIs and ended with 46 COPECs at the Large Ponds; these are a mixture of inorganics and organics. Surface water had 12 detected COIs and ended with 4 COPECs at the Large Ponds; these are both inorganics and organics. The conclusion of the ERA and listing of final COPECs are available to the RVAAP Team to allow a more informed scientific management decision on the path forward for FBQ as discussed in Chapters 8.0 and 9.0. The most likely outcomes associated with the SMDP for the ERA, as mentioned in Table 7-19 and Section 7.12.3, are: (1) risk management of the ecological resources, (2) remediation of some of the source material, or (3) conduct of more investigation. In the FS, a WOE approach to the COPECs involved at FBQ would assist in defining the best outcome or decision. Thus, the information in the Level II screening ERA, along with comparisons to background and ESVs and other topics in the weight-of-evidence assessment, are presented to assist risk managers in making decisions to proceed with the SMDP.

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8.0 SUMMARY AND CONCLUSIONS

This chapter briefly summarizes the existing FBQ conditions that were found during the RI, the possible fate and transport of contaminants detected at the AOC, and the risk assessment tasks that were completed.

8.1 SUMMARY OF CONTAMINANT NATURE AND EXTENT

During the Phase I and II investigations at FBQ and the 40-mm Firing Range, 241 environmental samples were collected as follows: 100 surface soil samples, 67 subsurface soil samples, 48 sediment samples, 14 surface water samples, and 12 groundwater samples. The following text provides a summary of the results of the investigation.

8.1.1 Surface Soil

Based on the evaluation of the occurrence and distribution of contaminants in surface soil, SRCs are generally found

- At the FBQ, explosives and propellants are found with the greatest detection frequency at surface soil samples (FBQ-039, -042, -046, -050, and -052) located in the higher elevations northeast of the Quarry Ponds.
- At the FBQ, surface soil sample locations with ten or more inorganic SRCs above background include FBQ-002, -004, and -045, and were generally located in the higher elevations northeast of the northern-most Quarry Pond.
- At FBQ, SVOCs were only detected at FBQ-017 and -060.
- At FBQ, one pesticide was detected at two sample locations, FBQ-009 and -029.
- At the 40-mm Firing Range, FBQ-098 had the greatest number (six) of detected explosive/propellant compounds in surface soil samples.
- At the 40-mm Firing Range, the greatest number of surface soil inorganic SRCs above background are located at sample locations throughout the central portion of the 40-mm Firing Range area (FBQ-066, -078, -079, -086, -087, and -091).
- At the 40-mm Firing Range, seven VOCs were detected.
- At the 40-mm Firing Range, six pesticides were detected at FBQ-083.
- PCBs were not detected for either the FBQ or 40-mm Firing Range.

8.1.2 Subsurface Soil

Based on the evaluation of the occurrence and distribution of contaminants in subsurface soil at FBQ, the following observations can be made:

- At the FBQ, two explosive/propellant compounds were detected at three locations (FBQ-003, -009, and -019).
- At the FBQ, 13 inorganic compounds were detected above background, with 4 or more inorganic SRCs above background at the following sample locations: FBQ-017, -019, -021, -026, -028, -040, and -059.
- At the FBQ, six VOCs were detected at FBQ-003, -017, -018, -019, -051, -060, and -083.
- At the 40-mm Firing Range, three explosives/propellants were detected at least once at five sample locations (FBQ-067, -079, -082, -083, and -086).
- At the 40-mm Firing Range, nine inorganics were detected above background, with four or more inorganic SRCs above background at the following sample locations: FBQ-062, -063, -077, and -095.
- At the 40-mm Firing Range, six VOCs were detected at two locations, FBQ-083 and -086.
- No SVOCs, PCBs, or pesticides were detected in the subsurface soil samples collected from either FBQ or the 40-mm Firing Range area.

8.1.3 Sediment

The interpretation of chemical data obtained from FBQ sediment is summarized as follows:

- Explosives/propellants were detected in every sediment sample collected from the Quarry Ponds (except FBQ-147) and in almost half of the sediment samples collected from the settling basins.
- Explosives/propellants were not detected at samples collected from the unnamed creek in the southwest portion of the AOC, or in sediment samples collected south of the southern-most Quarry Pond.
- The following inorganic SRCs (with maximum concentration detected) occur in sediment above background levels:
  - Aluminum (22,100 mg/kg at FBQ-132),
  - Antimony (128 mg/kg at FBQ-146),
  - Arsenic (33.3 mg/kg at FBQ-143),
  - Barium (976 mg/kg at FBQ-155),
  - Beryllium (1.2 mg/kg at FBQ-130),
  - Cadmium (18.9 mg/kg at FBQ-148),
  - Chromium (1,140 mg/kg at FBQ-126),
  - Hexavalent chromium (33 mg/kg at FBQ-148),
  - Cobalt (18 mg/kg at FBQ-155),
  - Copper (660 mg/kg at FBQ-091),
  - Lead (31.3 mg/kg at FBQ-097),
  - Manganese (4,100 mg/kg at FBQ-141),
  - Mercury (35 mg/kg at FBQ-146),

- Nickel (80.5 mg/kg at FBQ-158),
- Selenium (8.2 mg/kg at FBQ-155),
- Silver (12.4 mg/kg at FBQ-146),
- Vanadium (42 mg/kg at FBQ-140), and
- Zinc (3,620 mg/kg at FBQ-148).

- The sample locations that had 14 or more inorganic SRCs above background are FBQ-126, -127, -142, -148, and -155.
- Sixteen SVOC SRCs were detected, with the highest concentrations measured for 9 of the 16 at FBQ-148, 3 of 16 at FBQ-141, and 1 of 16 at FBQ-156. SVOCs were also detected at FBQ-145 and -163.
- Five VOC SRCs were detected in sediment, with the highest concentrations measured for two of five at FBQ-156, one of five at FBQ-145, and one of five at FBQ-133. One VOC SRC was also detected at FBQ-142, -143, and -156.
- No PCBs or perchlorate were detected in sediment samples.
- Eleven pesticides were detected, seven of which were retained as SRCs and were detected at FBQ-132 and -139.

8.1.4 Surface Water

The following explosives/propellants were detected in surface water samples:

- 2-Amino-4,6-DNT and 4-amino-2,6-DNT was detected only at FBQ-134, obtained from one of the smaller settling basins.
- Nitrocellulose, which was detected at 12 of 15 stations, the highest concentration measured was 1.1 μg/L at FBQ-145.

The following inorganics were detected above facility-wide 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 site background occurred in surface water at station FBQ-130, which was 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 surface water samples for the Phase I/II RI: 4-methlphenol, bis(2-ethylhexyl) phthalate and phenol. The following VOCs were detected in 15 surface water samples collected for the Phase I/II RI:

- 2-Butanone was detected at three locations: FBQ-131 (5.1 μg/L), FBQ-132 (5 μg/L), and FBQ-134 (3.4 μg/L).
- Carbon disulfide was detected at three locations: FBQ-134 (1.7 μg/L), FBQ-139 (0.94 μg/L), and FBQ-141 (1.8 μg/L).
- Methylene chloride was detected at two sample locations: FBQ-145 (4.5 μg/kg) and FBQ-147 (4.7 μg/kg).

- Perchlorate was detected at two of nine original sample locations: 7.5 µg/L at FBQ-132 and 25 µg/L at FBQ-134; however, these locations were resampled in June 2004 and perchlorate was not detected in subsequent samples.

- Styrene was only detected at FBQ-132 (1.1 µg/L).

- Toluene was detected at ten sample locations, the highest concentration measured was 20 µg/L at FBQ-131.

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 site generally have a greater number of SRCs than the surface water sampled from the upgradient Quarry Ponds located to the east.

8.1.5 Groundwater

Wells Screened in Unconsolidated Materials

Explosives/propellants were detected in five of the six monitoring wells screed in the unconsolidated materials. The following explosives/propellants were detected:

- 2-amino-4,6-DNT – detected in FBQ-168.
- 4-amino-2,6-DNT – detected in FBQ-168.
- Nitrocellulose was detected FBQ-167, -168, -169, -176, and -177.

Inorganic SRCs detected above background in all six unconsolidated monitoring wells were barium and manganese. Aluminum and nickel in were detected in three, zinc and cobalt in two, and copper and cadmium in one. FBQ-169 had the most inorganic SRCs at the maximum concentration detected in groundwater sampled from the unconsolidated materials.

The SVOCs caprolactum (three of six samples) and bis(2-ethylhexyl) phthalate (three of six samples) were detected in the monitoring well samples. The following VOCs were detected in groundwater samples collected from the unconsolidated materials:

- 1,1,1-Trichloethane was detected at FBQ-167.
- 1,1-DCE was detected at FBQ-167 and -169.
- Acetone was detected at FBQ-167, -168, and -169.
- Carbon disulfide was detected at FBQ-177

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

Wells Screened in Sandstone Bedrock

Six explosive/propellant compounds were detected in the monitoring wells screened in bedrock. These compounds are as follows:

- 2,4,6-TNT was detected at FBQ-173 and -174.

- 2,4-DNT was detected in FBQ-174.

- 2-Amino-4,6-DNT was detected at FBQ-173 and -174.
- 4-Amino-2,6-dDNT was detected at FBQ-173 and -174.
- Nitrobenzene was detected at FBQ-173.
- Nitrocellulose was detected in five of the six wells screened in bedrock, the highest concentration measured was at FBQ-175 (0.32 μg/L). Nitrocellulose was not detected in FBQ-166.

Barium and manganese and was detected in all six bedrock-screened monitoring wells. Zinc was detected in four of the wells, cobalt in three of the samples, nickel in two of the samples, and aluminum and hexavalent chromium in one of the samples. FBQ-173 had the most inorganic SRCs detected (aluminum, cobalt, copper, lead, manganese, and nickel).

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. The following VOCs were detected in groundwater samples collected from bedrock:

- Acetone was detected in two of three samples, the highest concentration measured was at FBQ-175 (6.2 μg/L).
- TCE was detected at FBQ-170 (12 μg/L) and FBQ-171 (7.1 μg/L).

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, FBQ-173. The monitoring wells with the lowest number of SRCs are the downgradient wells, FBQ-166, -177, and -176.

8.2 SUMMARY OF CONTAMINANT FATE AND TRANSPORT

Based on site characterization and monitoring data, metals, organics, and explosives-related compounds exist in the surface soil, subsurface soil, and groundwater at FBQ and the 40-mm Firing Range. Based on site 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 MCLs/RBCs. Fate and transport modeling indicate 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 for the three source areas are as follows.

Fuze and Booster Quarry Landfill/Ponds

2,4-DNT; 2,6-DNT; nitrobenzene; RDX; methylene chloride; chromium; and selenium were identified as initial CMCOPCs for from 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 SESOIL modeling.

RDX and chromium were identified as CMCOCs based on 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. Although the maximum groundwater concentrations of these constituents were predicted or observed to exceed MCLs/RBCs within the site boundary, none of these constituents were predicted to reach the downgradient receptor location (i.e., unnamed creek) at concentrations exceeding their respective MCL/RBC.

40-mm Firing Range

2,4-DNT; 3-nitrotoluene; nitrobenzene; lindane; 1,1-DCE; and chromium were identified as initial CMCOPCs for the 40-mm Firing Range based on soil screening analysis. Only chromium was identified as final CMCOPCs for FBQ based on source loading predicted by the SESOIL modeling. Chromium was also identified as CMCOCs based on AT123D modeling. The maximum groundwater concentration of chromium was predicted to exceed its MCL below the source as well as at the downgradient source boundary. However, it was not predicted to reach the downgradient receptor location (i.e., unnamed creek) within 1,000 years of simulation time.

Sediment Aggregate at FBQ

- 1,3-Dinitrobenzene, 1,3,5-trinitrobenzene, 2,6-DNT; 3-nitrotoluene; nitrobenzene; and selenium were identified as initial CMCOPCs for from the sediments based on soil screening analysis.

- None of the initial CMCOPCs were identified as final CMCOPCs for this source area based on source loading predicted by the SESOIL modeling. Therefore, contaminated sediments from this site are not predicted to impact groundwater in the future.

8.3 SUMMARY OF THE HUMAN HEALTH RISK ASSESSMENT

This HHRA was conducted to evaluate risks and hazards associated with contaminated media at the FBQ AOC at RVAAP. Risks and hazards were estimated for four representative receptors (National Guard Trainee, Fire/Dust Suppression Worker, Security Guard/Maintenance Worker, and Hunter/Trapper/Fisher) exposed to four media (surface soil, groundwater, sediment, and surface water). The following steps were used to generate conclusions regarding human health risks and hazards associated with contaminated media at FBQ:

- identification of COPCs,
- calculation of risks and hazards,
- identification of COCs, and
- calculation of RGOs.

Results characterization results for the representative receptors are summarized below for each medium.

- Two surface soil COCs (arsenic and manganese) were identified for the National Guard Trainee and one (arsenic) for the Security Guard/Maintenance Worker. EPCs for both these metals are below background concentrations.

- No surface soil COCs were identified for the Hunter/Trapper/Fisher and Fire/Dust Suppression Worker.

- No groundwater COCs were identified for the National Guard Trainee. Fire/Dust Suppression Worker, Security Guard/Maintenance Worker, and Hunter/Trapper/Fisher are not exposed to groundwater.

- Two sediment COCs were identified for the National Guard Trainee at the Ditch (arsenic and manganese) and three COCs (arsenic, cadmium, and hexavalent chromium) were identified at the Quarry Ponds for this receptor.

- No sediment COCs were identified for the Fire/Dust Suppression Worker or Hunter/Trapper/Fisher.

- Two surface water COCs [arsenic and bis(2-ethylhexyl)phthalate] were identified for the National Guard Trainee at the Settling Basins. No surface water COCs were identified for this receptor at the Drainage Ditch or Quarry Ponds.

- No surface water COCs were identified for any of the applicable representative receptors at the Drainage Ditch and Quarry Ponds.

- Waterfowl concentrations were conservatively modeled for all COPCs identified in the sediment and surface water at the FBQ Quarry Ponds. The total estimated ILCR and HI for ingestion of hypothetical waterfowl exposed exclusively at the Quarry Ponds exceeded the target HI of 1.0 and target ILCR of 1.0E-06. Because of the high level of uncertainty associated with modeling tissue concentrations and the actual location of exposure of waterfowl harvested at the Quarry Ponds, RGOs are not calculated for this indirect exposure pathway.

Risks and hazards were also calculated for potential exposure to surface soil, subsurface soil, groundwater, sediment, and surface water by a Resident Subsistence Farmer (adult and child). While a LUP has been drafted for the RTLS, and OHARNG will control the property, there is uncertainty in the details of the future land use (e.g., if the perimeter fence is not maintained, a trespasser could enter the property). There is little to no uncertainty associated with the assumption that RVAAP will not be released for residential use; however, a Resident Subsistence Farmer receptor was evaluated to provide a baseline scenario to evaluate unrestricted release in the FS.

8.4 SUMMARY OF THE SCREENING 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 old fields, woodlots, and grassy areas. Various classes of receptors, such as vegetation, small and large mammals, and birds, have been observed at the site. The presence of suitable habitat and observed receptors at the site warranted a screening ERA. Thus, Ohio EPA protocol (Level I) was met and Level II was needed.

The Level II screening ERA performed for FBQ included soils, sediment, and surface water using Ohio EPA guidance methods. The Level II screen consisted of a media-specific data evaluation for detected COIs, as well as a media-specific screen. The data and media evaluation were conducted to identify whether the chemicals could be initially eliminated from further consideration due to low frequency of detection (data evaluation) and whether the chemicals were site related and have impacted the site [media evaluation that included comparison of detected concentrations against background (and SRVs for sediment) and identification of PBT compounds]. Any input COIs that were not eliminated during the data evaluation were carried forward to the media screen. The media screen entailed comparing concentrations of inputted chemicals against ESVs (for soil and sediment) and OAC WQS for surface water. Chemicals whose concentrations exceeded or lacked the ESVs or OAC WQS, as well as chemicals that were PBT compounds, were retained as COPECs while all other chemicals were eliminated from further action.

8.4.1 Soil

For surface soil, 45 detected COIs were inputted into the data and media evaluations, wherein 4 were eliminated due to low frequency of detection and not being PBT compounds, so 41 were identified as COPECs and carried forward to the media screening. Of the 41 COPECs inputted into the media screening, 7 were eliminated because their concentrations did not exceed their ESVs and they were not PBT compounds, so 34 chemicals were retained as COPECs for surface soil.

For subsurface soil, 27 detected COIs were inputted into the data and media evaluations, wherein 6 were eliminated due to either low frequency of detection or MDC being less than background and not being PBT compounds, so 21 were identified as COPECs and carried forward to the media screening. Of the 21 COPECs inputted into the media screening, 6 were eliminated because their concentrations did not exceed their ESVs and they were not PBT compounds, so 15 chemicals were retained as COPECs for subsurface soil.

8.4.2 Sediment

For sediment, and specifically the Large Ponds, 56 detected COIs were inputted into the data and media evaluations, wherein 4 were eliminated due to either low frequency of detection or MDCs being less than the Ohio EPA SRVs or background and they were not PBT compounds. Thus, 52 of the 56 detected COIs were identified as COPECs and carried forward to the media screening. Of the 52 COPECs inputted into the media screening, only 6 were eliminated because their concentrations did not exceed their ESVs and they were not PBT compounds, so 46 chemicals were retained as COPECs for sediment. For the Drainage Ditch, we started with 51 detected COIs and ended with 37 COPECs. For the Small Basins, the numbers were also 51 (starting) and 43 (ending).

8.4.3 Surface Water

For surface water, and specifically the Large Ponds, 12 detected COIs were inputted into the data and media evaluations, wherein 6 were eliminated due to MDCs being less than background and not being a PBT compound. Thus, 6 of the 12 detected COIs were identified as COPECs and carried forward to the media screening. Of the 6 COPECs inputted into the media screening, 2 were eliminated because their concentrations did not exceed their OAC WQC and they were not PBT compounds, so 4 chemicals were retained as COPECs for surface water. For the Drainage Ditch, we started with 16 detected COIs and ended with 5 COPECs. For the Small Basins, the numbers were 29 (starting) and 10 (ending).

8.4.4 Conclusions

Based on the presence of multiple COPECs in soil, sediment, and surface water, as well as the presence of site-specific ecological receptors and complete exposure pathways to those COPECs at FBQ, a recommendation is made to move to a SMDP. The most likely outcomes associated with the SMDP for the ERA, as mentioned in Chapter 7.0, are: (1) risk management of the ecological resources based on the military land use or other reasons that may include development of RGOs or WOE analysis that no RGOs are required; (2) remediation of some of the source material, if required, to reduce ecological risks; or (3) conduct of more investigation, such as a Level III. In the FS, a WOE approach to the COPECs involved at FBQ would assist in defining the best outcome or decision. Thus, the information in the Level II screening ERA, along with comparisons to background and ESVs and other topics in the weight-of-evidence assessment, are presented to assist risk managers in making decisions to proceed with the SMDP.

9.0 RECOMMENDATIONS

The purpose of this investigation was to define the nature and extent of contamination at FBQ and the nearby 40-mm Firing Range and to support an HHRA and ERA at both sites. Recommendations regarding FBQ are provided below. Data collected at the 40-mm Firing Range are presented in this RI up through nature and extent (Chapter 4). Subsequent evaluation of the 40-mm Firing Range data is presented in *Evaluation of Chemical Residuum at the 40-mm Range, Ravenna Army Ammunition Plant, Ravenna, Ohio*.

9.1 NATURE AND EXTENT OF CONTAMINATION

It is recommended that an FS be performed for FBQ. The future land use and controls of this AOC should be determined prior to developing plans for an FS. Identification of future land uses provides the basic information necessary to select the appropriate remedial response needed to achieve protection of human health and the environment, allows development of appropriate remedial action objectives, and allows finalization and application of remedial goals for appropriate potential receptors identified in the risk assessments.

The lateral and vertical extent of contamination was not determined in all cases for each media. The following uncertainties should be addressed to allow for a complete evaluation of possible remedial actions:

1. Determine the lateral and horizontal limits of inorganic compounds in the surface and subsurface soil at FBQ. A Supplemental Phase II sampling at FBQ will be implemented to 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. In addition, one location exceeds background for manganese (1,450 mg/kg) that is only partially bounded, for which an additional sample will be collected to define the extent in that area.

2. The unnamed tributary near Greenleaf Road receives much of the surface water runoff from FBQ and ultimately flows into Hinckley Creek. Sediment samples were collected from the unnamed tributary near Greenleaf Road, however, surface water was not present and samples could not be collected to evaluate potential impacts to surface water leaving FBQ. Sediment and surface water samples were collected from the up-gradient settling basins, drainage ditches and quarry ponds as well as from the up-gradient surface soils that may contribute to the unnamed tributary. Nature, extent, and potential risk from exposures at these up-gradient areas were characterized and evaluated in this RI Report. In addition to the evaluation performed in this RI, no biological impairment associated with chemical contaminants was observed based on sampling results from Hinckley Creek as noted in the FWSW Report (USACE 2005). Thus potential surface water impacts have been sufficiently characterized at FBQ.

3. Perchlorate was detected in two of ten surface water samples collected in 2003. Perchlorate was not detected in subsequent surface water and sediment samples collected in 2004. EPA Method 314.0 was used to analyze these samples and has been demonstrated to indicate false positives as a result of sediment or dissolved ions commonly found in surface water. Agreement on the method and potential refinements in the methodology and interpretation of the data need to occur before further perchlorate analysis is conducted at RVAAP.

9.2 HUMAN HEALTH RISK ASSESSMENT

Arsenic and manganese were identified as COCs in soil and sediment for the National Guard Trainee at FBQ; however, the 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. It is recommended that decision makers carefully consider the need for further investigation or remedial action based on the risk assessment results for this receptor taken at face value.

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 EU. Therefore, as with the soil and sediment results, it is recommended that decision makers carefully consider the need for further investigation or remedial action based on the calculated risks using these data.

9.3 ECOLOGICAL RISK ASSESSMENT

The screening ERA identified the presence of multiple COPECs in soil, sediment, and surface water, as well as the presence of site-specific ecological receptors and complete exposure pathways to those COPECs at the FBQ site. A recommendation is made to move to a SMDP. The most likely outcomes associated with the SMDP for the ERA, as mentioned in Chapters 7 and 8, are: (1) risk management of the ecological resources based on the military land use or other reasons that may include development of RGOs or WOE analysis that no RGOs are required; (2) remediation of some of the source material, if required, to reduce ecological risks; or (3) conduct of more investigation, such as a Level III. In the FS, a WOE approach to the COPECs involved at FBQ would assist in defining the best outcome or decision. Thus, the information in this Level II screening ERA presented in this report can be used to assist risk managers in making their decision associated with the SMDP.

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DRAFT PHASE I/PHASE II REMEDIAL INVESTIGATION OF THE FUZE AND BOOSTER QUARRY/LANDFILL PONDS AT THE RAVENNA ARMY AMMUNITION PLANT, RAVENNA OHIO
COMMENT RESPONSE TABLE
NOVEMBER 18, 2005

Cmt No.	Page or Sheet	Comment	Recommendation	Response
Ohio EPA NEDO, DERR/DDAGW and SWDO OFFO (T. Fisher, C. McCambridge, L. Moore)				
1.	NEW, General	Since the 40mm Range is going to be evaluated as a stand alone document and considering that the data from the 40 mm range is not included in the risk assessment evaluation found in this report, the Ohio EPA questions what value there is for having text discussing the 40-mm firing range in this report.	Please consider removing all discussion of the 40 mm range from this report.	Clarification. It was determined during discussions concerning the preliminary draft CRT that the 40-mm Firing Range data collection/nature and extent discussions would remain in the FBQ RI Report. In response to Ohio EPA Comment #39 on the preliminary draft FBQ RI Report, the text was revised to differentiate between samples collected at FBQ and samples collected at the 40-mm Firing Range and a reference was included in the FBQ RI Report to the subsequent data evaluation report being prepared for the 40-mm Firing Range by USACE. *Please also see response to Ohio EPA Comment #3.*
2.	NEW, General	Potentially Exposed Populations - Issue = Inclusion of the Trespasser. Ohio EPA has repeatedly stated that the Trespasser Receptor was not to be evaluated as a receptor in the risk assessment until the USACE and Ohio EPA had an opportunity to review, comment and approve the assumptions for this receptor. However, the trespasser does appear in the risk assessment found in Section 6.0. Ohio EPA has reviewed the trespasser assumptions and provided comments, however, these comments have not yet been resolved.	Until resolution and consensus is reached, the trespasser should be removed.	Agree. The draft FBQ RI Report was completed prior to resolution of a similar comment on RQL, CBP, and EBG RI Reports; thus, the trespasser scenario was not removed prior to submission of the draft FBQ RI Report. Similar to comment resolution on RQL, CBP, and EBG RI Reports, the trespasser scenario will be removed from the Draft FBQ RI Report and included in the FS as an appendix. The trespasser scenario will be finalized as part of the FS review/revision process.

Cmt No.	Page or Sheet	Comment	Recommendation	Response
3.	NEW, Section 1.1 Scope and Purpose, page 1-5, lines 20 -23	The text states that "data collected at the 40-mm Firing Range is included in this RI up through nature and extent (Chapter 4)." This does not appear to be the case. The 40-mm Firing Range is included in Section 5.6 of the Fate and Transport Chapter (Chapter 5) and in Sections 8.1 and 8.2 of the Summary and Conclusions Chapter (Chapter 8).	Please make the appropriate changes to the text.	Clarification. Per 07 Nov. 2005 FBQ Draft RI Report CRT teleconference text revised to state: "The 40-mm Firing Range (AOC-32) was also investigated during the Phase I/Phase II RI at FBQ. Data collected at the 40-mm Firing Range is included in this RI; however it is not included in Section 6 (HHRA) or Section 7 (ERA). Evaluation of the 40-mm Firing Range data is presented in the *Phase I Remedial Investigation of the 40-mm Range, Ravenna Army Ammunition Plant, Ravenna, Ohio* (USACE 2006)." Per USACE e-mail dated 11-17-2005 and subsequent discussions with USACE on 11-17-2005, the title of the 40-mm Firing Range report will not be updated but will remain as previously listed: *Evaluation of Chemical Residuum at the 40- mm Range, Ravenna Army Ammunition Plant, Ravenna, Ohio*. This USACE-supplied title has been substituted in the text referenced above. All other changes have been made as requested.
4.	Figure 3-2, Monitoring Well and Test Pit Locations, pg. 3-13.	There is no means of differentiating which wells are screened in bedrock vs. wells that are screened in the unconsolidated materials.	Please indicate in this Figure which wells are bedrock wells and which wells are screened in the unconsolidated materials.	Agree. Figure 3-2 will be revised to differentiate wells that were screened in bedrock and wells that were screened in unconsolidated material.

Cmt No.	Page or Sheet	Comment	Recommendation	Response
5.	OLD, CRT Comment #9	The response stated that reference to bulk storage of explosives was removed from the sentence. This did not occur	Please remove reference to bulk storage explosives in the text.	Agree. Section 1.2, page 1-6, lines 17-20, text in draft report will be revised to state: "The only activities still being carried out from the wartime era are the infrequent demolition of unexploded ordnance (UXO) found at the Installation."
6.	OLD, CRT Comment #10	The response stated that an explanation for this symbol will be added to the figure indicating this is a telephone pole. This did not occur.	Please indicate on the figure that these symbols represent telephone poles.	Agree. Figure 1-4 will include a symbol defining the telephone poles in the legend in the FINAL version.
7.	OLD, CRT Comment #41	The response stated that an explanation for this symbol will be added to the figure indicating this is a telephone pole. This did not occur.	Please indicate on the figure that these symbols represent telephone poles.	Agree. Figure 3-1 will include a symbol defining the telephone poles in the legend.
8.	OLD , CRT Comment #43	The response stated that an explanation for this symbol will be added to the figure indicating this is a telephone pole. This did not occur.	Please indicate on the figure that these symbols represent telephone poles.	Agree. Figure 3-2 will include a symbol defining the telephone poles in the legend.
9.	OLD, CRT Comment #46	The response stated that an explanation for this symbol will be added to the figure indicating this is a telephone pole. This did not occur.	Please indicate on the figure that these symbols represent telephone poles.	Agree. Figure 3-3 will include a symbol defining the telephone poles in the legend.
10.	OLD, CRT Comment #47	The response stated that an explanation for this symbol will be added to the figure indicating this is a telephone pole. This did not occur.	Please indicate on the figure that these symbols represent telephone poles.	Agree. Figure 3-4 will include a symbol defining the telephone poles in the legend.
11.	OLD, CRT Comment #57	The response stated that an explanation for this symbol will be added to the figure indicating this is a telephone pole. This did not occur.	Please indicate on the figure that these symbols represent telephone poles.	Agree. Figure 4-2 will include a symbol defining the telephone poles in the legend.

Cmt No.	Page or Sheet	Comment	Recommendation	Response
12.	OLD, CRT Comment #65	The response stated that an explanation for this symbol will be added to the figure indicating this is a telephone pole. This did not occur.	Please indicate on the figure that these symbols represent telephone poles.	Agree. Figure 4-3 will include a symbol defining the telephone poles in the legend.
13.	OLD, CRT Comment #68	Response indicated that figure would be revised to include information as to why samples were not collected. This did not occur.	Please provide this information as requested.	Agree. The legend in Figure 4-3 will be changed to state "Not Sampled (please refer to Table 3-1)."
14.	OLD, CRT Comment #69	The response stated that an explanation for this symbol will be added to the figure indicating this is a telephone pole. This did not occur.	Please indicate on the figure that these symbols represent telephone poles.	Agree. Figure 4-4 will include a symbol defining the telephone poles in the legend.
15.	OLD, CRT Comment #73	Response indicated that figure would be revised to include information as to why samples were not collected. This did not occur.	Please provide this information as requested.	Agree. The legend in Figure 4-4 will be changed to state "Not Sampled (please refer to Table 3-1)."
16.	OLD, CRT Comment #81	The response stated that an explanation for this symbol will be added to the figure indicating this is a telephone pole. This did not occur.	Please indicate on the figure that these symbols represent telephone poles.	Agree. Figure 4-5 will include a symbol defining the telephone poles in the legend.
17.	OLD, CRT Comment #83	The response stated that an explanation for this symbol will be added to the figure indicating this is a telephone pole. This did not occur.	Please indicate on the figure that these symbols represent telephone poles.	Agree. Figure 4-6 will include a symbol defining the telephone poles in the legend.
18.	OLD, CRT Comment #96	The response stated that an explanation for this symbol will be added to the figure indicating this is a telephone pole. This did not occur.	Please indicate on the figure that these symbols represent telephone poles.	Agree. Figure 4-8 will include a symbol defining the telephone poles in the legend. Also, although not commented on (OLD, CRT Comment #89), Figure 4-7 will include a symbol defining the telephone poles in the legend.

Cmt No.	Page or Sheet	Comment	Recommendation	Response
19.	OLD, CRT Comment #100	The response stated that the following footnote would be added to the table: "Analytes may have been eliminated as SRCs because they were detected at concentrations less than installation background levels." This did not occur.	Please add this statement to the table footnote.	Agree. The following footnote was added to Table 4-10 for the FINAL version: "Analytes may have been eliminated as SRCs because they were detected at concentrations less than facility-wide background criteria."
20.	OLD, CRT Comment #104	The response stated that an explanation for this symbol will be added to the figure indicating this is a telephone pole. This did not occur.	Please indicate on the figure that these symbols represent telephone poles.	Agree. Figure 4-9 will include a symbol defining the telephone poles in the legend.
21.	OLD, CRT Comments #107, #109, #110, #112, #116	The responses to these comments indicated that the text would be revised, using the words "Unconsolidated Materials." This did not occur. The use of "Unconsolidated Sediments" with respect to glacial overburden is still being used and is not acceptable to the Ohio EPA.	Please change all occurrence of "Unconsolidated Sediments" to "Unconsolidated Materials" in the text.	Agree. The intent of OLD CRT Comments #107, #109, #110, #112, and #116 was not completely understood with regards to the use of "Unconsolidated Materials" instead of "Unconsolidated Sediments." Global search performed and all references of "Unconsolidated Sediments" were changed to "Unconsolidated Materials".
22.	NEW, Section 5.2, pg. 5-1, lines 5 and 21	The text stated that sediment sampling data shows the presence of chemicals of potential concern (COPCs) (Section 2.7.2, pg. 2-15 and Section 6.2.2.4, pg. 6-17). However, the sediment media was not considered in the modeling exercise. The reason for not including sediment to ground water pathway in the contaminant fate and transport modeling was not clear in the submittal.	Please provide a discussion of whether the sediment to ground water pathway was considered, but was eliminated from further evaluation.	Agree. SESOIL modeling will be re-run to include sediment results. Results of the modeling will be included in the FINAL version of the RI Report.

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23.	NEW, Section 5.2, pg. 5-3, lines 17 and 18	The text indicates that *"metals in soils are commonly found in several forms..."*	Please include a reference for this statement.	Agree. Text revised to include reference to Shuman 1991. Text revised as follows: "Metals in soil are commonly found in several forms, including dissolved concentrations in soil pore water, metal ions occupying exchange sites on inorganic soil constituents, specifically adsorbed metal ions on inorganic soil constituents, metal ions associated with insoluble organic matter, precipitated inorganic compounds as pure or mixed solids, and metal ions present in the structure of primary or secondary minerals (Shuman 1991)."
24.	NEW, Section 5.2.5, pg. 5-4, line 11	The text notes that chemical compounds related to explosives were detected in soil at FBQ. However, it is unclear whether these compounds were also detected in sediments at FBQ.	Please provide a clarification as to whether chemical compounds related to explosives were also detected in sediments at FBQ.	As stated in Section 4.5.2, there were detections of explosives in sediment at FBQ. The statement on line 11 of Page 5-4 will be revised to state: "Explosive compounds were detected in soil and sediment at FBQ."
25.	NEW, Section 5.2.5, pg. 5-4, lines 20 and 21	The text indicates that the biotransformation of 2,4-DNT has been *"systemically studied"* and refers to Figure 5-2. The reference to this biotransformation study indicated in the text and in Figure 5-2 is unclear.	Please include a reference for this statement and corresponding Figure 5-2.	Agree. Text revised as follows: "The biotransformation of 2,4-DNT has been systematically studied in laboratory cell cultures (McCormick et al. 1978)." Figure title revised as follows: Figure 5-2. 2,4-DNT Biotransformation Pathway (McCormick et al. 1978).

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26.	NEW, Section 5.3.1, pg. 5-6,	The text stated that sediment sampling data shows evidence of COPCs (Section 2.7.2, pg. 2-15 and Section 6.2.2.4, pg. 6-17). However, these chemicals in sediments were not considered in the fate and transport modeling. The reason for this omission is not apparent in the submittal.	Provide a discussion why sediment contaminant sources were eliminated from contaminant fate and transport analysis.	Agree. SESOIL modeling will be updated to include an evaluation of potential leachability of impacted sediment in the settling basins and drainage ditches at FBQ (Sediment Aggregate). These sediments are only periodically inundated (e.g., during storm events) and, consistent with previous RVAAP RIs for similar AOCs (e.g., Erie Burning Grounds), they will be addressed as soil matrices. The updated SESOIL model will not include sediment in the Quarry Ponds as these are sub-aqueous and in direct contact with groundwater. Impacts to surface water in the Quarry Ponds were directly measured in this RI (Section 4.6). Results of the updated SESOIL modeling are included in Section 5 of the FINAL version of the RI Report.
27.	NEW, Section 5.3.2, pg. 5-6, lines 25, 35, and 36	The text appears to be discussing soils for *"RVAAP"* (line 26) and *"Sebring soils"* (line 35). It is unclear if this text is characterizing soils for the entire RVAAP or specifically at FBQ. It is also unclear where Sebring soils were found at FBQ.	Please provide clarification to these issues.	Agree. Section 5 addresses FBQ and the 40-mm Firing Range. Text in this section will be clarified. The reference to Sebring soils will be deleted as it is not applicable to either site.
28.	NEW, Section 5.3.4, pg. 5-7	a) Was surface water flow considered an erosional transport mechanism for contaminated soils to nearby streams and ponds at FBQ? If not, why is erosion not considered at FBQ? b) The text indicates that precipitation and temperature data *"for the 100-year period"* was used. It is unclear what 100-year period is being referenced.	a) Please provide clarification to these issues. b) Please clarify this statement.	Discussion requested. Surface water and sediment transport are considered minor future pathways and were not evaluated in fate and transport modeling although this pathway may have been more significant in the past. Current impacted surface soils are limited in extent (e.g., few detects of explosives/propellants, SVOCs, and VOCs; highest detects of inorganics limited to few sample locations). A broader range of constituents were detected in the quarry pond sediment than in surface soils. Vegetation limits sediment

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				transport in the vicinity of the quarry ponds. The southernmost quarry pond has an overflow pipe that discharges water to the west – presumably the nearby ditch. The other two quarry ponds do not have overflow drainage points. Streams at FBQ are ephemeral and only limited surface water was available for sample collection – stream just west of quarry ponds was sampled but unnamed tributary near Greenleaf Road was not. The settling basins by design limit sediment transport. In addition, the western portion of the site where these are located is relatively flat further limiting significant sediment transport. Vegetation also limits sediment transport in the vicinity of the unnamed tributary near Greenleaf Road. Per 07 Nov. 2005 FBQ Draft RI Report CRT teleconference, this discussion has been added to Section 5.3.3 Contaminant Release Mechanisms and Migration Pathways. b) Clarification. For developing a steady-state water balance scenario HELP model was used to generate a 100-year climatic conditions (e.g., rainfall, temperature, solar radiation,etc). These data were used to simulate water balance at this site using HELP model. Text revised to state: "The water balance estimations were developed using the Hydrologic Evaluation of Landfill Performance (HELP) model (Schroeder et al. 1994) calculations for FBQ site conditions using precipitation and temperature data for a 100-year period generated synthetically in HELP using coefficients for Cleveland, Ohio."

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29.	NEW, Section 5.5.1, pg. 5-11	It is unclear whether the SESOIL and AT123D models were calibrated.	Please provide clarification to this issue.	Agree. The follow text will be added to Section 5.5.1. "The SESOIL model was calibrated to match the percolation rate developed by the HELP model simulation. If the concentration in the groundwater was observed to be higher than the leachate concentration predicted by SESOIL, the AT123D was calibrated to match the observed groundwater concentration."
30.	NEW, Section 5.5.2.1, Table 5-1, pg. 5-10	<u>SESOIL Model - Input Values:</u> This model was used as a soil leachability analysis to identify the predicted peak leachate and ground water COPC concentrations beneath the source area. a) The model input values of bulk density, total porosity, and fraction organic carbon content were based on *"site-specific geotechnical data"* that are listed in Table 5-1. The information on the location and depth of the soil samples analyzed for these soil parameters is not provided in the submittal. b) It is not clear whether maximum or average COPC concentrations were used in this modeling exercise. Were the COPC concentrations used representative of the FBQ area? c) It is unclear whether air-filled soil porosity was used as an input value during SESOIL modeling.	a) Please provide clarification as to the location and depth of the soils samples analyzed for these SESOIL input parameters. b) Please provide clarification to this issue. c) Please provide clarification to this	Agree. Text in Section 5.5.2.1 will be revised as noted after the following clarifications. a) Agree. The following footnote has been added to Table 5-1 for bulk density, total porosity, and fraction organic carbon: "See Table 4-1 for information on the depths and locations of geotechnical samples" b) Clarification. The loading soil concentrations used in the modeling exercise represent the exposure point concentrations (i.e., smaller of the maximum or the 95% UCL within the contaminated soil zone interval). c) Clarification. Air-filled soil porosity is not an input parameter for SESOIL. SESOIL estimates the air-filled soil porosity by subtracting the average soil moisture from the porosity. The average soil moisture is developed by the hydrologic cycle of SESOIL. In response to comments a, b, and c above text in Section 5.5.2.1 revised to state: "Details of the model layers utilized in this modeling are presented in Tables L-9 and L-10 of Appendix L. The SESOIL

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			issue.	model was calibrated against the percolation rate by varying the intrinsic permeability and by keeping all other site-specific geotechnical parameters fixed. The final site-specific hydrogeologic parameter values used in this modeling are shown in Table 5-1. Fraction organic carbon, bulk density, and porosity were determined based on site-specific geotechnical data collected (See Table 4-1). The hydraulic conductivity value represents the geometric mean from the slug test analysis (slug in and slug out) conducted from monitoring wells FBQ-166 through FBQ-177. Longitudinal dispersivity is assumed to be 10 based on Gelhar and Axness (1981) suggestion of using 10% of the mean travel distance for estimating. Gelhar et al. (1985)indicates no definite conclusion can be reached greater than 100m distance. Therefore 0.1 X 100m, or 10 is used as the longitudinal dispersivity. The loading soil concentrations used in the model represent the exposure concentration (i.e., smaller of the maximum detected concentration or the 95% UCL).
31.	NEW, Section 5.5.2.1, Table 5-1, pg. 5-13	SESOIL Model: Equation 5-8 indicated that the leachate travel time was denoted as T_r. However, the symbol T_t was used to denote the leachate travel time.	Please provide a clarification as to which symbol (T_r or T_t) will be used for the leachate travel time.	Clarification. This was a typo and has been corrected to T_r.
32.	NEW, Section 5.5.2.1,Table 5-1, pg. 5-10	AT123D Model - Input Values: This model was used to predict the future concentrations of COPCs in ground water exiting the downgradient boundary of FBQ. a) The aquifer thickness input value was based	a) Provide a discussion concerning the how the aquifer thickness value was derived in Table 5-1. Which well/boring logs were used to derive the average thickness for FBQ?	Agree. Text in Section 5.5.2.1 will be revised as noted after the following clarifications. a) Clarification. Aquifer thickness was developed based on an average value estimated from 12 well/boring logs, namely, FBQ-166 through FBQ-177.

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		on *"average site-specific"* data. b) The source of the hydraulic conductivity value was listed as *"site-specific slug test data"* in Table 5-1. It is unclear whether this value was based on information from only one well or from several wells. c) The longitudinal dispersivity value was *"assumed"* to be 10. It is unclear what reference this assumption was based.	b) Provide a discussion for this issue. If information multiple wells were used, please indicate the wells from which slug test data was used. Was the chosen value based on average of several values or it was chosen to represent the worst case scenario? c) Please provide clarification as to what reference was used to determine this value.	b) Clarification. The hydraulic conductivity value also represent a geometric mean from the slug test data of all the wells considered for slug test analysis (FBQ-166 through FBQ-177). Hydraulic conductivity values from both slugs in and out were utilized. c) Clarification. The longitudinal dispersivity can be estimated from tracer test data, if not available then by using a analytical expression or based on plume length. However none of this information are available for this site. Therefore, a value of 10 was assumed based on Gelhar and Axnes (1981) using 10% of the mean travel distance and Gelhar et al. (1985) indicating no definite conclusion can be reached greater than 100m distance. Therefore, 10 or (0.1 X 100m) was used as the longitudinal dispersivity. This is consistent with previous RVAAP F&T modeling parameters. Based on response to comments to a, b, and c above, text in Section 5.5.2.1 revised to state: "Details of the model layers utilized in this modeling are presented in Tables L-9 and L-10 of Appendix L. The SESOIL model was calibrated against the percolation rate by varying the intrinsic permeability and by keeping all other site-specific geotechnical parameters fixed. The final site-specific hydrogeologic parameter values used in this modeling are shown in Table 5-1. Fraction organic carbon, bulk density, and porosity were determined based on site-specific geotechnical data collected (See Table 4-1). The hydraulic conductivity

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				value represents the geometric mean from the slug test analysis (slug in and slug out) conducted from monitoring wells FBQ-166 through FBQ-177. Longitudinal dispersivity is assumed to be 10 based on Gelhar and Axness (1981) suggestion of using 10% of the mean travel distance for estimating. Gelhar et al. (1985)indicates that no definite conclusion can be reached greater than 100m distance. Therefore 0.1 X 100m, or 10 is used as the longitudinal dispersivity. The loading soil concentrations used in the model represent the exposure concentration (i.e., smaller of the maximum detected concentration or the 95% UCL).
33.	NEW, Section 6.2, Data Evaluation	Please include a table that lists the sample ID and corresponding depth for each exposure medium evaluated in the risk assessment (similar to tables 6-1 to 6-6 in the Central Burn Pits RI Report). This will help clarify what analytical results comprise the human health risk assessment database for each receptor being evaluated.	Please make the appropriate changes to the text.	Agree. Six new tables (Tables 6-1 through 6-6) have been incorporated into the text – similar to tables incorporated into RQL, EBG, and ODA2 RI Reports. All subsequent Table numbers and Table call outs in Section 6 will be revised accordingly.
34.	NEW, Table 6-2, page 6-19, footnote d	From Ohio EPA's perspective, the reason for not including the trespasser receptor in the FWHHRAM was not related to the presence or absence of the perimeter fence.	After resolution of comments on the inclusion of the trespasser are reached, the footnote should be revised by removing the first portion of the footnote so that it starts with "Ravenna Training and Logistics Site is a fenced/secure....".	Agree. The trespasser scenario has been included in the FS (please see Ohio EPA comment #2); therefore, this comment will be addressed in the Draft FS.

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35.	NEW, Section 6.3.2 Potentially Exposed Populations, page 6-9.	The discussion of the Adult and Child Resident Subsistence Farmer and the Juvenile Trespasser are found at the end of the "Recreational Hunter/Trapper/Fisher discussion and should be moved so that they are separate. Since the discussion of these receptors is brief, a subsection title such as "Other Receptors" may be appropriate.	Please revise.	Agree. The juvenile trespasser has been removed from the RI and included in the FS (please see Ohio EPA comment #2). The Resident Farmer will be presented as a separate subsection as shown below. ***"Other Receptors*** In addition to the representative receptors described above, a Resident Subsistence Farmer (adult and child)] is evaluated to provide a baseline for evaluating this site with respect to unrestricted release. These additional receptors are not anticipated at FBQ due to physical constraints (e.g., wetlands, MEC) and intended future land use by OHARNG."
36.	NEW, Section 6.4 Toxicity Assessment, page 6-26.	Please provide a list of the hierarchy of toxicity sources (for example, Tier I = IRIS, etc.).	Please revise.	Agree. Per 07 Nov. 2005 FBQ Draft RI Report CRT teleconference, SAIC researched the details of where non-IRIS toxicity values came from, possible alternatives to HEAST, and the potential impact of not using HEAST as a source of toxicity values: • The toxicity values for copper, 2,6-dinitrotoluene, and trichloroethene are available from non-HEAST sources; therefore, these toxicity values and risk calculations would remain unchanged. • The inhalation RfD values for barium and methylene chloride taken from HEAST do not appear to be available from other sources; therefore, if HEAST is not used hazards from the inhalation pathway for these COPCs would not be quantified. The oral toxicity values for these COPCs are from IRIS and are unaffected. HQs for these COPCs

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				were well below 1 using the HEAST values; therefore, the conclusions of the risk assessment would not be impacted. • The toxicity value (oral RfD of 7.0E-03 mg/kg-day) for vanadium is taken from HEAST. An alternative value of 1.0E-03 mg/kg-day is referenced in the Region 9 PRG tables as coming from NCEA; however, this value no longer appears to be available from NCEA directly; therefore the HEAST value is used. If the RfD reported by Region 9 is used, the maximum HQ calculated for vanadium (0.063 for Resident Farmer child) exposed to sediment at the Quarry Ponds) would remain below 1 (0.44); therefore, the conclusions of the risk assessment would not be impacted. • The toxicity values for aluminum are provisional values. Revised text has been added to Sections 6.4 and 6.6.3 clarifying the sources of toxicity data and the use of HEAST. Revised text is provided following this CRT.

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37.	NEW, Section 6.6.4.2 Contribution from Background, page 6-43, last paragraph.	Remove the sentence and reference to Cox and Colvin 1996 as this study was not accepted by Ohio EPA and at Ravenna, we have site-specific background levels for arsenic that are more relevant to this site than those provided by Cox and Colvin study.	Please revise.	Clarification. The purpose of this paragraph is to provide a perspective of arsenic concentrations that occur in Ohio and in the US in general – not just at RVAAP. Text has been added to provide RVAAP-specific values as shown below. "Arsenic pollution is widespread. Human exposure to both naturally occurring and manufactured arsenic may occur through air, food, and water (Bingham et al. 2001). Arsenic is a widespread soil contaminant because of past use of arsenic-containing pesticides. Native soil concentrations of arsenic are typically in the range of 1.0-40 ppm, and in extreme states, as high as 0.1-500 ppm (Dragun 1988). Arsenic content of soils in Ohio range from 0.5 to 56 mg/kg (Cox and Colvin 1996) and the United States Geological Survey's Certificate of Analysis of the Devonian Ohio Shale estimates arsenic concentrations of 68.5 mg/kg are naturally present in bedrock shales (USGS 2004). Background concentrations of arsenic in soils at RVAAP range from 3.5 to 19.8 mg/kg."
38.	NEW, Section 6.8 Summary and Conclusions, page 6-45.	This section and discussion should be moved and presented after Table 6-11 through Table 6-16 and prior to Table 6-17.	Please make the appropriate changes to the text.	Agree. The page breaks have been moved so that Section 6.8 does not begin until after Table 6-16.

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39.	NEW, Section 7.3.1.3 Jurisdictional Wetlands, page 7-6.	Has the quality and category of these wetlands been determined?	The Ohio Rapid Assessment Method for Wetlands is one such method that can be used to do so.	Clarification. The quality and category of the wetlands at FBQ have not been determined in accordance with established protocols. The following text has been added to the end of paragraph 1 in the section titled "Jurisdictional Wetlands" on page 7-7: "During a site-walkover at FBQ, water, vegetation, and perhaps hyrdric soils that maintain one or more acres of this type of habitat was noted in the southwestern portion of FBQ. However, the exact quantity, quality, and category of the potential wetlands habitat has not been determined by a method such as the Ohio Rapid Assessment Method for Wetlands."
40.	NEW, Table 7-3 Summary of Fuse and Booster Surface Soil (0-1 ft BGS).	Chemicals qualifying for elimination from ERA and the Rationale for Elimination - this summary table is a nice addition to the ecological risk evaluation discussion.	No action required.	Thank you.

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41.	NEW, Section 7.0. Screening Ecological Risk Assessment	Were HQ estimates generated for COPEC's that were identified from the screening? If so, where are these results?	Please explain.	Clarification. Hazard quotients (Ohio EPA Level III) were not developed for FBQ. Therefore, there are no summary tables of COECs with HQs lesser than or greater than 1, but there are summaries of COPECs where ESVs are exceeded for surface soil (Table 7-4), subsurface soil (Table 7-6), sediments (Tables 7-8, 7-10, and 7-12), and surface water (Table 7-14, 7-16, and 7-18). Further, there are textual summaries of the findings in section 7.6 of the RI. Level II work was recently completed for other AOCs, such as RQL and ODA2, where like FBQ, the findings were sufficient on which to build a weight-of-evidence assessment. These weights-of-evidence were just published (October 2005) in the FS and are now available for review and comment by the Ohio EPA and the Army. Thus, there is now organized information about ecological risk beyond Level II information for FBQ that promises to be helpful in understanding and making decisions.

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42.	NEW, Section 8.4.4 page 8-8, last sentence. levels for these compounds in context of ecological risk.	Please define RQL - is this Ramsdell Quarry Landfill? Additional rationale is needed to support why the author believes a WOE approach in the FS will be enough to support the SMDP when there have not been any HQ estimates presented for this data and PBT compounds have been identified. It may be helpful to discuss how the site concentrations of the COPECs compare to background levels for these compounds in context of ecological risk.	Please correct. Please make the appropriate changes to the text.	The term RQL has been changed to FBQ. The recently developed weight-of-evidence assessment for FBQ (published in October 2005 in the FS) contains a section titled "Limited Extent of Soil Contamination" in which the concentrations of around 30 soil COPECs were compared to background concentrations and to ESVs. The sense of this comparison is that (1) inorganics are not highly elevated above background and (2) organics have few exceedances of ESVs. This means that exposure and risk would be low at FBQ. This is further substantiated by the fact that walk-overs at FBQ show healthy looking and functioning terrestrial plants and animals. The aquatic ecosystem was also healthy and functioning according to the site-wide biology and surface water study (viewed as Ohio EPA Level IV) by Ohio EPA and the Army. There are more details about this in the complete weight-of-evidence in the FS. And in anticipation of this, but not wanting to write an overwhelming amount of information in a conclusion of the RI (both chapters 7 and 8), the last sentence in section 7.8 and section 8.4.4 has been rewritten as follows: "Thus, the information in the Level II screening ERA, along with comparisons to background and ESVs and other topics in the weight-of-evidence assessment, are presented to assist risk managers in making decisions to proceed with the SMDP."

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43.	NEW, Section 8.4.4 Conclusions, page 8-8	The text mentions that a recommendation is made to move to a SMDP. SMDP is not on the Acronym list.	Please add SMDP to the Acronym List	Agree. SMDP was added to the Acronym List.
44.	NEW, Section 9.1 Nature and Extent of Contamination, page 9-1	The text states that the lateral and vertical extent of contamination was not determined in all cases for each media. Furthermore, it was recommended to determine the lateral and vertical horizontal limits of inorganic compounds in the surface and subsurface soil at FBQ.	The nature and extent of inorganic compound contamination at FBQ should be known and/or quantitatively determined with additional investigations prior to the development of the FS.	Clarification. A Supplemental Phase II Remedial Investigation is planned at FBQ to define the extent of inorganic compound contamination in surface and subsurface soil. The supplemental investigation will be included in the FS and will complete delineation of extent at FBQ. In paragraph 3 (Number 1) of Section 9.1, the text will be revised to state "A Supplemental Phase II sampling at FBQ will be implemented to 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. In addition, one location exceeds background for manganese (1,450 mg/kg) that is only partially bounded, for which an additional sample will be collected to define the extent in that area." Discussion requested with regards to surface water (Section 9.1, Item #2). Sediment samples were collected from the unnamed tributary near Greenleaf Road but surface water samples could not be collected. The nature and extent of potential up-gradient source areas has been evaluated. *Please also see Ohio EPA Comment #28.*

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				Proposed text to address Item #2 was provided via e-mail transmittal dated 11-10-2005 requesting review and input from RVAAP Team. No comments or requested changes were received as of the FBQ RI Report milestone deadline. Text has been revised to address Item #2 per the comment resolution meeting and 11-10-2005 memo as follows: "The unnamed tributary near Greenleaf Road receives much of the surface water runoff from FBQ and ultimately flows into Hinckley Creek. Sediment samples were collected from the unnamed tributary near Greenleaf Road, however, surface water was not present and samples could not be collected to evaluate potential impacts to surface water leaving FBQ. Sediment and surface water samples were collected from the up-gradient settling basins, drainage ditches and quarry ponds as well as from the up-gradient surface soils that may contribute to the unnamed tributary. Nature, extent, and potential risk from exposures at these up-gradient areas were characterized and evaluated in this RI Report. In addition to the evaluation performed in this RI, no biological impairment associated with chemical contaminants was observed based on sampling results from Hinckley Creek as noted in the FWSW Report (USACE 2005). Thus potential surface water impacts have been sufficiently characterized at FBQ."

Ohio EPA Comment # 36 – Hierarchy of toxicity value sources:

Revised text after the opening paragraph in Section 6.4: The primary source of toxicity information is IRIS. However, some chemicals have no values in IRIS or have no values for some exposure pathways in IRIS. For chemicals without values on IRIS, in accordance with the U.S. EPA - OSWER Directive (2003) and Ohio EPA DERR Technical Decision Compendium (2004), the following additional sources are used:

- U.S. EPA Office of Research and Development Provisional Peer Reviewed Toxicity Values (PPRTVs), EPA Superfund Health Risk Technical Support Center (STSC), and National Center for Environmental Assessment (NCEA).

- In the case where PPRTVs are not available and NCEA cannot provide any provisional toxicity values, the following resources are used:

    - California Environmental Protection Agency toxicity values (peer reviewed: http://www.oehha.ca.gov/risk/chemicalDB//index.asp);
    - U.S. CDC - ATSDR Toxicological Profiles (peer reviewed: http://www.atsdr.cdc.gov/mrls.html);
    - HEAST values (not yet peer reviewed, HEAST values are generally used only if no other values are available);
    - U.S. EPA Criteria Documents (the documents include but are not limited to: drinking water criteria documents; drinking water health advisory summaries; ambient water quality criteria documents; and air quality criteria documents).

A complete listing of toxicity values used in this Baseline HHRA is provided in Appendix M, Tables M-8 and M-9."

Additional text for Uncertainty Analysis (Section 6.6.3): "Several toxicity values were used from HEAST (EPA, 1997) because more recent sources were not available. Use of values from this source introduces a high level of uncertainty into the results because (1) values in HEAST have not undergone the same level of review as values in IRIS and some other sources and (2) the last time HEAST was updated was 1997. Exclusion of these values would result in not being able to quantify potential risk from these chemicals/pathways which would also introduce risk into the evaluation. Chemicals with toxicity values taken from HEAST are: barium (inhalation RfD), methylene chloride (inhalation RfD), and vanadium (oral RfD)."