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FINAL FOCUSED REMEDIAL INVESTIGATION AND FEASIBILITY STUDY FOR SITE 5 GROUNDWATER SURFACE WATER AND SEDIMENT ALLEGANY BALLISTICS LABORATORY ROCKET CENTER WV

9/1/2004

CH2M HILL

Final

Focused Remedial Investigation and Feasibility Study for Site 5 Groundwater, Surface Water, and Sediment at Allegany Ballistics Laboratory Rocket Center, West Virginia

Contract Task Order 0085

September 2004

Prepared for

Department of the Navy
Naval Facilities Engineering Command
Atlantic

Under the

LANTDIV CLEAN III Program
Contract N62470-02-D-3052

Prepared by

CH2MHILL

Herndon, Virginia

SIGNATURE PAGE

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Rocket Center, West Virginia

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Acronyms and Abbreviations

ABL	Allegany Ballistics Laboratory
ARAR	Applicable or Relevant and Appropriate Requirement
ATK	ATK Tactical Systems Company LLC
atm-m^3/mol	atmospheres-cubic meters/mole
ATSDR	Agency for Toxic Substance and Disease Registry
AUF	area use factor
BAF	bioaccumulation factor
BAT	best available technology
BAT AMC	BAT average monthly concentration
BCF	bioconcentration factor
BERA	baseline ecological risk assessment
bgs	below ground surface
BOD	biological oxygen demand
BTAG	Biological Technical Assistance Group
BW	body weight
CAMU	Corrective Action Management Unit
CBC	Christmas bird count
CDN	composite drainage net
CERCLA	Comprehensive Environmental Resource, Conservation, and Liability Act
cfs	cubic feet per second
CFR	Code of Federal Regulations
CLP	Contract Laboratory Program
COC	chemical of concern
COD	chemical oxygen demand
COPC	chemical of potential concern
CS	confirmation study
CSF	cancer slope factor
CSR	Code of State Rules
CT	central tendency
CWA	Clean Water Act
DCA	dichloroethane
DCE	dichloroethene
DL	detection limit
DPT	direct-push technology
DQO	data quality objective
ELCR	excess lifetime cancer risk
EPC	exposure point concentration
ERA	ecological risk assessment
ERD	enhanced reductive dechlorination

FAWQC	federal ambient water quality criteria
FMC	flexible membrane cap
FS	feasibility study
ft/day	feet per day
ft/year	feet per year
GCL	geosynthetic clay liner
GOCO	government-owned, contractor-operated
GPR	ground penetrating radar
GPS	global positioning system
HEAST	Health Effects Summary Tables
HHRA	human health risk assessment
HI	hazard index
HQ	hazard quotient
IAS	initial assessment study
IC	institutional control
IEUBK	Integrated Exposure Uptake Biokinetic Model
IRIS	Integrated Risk Information System
IRP	Installation Restoration Program
km	kilometer
LANTDIV	Atlantic Division
LC	low concentration
LMS	linearized multi stage
LOAEL	lowest observed adverse effect level
LTM	long-term monitoring
MC	methylene chloride
MCL	Maximum Contaminant Limit
MDNR	Maryland Department of Natural Resources
MERD	metal ERD
MF	modifying factor
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
MNA	monitored natural attenuation
msl	mean sea level
NACIP	Navy Assessment and Control of Installation Pollutants Program
NAVFACENGCOM	Naval Facilities Engineering Command
NAVSEA	Naval Sea Systems Command
NCP	National Contingency Plan
NFESC	Naval Facilities Engineering Service Center
NOAEL	no observed adverse effect level
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NTU	nephelometric turbidity unit

O&M	operation and maintenance
OMB	Office of Management and Budget
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PCOC	potential chemical of concern
PRAP	Proposed Remedial Action Plan
PRB	permeable reactive barrier
PRG	Preliminary Remediation Goal
PWA	Production Well A
QA/QC	quality assurance/quality control
RAGS	Risk Assessment Guidance for Superfund
RAO	remedial action objective
RBC	risk-based concentration
RCRA	Resource Conservation and Recovery Act of 1976
RD	reductive dechlorination
RDA	Recommended Dietary Allowance
RfD	reference dose
RI	remedial investigation
RI/FS	remedial investigation/feasibility study
RME	reasonable maximum exposure
ROD	Record of Decision
SARA	Superfund Amendments and Reauthorization Act
SERA	screening ecological risk assessment
SF	slope factor
SLC	screening level concentration
SMDP	Scientific Management Decision Point
SQL	sample quantitation limit
SVOC	semi-volatile organic compound
$t_{1/2}$	half-life
TAL	Target Analyte List
TCA	trichloroethane
TCE	trichloroethene
TCL	Target Compound List
TOC	total organic carbon
UCL	upper confidence limit
UF	uncertainty factor
µg/L	microgram per liter
UPRCWTP	Upper Potomac River Commission Wastewater Treatment Plant
USEPA	United States Environmental Protection Agency
VC	vinyl chloride
VOC	volatile organic compound
WVDEP	West Virginia Department (Division prior to May 1, 2001) of Environmental Protection

SECTION 1

Introduction

This report is being submitted to the Naval Facilities Engineering Command (NAVFACENGCOM), Atlantic Division (LANTDIV) under the Navy C.L.E.A.N. III Contract No. N62470-02-D-3052 to document the Focused Remedial Investigation (RI) and Focused Feasibility Study (FS) conducted for Site 5 groundwater, surface water, and sediment at Allegany Ballistics Laboratory (ABL) in Rocket Center, West Virginia. Allegany Ballistics Laboratory (ABL) is a government-owned (Navy), contractor-operated [ATK Tactical Systems Company LLC[1] (ATK)], research, development, testing, and production facility for solid propellants and motors used for ammunition, rockets, and armaments.

The ABL facility consists of two plants and several additional sites. Site 5 at ABL consists of a 1.3-acre closed landfill located just south of Plant 2, adjacent to the North Branch Potomac River (Figure 1-1).

The results of the Focused RI, indicate that groundwater contamination associated with the site presents a potential threat to human health, although no environmental risks associated with Site 5 groundwater were identified. The Focused FS was conducted to develop and evaluate remedial action alternatives to address potential risks associated with Site 5 groundwater. It was not necessary to evaluate remedial alternatives for surface water and sediment associated with Site 5 because no constituents of concern (COCs) were identified for these media.

1.1 Project Background

ABL is a government-owned (Navy), contractor-operated [ATK Tactical Systems Company LLC[1] (ATK)], research, development, testing, and production facility for solid propellants and motors used for ammunition, rockets, and armaments.

The facility is located in Mineral County, in the northeastern part of West Virginia, approximately 10 miles southwest of Cumberland, Maryland, along the West Virginia and Maryland border. The facility lies between the North Branch Potomac River, to the north and west, and Knobly Mountain, to the south and east. Several small towns are located near the facility, including Short Gap, West Virginia to the southeast, and Pinto, Maryland to the north. The land surrounding the ABL facility is primarily rural agricultural and forest.

ABL consists of about 1,634 acres of land with about 350 buildings. The facility is divided into two distinct operating plants, Plant 1 and Plant 2. Plant 1 is the government-owned, contractor-operated (GOCO) facility owned by the Navy and leased to ATK, by the Naval Sea Systems Command (NAVSEA) through a Facilities Use Contract. It occupies about 1,577 acres in area (including a large undeveloped area). Plant 2, owned and operated by ATK, occupies the remaining 57 acres.

1 All site work through the Phase II RI was performed when Hercules Aerospace Company (Hercules) operated the facility. Since 1995, ATK has been the operator.

The Navy and Hercules[2] conducted the 1992 RI under the Navy's Installation Restoration Program (IRP). The IRP conforms to the rules, regulations, guidance, and criteria established by the USEPA for the Superfund program.

Twelve present and former IRP sites were identified at Plant 1 of ABL. Eight IRP sites are located within the developed area of Plant 1, and three remaining sites within the undeveloped area. On May 31, 1994, ABL Plant 1 was added to the National Priorities List (NPL). Plant 2 is not on the NPL. Figure 1-1 shows the relative locations of the two plants and active IRP Sites.

Several environmental investigations have been conducted at Site 5 since 1983. A more detailed discussion of these investigations is presented in Section 2.3. The investigations included an Initial Assessment Study/Confirmation Study (IAS/CS) (1983 through 1987), a Remedial Investigation (RI) (1992), a Phase II RI (1994), and a Focused FS (1996). Numerous soil, groundwater, surface water, and sediment samples were collected and analyzed for a variety of parameters to assess the site condition during these investigations.

In February 1997, a Record of Decision (ROD) for the Site 5 landfill contents and surface soil was signed. The ROD selected landfill capping and long-term monitoring (LTM) of groundwater. The landfill cap installation was completed in September 1997. An LTM program for groundwater was implemented in 1998 as part of the operations and maintenance of the landfill cap remedy.

1.2 Project Objectives

The primary objective of this report is to present the results of the Focused RI and the Focused FS. The Focused RI includes a refined human health risk assessment (HHRA) and ecological risk assessment (ERA) for the Site 5 groundwater, surface water, and sediment. The results of the risk assessments were used to develop Preliminary Remediation Goals (PRGs), as necessary, for these media.

The Focused FS documents the evaluation of remedial action alternatives to address potential risks associated with Site 5 groundwater. The Focused FS will be used to select a remedial alternative that complies with the requirements of the National Contingency Plan (NCP). The NCP states that a remedy is cost-effective if its costs are proportional to its overall effectiveness (40 Code of Federal Regulations (CFR) 300.430(e)).

The Focused FS is not intended to serve as a design document; rather, it gives a conceptual overview of remedial alternatives and an assessment of their feasibility. The Focused FS discusses criteria used to evaluate remedial alternatives and to determine the effects of implementing them.

1.3 Project Scope

Historical investigations (CH2M HILL, 1996a, 1996b, and 1996c) assessed environmental conditions at Site 5 and reported that contaminants present in groundwater posed a potential risk. However, these investigations did not sufficiently delineate the extent of

2 The RI was conducted by Hercules. All Installation Restoration work conducted since the RI (e.g., Phase II RI and Focused RI) has been conducted by the Navy.

groundwater contamination and did not adequately assess potential risks associated with the surface water and sediment in the adjacent North Branch Potomac River. Therefore, the Focused RI was conducted to:

- Collect additional site characterization data to further define the nature and extent of groundwater, surface water, and sediment contamination at Site 5.
- Revise estimates of potential human health and ecological risks based on a more comprehensive set of data and current risk assessment guidance.

Using the findings of the Focused RI, the Focused FS presents the development and evaluation of remedial alternatives for Site 5. Each alternative was developed to address potentially unacceptable threats to human health and the environment posed by contaminated groundwater. The NCP requires the remedial alternatives be evaluated against the nine criteria listed below.

- Protection of human health and the environment
- Compliance with Applicable or Relevant and Appropriate Requirements (ARARs)
- Long-term effectiveness and permanence
- Reduction of toxicity, mobility, and volume through treatment
- Short-term effectiveness
- Implementability
- Cost
- State acceptance
- Community acceptance

The first seven criteria are addressed in this Focused FS. The last two criteria will be addressed in a subsequent ROD for Site 5.

The Draft Focused RI and Draft Focused FS were conducted, as originally scoped, utilizing LTM data collected through February 2002. Since that time, LTM sampling events have been conducted in October 2002, July 2003, and April 2004. Results from these more recent events are consistent with those obtained from the February 2002 effort and, therefore, would not alter the Focused RI conclusions and the development of remedial alternatives presented in the Focused FS. Consequently, only the data collected through February 2002 are included in this report.

1.4 Report Organization

This Report comprises 14 sections and 12 appendices. Section 2 describes the site setting and summarizes the previous environmental investigations. Section 3 describes the Focused RI field investigation activities. Section 4 presents the site geology and hydrogeology. Section 5 discusses the nature and extent of contamination in Site 5 groundwater, surface water and sediment. Contaminant fate and transport is discussed in Section 6. Sections 7 and 8 provide an updated HHRA and ERA, respectively, including identification of chemicals of concern (COC) in Site 5 groundwater, surface water and sediment. Section 9 provides summary and conclusions of the Focused RI. Section 10 lists the remedial action objectives (RAOs), ARARs, and PRGs specific to Site 5. Section 11 presents remedial technologies and alternatives applicable to remediation of Site 5 and the seven criteria used to screen the

technologies. The evaluation of the selected remediation alternatives using the nine criteria is presented in Section 12. Section 13 provides a summary and presents conclusions of the Focused FS. Section 14 lists the references cited in this report. Appendix A presents soil logs from the Focused RI borings. Appendix B presents construction diagrams for the wells installed during the Focused RI. Appendix C presents the analytical data for constituents detected in groundwater samples from Site 5 prior sampling event included in the Focused RI. Appendix D presents the complete set of raw analytical data for the groundwater, surface water, and sediment samples collected in support of the Focused RI and Focused FS. Appendix E presents the raw analytical data from the direct-push technology (DPT) investigation conducted as part of the Focused RI. Appendix F and G provide tables associated with the HHRA and ERA, respectively. Tables of chemical-specific, location-specific, and action-specific ARARs comprise Appendix H. Appendix I presents the calculated PRGs for the Site. The MNA Technical Memorandum on MNA, and the associated tables and figures, are presented in Appendix J. An evaluation of the West Virginia Toxic Pollutant Control Strategy for Development of Preliminary Surface Water Discharge Limits is presented in Appendix K. The cost estimates for alternatives evaluated in the FS are presented in Appendix L.

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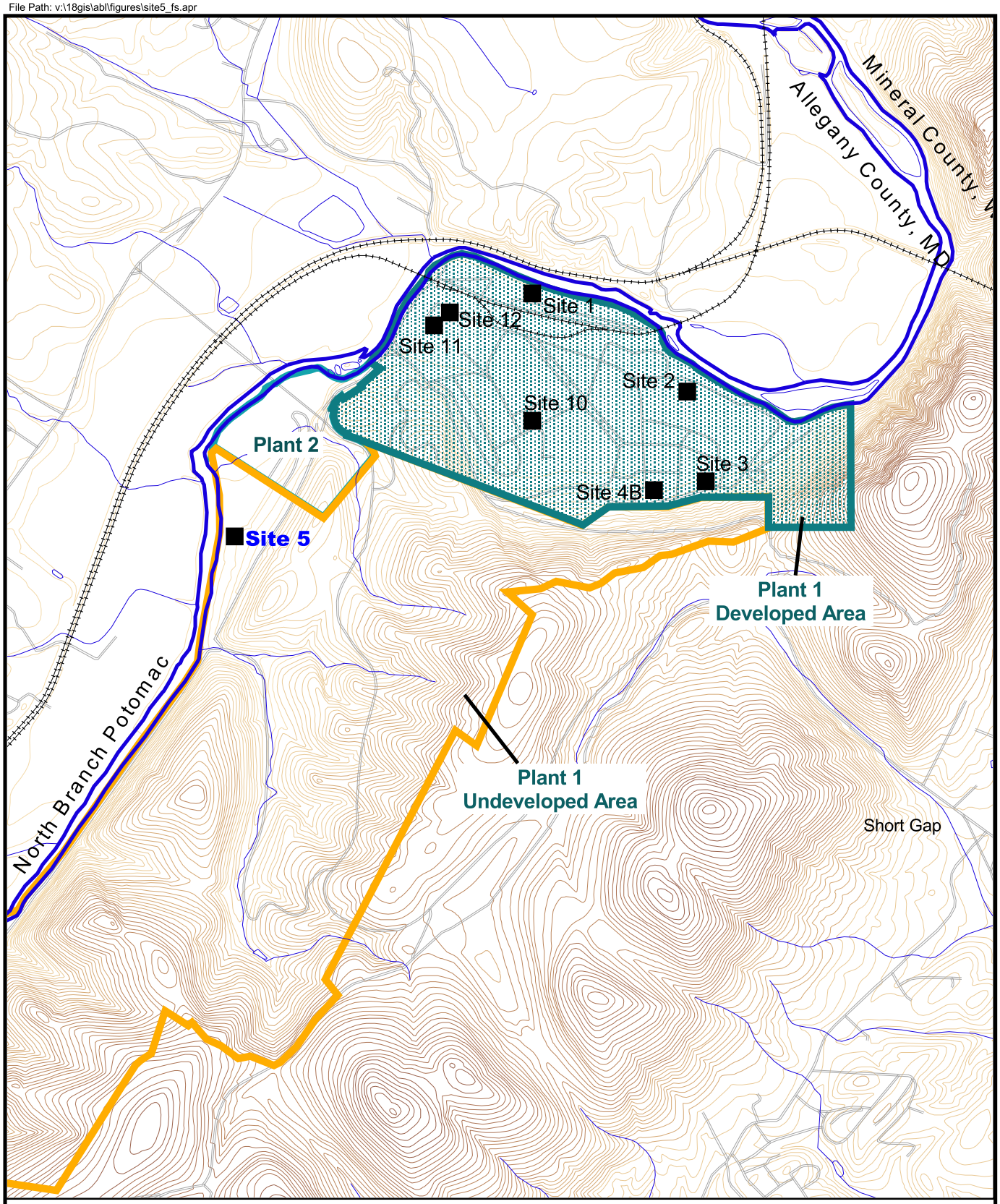

Source: USGS 7.5 minute Cresaptown, WV-MD digital quadrangle map

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One Inch Equals
Two Thousand Feet

Figure 1-1
Location of IRP Sites
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

CH2MHILL

SECTION 2

Site Background

The following subsections describe the physical setting of Site 5, and summarize the site history, including land use and previous investigations.

2.1 Site Setting

The physical setting of the ABL facility is described below using available information compiled from literature review, existing documents, and site visits.

2.1.1 Site Location and Description

Site 5 is located just south of Plant 2, adjacent to the North Branch Potomac River (Figure 1-1). Site 5 is a 1.3-acre former landfill that was capped and planted with grass in 1997. A system of unvegetated drainage ditches borders the Site 5 landfill. This ditch system, portions of which are reinforced with large gravel (rip-rap), converges at a point just northwest of the landfill. Surface runoff from the landfill cap and higher areas to the east flows into these ditches and then in a generally northwestern direction into the North Branch Potomac River.

2.1.2 Climate

Site 5 and its environ are characterized by warm summers and cold winters with a fairly even distribution of precipitation throughout the year. The mean annual temperature is approximately 53° F, with an average minimum daily temperature of 20° F (January) and an average daily maximum temperature of 87° F (July). The average annual precipitation is about 33 inches. The average annual snowfall is 28.1 inches. The prevailing wind direction in this area is from the northwest, at an average speed of 6.2 miles per hour (Kearney, 1993).

2.1.3 Topography

The 400-acre developed portion of Plant 1 and the entire area of Plant 2 are nearly flat. Site 5 is located on a terrace above the North Branch Potomac River. The Site 5 topography gently slopes toward the North Branch Potomac River then becomes steeper immediately adjacent to the river. Elevations in the undeveloped portion of ABL, which consists of heavily forested terrain, range from 675 to 1,600 feet above mean sea level (msl) (Kearney, 1993).

2.1.4 Surface Water Resources

The predominant hydrologic feature at ABL is the North Branch Potomac River, which borders the western and northern sides of the facility. The elevation of the river ranges from about 645 feet above msl at the eastern end of Plant 1 to about 655 feet above msl in the vicinity of Site 5, which is located on the western border of ABL. The river flows in a generally south to north direction past Site 5 and in a west to east direction along the northern facility boundary. The average annual river flow rate is estimated to be 886 cubic

feet per second as measured at the Pinto gauging station, located just upriver from Site 1 (USGS, 2001).

A system of drainage ditches borders the Site 5 landfill. This ditch system, portions of which are reinforced with large gravel (rip-rap), converges at a point just northwest of the landfill. Surface runoff from the landfill cap and higher areas to the east flows into these ditches and then in a generally northwestern direction into the North Branch Potomac River.

2.2 Site History

The Site 5 inert landfill operated from the early 1960s to 1985, accepting wastes generated by ABL and deemed to be inert. Inert wastes were defined as wastes not contaminated with explosives nor generated at an area on the facility where explosives were managed. Wastes reported to have been disposed of at Site 5 include drums that previously contained chlorinated solvents including trichloroethene (TCE), fluorescent tubes (potential mercury source), unknown laboratory and photographic chemicals, fiberglass and other resin-coated fibers, metal and plastic machining wastes, and construction and demolition debris.

Following the Record of Decision for Site 5 Landfill Contents (CH2M HILL, 1997a), a composite cap–geosynthetic clay liner (GCL) and flexible membrane cap (FMC) were installed in 1997, which are the primary-source control measures at the site.

2.3 Previous Investigations

Several remedial investigation and remedial action activities within the CERCLA and IRP processes have been conducted at ABL. Those relevant to Site 5 are summarized briefly below.

2.3.1 Initial Assessment Study/Confirmation Study (1983 through 1987)

An IAS was performed at ABL in 1983 under the Navy Assessment and Control of Installation Pollutants Program (NACIP). The purpose of the IAS was to identify and assess sites that might pose a threat to human health or the environment as a result of the former hazardous materials handling and operations (Environmental Science and Engineering, 1983).

Nine potentially contaminated sites, including Site 5, were identified at ABL based upon information obtained from historical records, photographs, site inspections, and personnel interviews. The IAS concluded that these sites did not pose an immediate threat. However, results of the IAS indicated the need for a confirmation study at seven of the nine sites, including Site 5, to assess the potential impacts on human health and the environment of suspected contaminants.

Based on the IAS recommendations and in accordance with the NACIP, a CS was initiated in June 1984 and completed in August 1987 (Roy F. Weston, 1997). The CS focused on identifying the existence, concentration, and extent of contamination at the seven sites recommended for further investigation in the IAS. Field activities conducted under the CS included monitoring well installation; groundwater, surface water, sediment, and soil gas sample collection and analysis.

As a result of the Superfund Amendments and Reauthorization Act of October 1986 (SARA), the Navy changed its NACIP terminology and scope under the IRP to follow the rules, regulations, guidelines, and criteria established by the United States Environmental Protection Agency (USEPA) for the Superfund program. Accordingly, the results of the CS are documented in the Interim RI Report (Roy F. Weston, 1989). The Interim RI Report recommended further remedial investigation activities for six of the seven sites identified in the IAS, including Site 5.

2.3.2 Remedial Investigation (1992)

Based on the recommendations of the Interim RI Report and in accordance with the Navy's modified IRP policy, Hercules (former Plant 1 operator) contracted CH2M HILL to conduct a RI. The RI followed USEPA RI/FS format under CERCLA as described in the EPA document *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA* (USEPA, 1988).

The RI consisted of a number of investigation activities at all Plant 1 sites. Historical aerial photographs were reviewed to determine the type and location of waste disposal units at Site 5 and other sites. A focused facility audit was also conducted to determine possible sources of contamination.

Field activities during the RI included installation of monitoring wells, soil sampling, groundwater sampling, surface water and sediment sampling, well testing, a fracture-orientation investigation, a downhole video-camera survey, and water-level measurements. A variety of analytical methods and techniques were employed during the RI.

In June 1993, the USEPA proposed the Plant 1 portion of the ABL facility for inclusion on the NPL based upon the calculated risks to human health and the environment. The Plant 1 portion of ABL was added to the NPL at *Federal Register*, Volume 59, Number 27989, on May 31, 1994.

The results of the 1992 RI are presented in the *Remedial Investigation of the Allegany Ballistics Laboratory* Report (CH2M HILL, 1996a). The RI Report recommended further investigation at Sites 1, 2, 3, 5 and Production Well A (PWA). Because Site 1 was the largest and most complex site at ABL, with the highest concentrations and widest variety of constituents detected in soil, groundwater, surface water, and sediment samples, a separate Focused RI/FS was recommended at the site to expedite the evaluation process. The remaining four sites were recommended for further investigation in a Phase II RI.

2.3.3 Phase II Remedial Investigation (1994)

In 1994, a Phase II RI was conducted to further define the nature and extent of contamination at sites 2, 3, 4, 5, and PWA. During this investigation, baseline human health and ecological risk assessments were performed to evaluate the risks posed by each site. The Phase II RI recommended that additional activities should be conducted at sites 3, 4B, 5 and PWA (CH2M HILL, 1996b).

2.3.4 Focused Feasibility Study for Site 5 Landfill Contents and Surface Soil (1996)

Based upon the results of the RI and Phase II RI activities at Site 5, a Focused FS for Site 5 landfill contents and surface soil was prepared (CH2M HILL, August 1996c). In addition, a Focused FS for Site 5 groundwater was drafted to develop and evaluate alternatives to address risk associated with Site 5 groundwater. The Focused FS for Site 5 groundwater was never finalized because the USEPA and the West Virginia Division of Environmental Protection (WVDEP) decided to evaluate groundwater data for 5 years after implementation of the landfill cap.

2.3.5 Record of Decision, Site 5 Landfill Contents and Surface Soil (1997)

In February 1997, the Navy and USEPA signed a ROD for the Site 5 landfill contents and surface soil (CH2M HILL, 1997a). The WVDEP concurred with the selected remedy. The selected remedy was landfill capping and LTM of groundwater and stormwater at the site and sediment adjacent to the site.

2.3.6 Remedial Action, Installation of Landfill Cap (1997)

The landfill cap installation was completed in September 1997. The landfill cap consists of a GCL installed atop a clay-grading layer followed by a geomembrane and has a composite drainage net (CDN) built-in (OHM Remediation Services Corporation, 1997). The CDN consists of a perimeter anchor trench (where the cap geosynthetics terminate) and drainage channels that discharge to several outlets that all terminate in the one stormwater outfall to the North Branch Potomac River. In addition, a landfill gas collection trench was constructed by excavating a trench through the landfill waste and installing a gas conveyance pipe along the center of the trench with gas vents at each end. An LTM program for groundwater was implemented in 1998 as part of the operations and maintenance of the landfill cap remedy.

2.3.7 LTM Report (May 2000)

Groundwater monitoring was conducted to evaluate whether installation of the landfill cap resulted in a decrease in contaminant concentrations in both the alluvial and bedrock aquifers. In several alluvial and bedrock aquifer monitoring wells, a slight decrease in volatile organic compound (VOC) and inorganic concentrations was observed. The sediment sample results indicated that no inorganic concentrations have increased significantly over time. The LTM report recommended further investigation of VOC contamination in the alluvial aquifer north of the Site 5 landfill and collection of additional field data to assess natural attenuation parameters (CH2M HILL, 2004b).

2.3.8 Natural Attenuation Screening Assessment (August 2000)

A screening assessment of the occurrence of natural attenuation through biological processes in the Site 5 alluvial aquifer plume was performed using data collected from wells selected for natural attenuation analysis (CH2M HILL, 2001). This assessment resulted in natural attenuation scores ranging from “inadequate” to “adequate” evidence for biodegradation of chlorinated solvents. The implications of this natural attenuation screening assessment were that natural attenuation in the form of reductive dechlorination

appeared to be inconclusive. Additional sampling events were recommended to determine if biodegradation was occurring at a rate sufficient to meet remediation objectives for the site in a period that was reasonable compared with other alternatives.

Based on these investigations, the primary constituents detected in all media at Site 5 are VOCs. TCE concentrations up to 110 micrograms/liter (µg/L) were detected in Site 5 groundwater. Semi-volatile organic compounds (SVOCs) and inorganics were also detected at Site 5 at low concentrations.

2.3.9 Final LTM Report for Sites 1, 5, and 10 (March 2004)

This LTM report (CH2M HILL, 2004) provided information for the 5-year ROD review required under CERCLA. It included analytical results for the groundwater (both alluvial and bedrock), stormwater, surface water, and sediment sampling activities at Site 5 conducted in August 2000, June 2001, February 2002, and October 2002. It also discussed the river biota sampling conducted in February 2002.

TCE was the VOC that was detected most frequently and at the highest concentrations in the groundwater (both alluvial and bedrock). Several inorganics (total and dissolved) were also detected in the groundwater.

Surface water and sediment samples were collected from the North Branch Potomac River, adjacent to Site 5. Several inorganics were detected in both surface water and sediment. Several SVOCs were detected in sediment.

Fish composite samples were also collected from three locations (one upstream and two downstream of Site 5) in the river and analyzed for TAL inorganics. The Hazard Index (HI) for both the child and adult residential receptors who ingest free-swimming fish from the river upstream and downstream of Site 5 exceed USEPA's threshold value of 1. Thallium is the major contributor to the HI exceeding 1. The noncarcinogenic hazard associated with ingestion of free-swimming fish from the upstream sample location indicates the HI for the child and adult receptors are below 1.

The risk results indicate that ingestion of fish from the river downstream of Site 5 may result in an unacceptable noncarcinogenic hazard for local residents who use the river near Site 5 as their only recreational fishing area. However, it is not likely that a recreational fisher would only fish in one location and only ingest fish caught from one location. Therefore, it is likely that a more realistic exposure scenario would not result in an unacceptable hazard to fishermen and their families.

It was recommended that monitoring well 5GW01 (screened in weathered bedrock rather than the alluvial aquifer), which was previously used as an alluvial background well, be removed from the sampling program. Well 5GW24 currently serves as the alluvial background monitoring well.

SECTION 3

Field Investigation Activities

As explained in Section 1, a review of historical groundwater, surface water, and sediment data at Site 5 indicated that additional sampling was necessary to adequately characterize the site and evaluate the associated potential human health and ecological risks. The Focused RI was performed to address this data gap.

The field investigation activities conducted for the Focused RI included a direct-push groundwater investigation, monitoring well installation, groundwater sampling, surface water sampling, and sediment sampling.

All sampling activities were conducted in accordance with the *Monitored Natural Attenuation Assessment Project Plans, Site 5 Inert Landfill* (CH2M HILL, 2000) and the *Post-Closure Operation and Maintenance Plan and Long-Term Monitoring Plan, Site 5 – Inert Landfill* (CH2M HILL, 1998a), as appropriate. All analyses were performed in accordance with USEPA Contract Laboratory Program (CLP) protocols and with the *Navy Installation Restoration Laboratory Quality Assurance Guide, Interim Guidance Document* (Naval Facilities Engineering Service Center ([NFESC], 1996).

3.1 Field Procedures

3.1.1 Direct-Push Investigation Activities

In May and June 2000, groundwater samples were collected from 31 locations within the alluvial aquifer using DPT to further delineate the extent of VOCs in groundwater and select locations for additional permanent monitoring wells. Figure 3-1 presents the DPT sampling locations. The DPT groundwater samples were analyzed at the ATK laboratory at ABL for VOCs (by Method 624).

Continuous soil samples were collected and logged at five DPT sampling locations to provide additional information on the geology of the alluvial deposits in the vicinity of Site 5. The soil logs generated from these activities are presented in Appendix A.

The DPT investigation was collected in general accordance with the approved Monitored Natural Attenuation (MNA) Work Plan. However, 31 DPT locations were installed rather than 25 as identified in the MNA Work Plan. The additional six locations were installed in the northwest part of Site 5 to more accurately delineate the extent of VOCs in groundwater near the North Branch Potomac River in this area.

3.1.2 Monitoring Well Installation

In July 2000, six alluvial groundwater monitoring wells were installed at Site 5 to provide permanent monitoring points along the extent of groundwater contamination and to collect data necessary to evaluate natural attenuation processes. The locations of these monitoring wells were selected based on the results of the DPT investigation. One well (5GW24) was installed in the alluvial aquifer cross gradient of the landfill to serve as the alluvial

background well. This location was selected because there is no alluvium upgradient of the landfill. The remaining five wells were installed downgradient of the landfill. The locations of the new and existing Site 5 monitoring wells are presented in Figure 3-2. Well construction diagrams for the six wells installed during the Focused RI are presented in Appendix B.

All drilling locations were accessible using a standard truck-mounted drilling rig. The wells were installed using the ODEX drilling method to the top of the bedrock (approximately 25 feet below ground surface [bgs]). Details for all new and existing Site 5 monitoring wells are presented in Table 3-1.

In general, monitoring wells were installed in accordance with the approved MNA Work Plan. However, because the VOC concentrations in the alluvial aquifer at Site 5 have historically been low (150 µg/L or less), installation of the two bedrock wells identified in the Work Plan was not warranted.

3.1.3 Water Level Survey

A water level survey was completed prior to conducting groundwater sampling. The depth to water was measured at each Site 5 well using a water level indicator to determine the groundwater elevation to the nearest 0.01 foot. Table 3-2 summarizes the results of four sets of water level measurements conducted between October 1998 and January 2002.

The depth to water measurements for the April 2001 monitoring round differed from those measured during the previous and subsequent monitoring rounds. This difference was likely due to seasonal fluctuations, because this sampling event occurred in the spring, when the rainfall is generally greatest, while the other sampling events occurred in the winter or late summer.

3.1.4 Monitoring Well Sampling

To support the Focused RI and to refine the understanding of the extent of groundwater contamination, the 6 new wells plus 13 existing wells were sampled in August 2000, April 2001, and February 2002. These wells continue to be sampled on a triquarterly basis (i.e., every 9 months) as part of the long term monitoring program for the landfill. Groundwater parameters were measured in the field using a Horiba U-22. Additionally, field test kits were used to determine sulfide and ferrous iron concentrations. Table 3-3 summarizes the analytical results of the field parameters, as well as the results for other parameters collected in support of the natural attenuation evaluation.

During the August 2000 sampling event, groundwater samples were submitted to Severn-Trent Laboratory and analyzed for the following parameters:

- Low concentration (LC) VOCs
- Total and dissolved Target Analyte List (TAL) metals
- Boron
- Molybdenum
- Total recoverable phenolics
- Cyanide
- Hardness
- Chemical oxygen demand (COD)

- Biological oxygen demand (BOD)
- Nitrate
- Nitrite
- Sulfate
- Chloride
- Ammonia
- Bicarbonate
- Total dissolved solids
- Total organic carbon
- Alkalinity
- Methane
- Ethane
- Ethene

In April 2001, February 2002, and October 2002, standard long-term groundwater monitoring events were completed at Site 5 in accordance with the MNA Work Plan. As discussed in Section 1.3, the Focused RI/FS utilizes groundwater data collected during the August 2000, April 2001, and February 2002 LTM events.

3.1.5 Surface Water and Sediment Sampling

Four sediment and surface water sample pairs were collected in August 2000, June 2001, and February 2002 along the eastern shore of the North Branch Potomac River. The locations of the four sample pairs, which were the same for all three events, are presented in Figure 3-2.

The sediment samples were analyzed for Target Compound List (TCL) VOCs, TCL SVOCs, cyanide, explosives, and TAL metals. The February 2002 sediment samples were also analyzed for pH, total organic carbon (TOC), percent solids, and acid volatile sulfide/ simultaneously extractable metals. Twelve additional sediment locations were sampled in February 2002 and analyzed for TCL SVOCs, TAL metals, pH, and TOC. The locations of these 12 additional sediment locations are presented in Section 8. During the June 2001 and February 2002 sampling events, the Encore sampling device was used to collect sediment samples for TCL VOC analyses. The four surface water samples were grab samples analyzed for TCL VOCs, cyanide, and total (unfiltered) TAL metals. The June 2001 surface water samples were also analyzed for hardness and dissolved (filtered) TAL metals.

The surface water and sediment samples were collected in general accordance with the approved LTM Work Plan. However, based on the results of the DPT groundwater investigation, two additional surface water/sediment samples were collected from the North Branch Potomac River. These additional locations, both near well 5GW20, were selected to determine if the TCE contaminated alluvial groundwater in this area is discharging to the river and impacting the surface water and sediment.

3.1.6 Field Quality Assurance/Quality Control

Quality assurance/quality control (QA/QC) procedures were routinely followed during the Focused RI to ensure the appropriate custody and integrity of environmental samples. Accordingly, equipment rinsate blanks, trip blanks, matrix spike /matrix spike duplicates, and field duplicates were collected at predetermined intervals. The QA/QC procedures

were consistent with those specified in the approved LTM and MNA Work Plans (CH2M HILL 1998a and 2000).

3.1.7 Surveying

The 6 monitoring wells, 31 DPT borings, and 4 surface water/sediment locations were surveyed. The DPT borings and surface water/sediment locations were surveyed by the field geologist with a Global Positioning System (GPS) unit. The wells were surveyed by a licensed surveyor using the West Virginia state plane coordinate system.

3.2 Laboratory Procedures/Data Validation

Groundwater, surface water, and sediment samples were analyzed variously for the following parameters: VOCs, TAL metals, and MNA parameters. Severn-Trent Laboratory of North Canton, Ohio performed the August 2000 LTM analytical services and Chemtech Laboratories of Edison, New Jersey performed the remainder of the analytical services, in accordance with USEPA CLP protocols and with the *Navy Installation Restoration Laboratory Quality Assurance Guide; Interim Guidance Document* (NFESC, 1996).

An independent contractor validated all laboratory analytical results. Environmental Data Services of Concord, NH validated the August 2000 laboratory data. EDQI of Exton, PA validated the June 2001 and February 2002 laboratory data. Heartland Environmental Services validated the October 2002 laboratory data. The data were fully validated using the *Region III Modifications to the National Functional Guidelines* for organic and inorganic data (USEPA, 1994). Once final electronic deliverables were received and validated, the data were electronically transferred to CH2M HILL's environmental data management system.

TABLE 3-1

Monitoring Well Construction Details Summary
Final Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Monitoring Well	Ground Elevation (ft above msl)	Top of Measuring Point Elevation (ft above msl)[a]	Screen Depth Interval (ft bgs)	Screened Unit[b]	West Virginia North (NAD 1983)	West Virginia East (NAD 1983)
5GW01	754.24	756.43	50–60[c]	A[e]	385060.1563	2152132.500
5GW02	686.46	688.43	37–50[c]	B	385241.6563	2151669.250
5GW03	686.89	688.65	35–50[c]	B	385366.5938	2151687.000
5GW04	686.35	688.66	73–83	B	385314.875	2151635.750
5GW05	686.34	688.80	65–75	B	385314.5	2151685.250
5GW06	753.86	755.68	80–90	B	385035.1875	2152122.750
5GW07	686.50	688.71	26–36	A	385318.4375	2151616.000
5GW08	686.26	688.94	25.3–35.3	A	385317.0313	2151658.750
5GW09	687.42	690.16	24–34	A	385439.4063	2151770.000
5GW10	688.31	689.78	63–78	B	385078.75	2151695.750
5GW11	687.67	690.69	15–25	A	385100.0313	2151699.000
5GW12	690.63	692.69	70–100	B	385554.9375	2151930.750
5GW13	687.06	688.78	14–24	A	385572.125	2151920.250
5GW14	687.76	689.03	40.5–70[d]	B	385444.4375	2151754.000
5GW15	687.88	689.82	20–30	A	385512.7813	2151845.000
5GW16	687.27	688.29	31–60[d]	B	385524.625	2151846.000
5GW17	674.81	676.34	9–24	A	385624.4375	2151762.250
5GW18	672.41	674.72	10–25	A	385698.613	2151965.464
5GW19	672.58	674.48	13–23	A	385890.897	2151613.862

TABLE 3-1

Monitoring Well Construction Details Summary
Final Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Monitoring Well	Ground Elevation (ft above msl)	Top of Measuring Point Elevation (ft above msl)[a]	Screen Depth Interval (ft bgs)	Screened Unit[b]	West Virginia North (NAD 1983)	West Virginia East (NAD 1983)
5GW20	672.59	674.47	15–25	A	386089.269	2151579.720
5GW21	666.89	669.22	7–17	A	386138.988	2151789.407
5GW22	672.38	674.29	11–21	A	385968.04	2151921.258
5GW23	670.52	672.71	10–20	A	385894.841	2152094.877
5GW24	666.27	667.66	4–14	A	383765.84	2151304.011

Notes:

[a] The top of measuring point is identified as the top of the surface casing for wells without a PVC well casing.
[b] Screened unit: A for alluvium; B for bedrock
[c] Effective screen interval listed; surface casing shrouds a portion of the screen.
[d] No screen installed; listed depth is open borehole interval.
[e] Alluvium not be present at this well location; well is likely screened entirely in weathered bedrock.

TABLE 3-2
Groundwater Elevations: October 1998 through January 2002
Final Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

					10/12/1998		01/18/1999		10/19/1999		08/10/2000		04/04/2001		01/31/2002	
Monitoring Well	Ground Elevation (ft above msl)	Top of Measuring Point Elevation (ft above msl)[a]	Screen Interval (ft bgs)	Screened Unit	Depth to Water (ft below Measuring Point)	Water-Level Elevation (ft above msl)	Depth to Water (ft below Measuring Point)	Water-Level Elevation (ft above msl)	Depth to Water (ft below Measuring Point)	Water-Level Elevation (ft above msl)	Depth to Water (ft below Measuring Point)	Water-Level Elevation (ft above msl)	Depth to Water (ft below Measuring Point)	Water-Level Elevation (ft above msl)	Depth to Water (ft below Measuring Point)	Water-Level Elevation (ft above msl)
5GW01	754.24	756.43	50–60	A	62.23	694.20	28.03	728.40	34.09	722.34	36.23	720.20	36.56	719.87	39.33	717.10
5GW02	686.46	688.43	37–50	B	27.02	661.41	27.57	660.86	26.03	662.40	26.16	662.27	19.45	668.98	27.26	661.17
5GW03	686.89	688.65	35–50	B	26.71	661.94	27.42	661.23	25.32	663.33	25.36	663.29	17.35	671.30	26.97	661.68
5GW04	686.35	688.66	73–83	B	29.40	659.26	29.67	658.99	29.48	659.18	28.84	659.82	25.29	663.37	29.54	659.12
5GW05	686.34	688.80	60–70	B	26.85	661.95	27.57	661.23	25.65	663.15	25.60	663.20	18.40	670.40	27.12	661.68
5GW06	753.86	755.68	80–90	B	78.40	677.28	85.51	670.17	72.71	682.97	67.17	688.51	72.45	683.23	75.27	680.41
5GW07	686.50	688.71	26–36	A	27.65	661.06	28.13	660.58	26.78	661.93	26.87	661.84	21.10	667.61	27.85	660.86
5GW08	686.26	688.94	20–30	A	27.66	661.28	28.16	660.78	26.69	662.25	26.78	662.16	20.50	668.44	27.09	661.85
5GW09	687.42	690.16	24–34	A	27.87	662.29	28.68	661.48	26.45	663.71	26.58	663.58	18.76	671.40	28.18	661.98
5GW10	688.31	689.78	63–78	B	27.13	662.65	27.90	661.88	26.93	662.85	26.54	663.24	21.73	668.05	27.60	662.18
5GW11	687.67	690.69	15–25	A	27.20	663.49	27.56	663.13	26.52	664.17	26.10	664.59	17.00	673.69	27.01	663.68
5GW12	690.63	692.69	70–100	B	29.43	663.26	29.79	662.90	29.22	663.47	28.34	664.35	22.54	670.15	29.41	663.28
5GW13	687.06	688.78	24–34	A	25.11	663.67	26.25	662.53	23.76	665.02	23.49	665.29	16.28	672.50	25.40	663.38
5GW14	687.76	689.03	40.5–70	B	26.81	662.22	27.57	661.46	25.40	663.63	25.48	663.55	18.11	670.92	27.10	661.93
5GW15	687.88	689.82	20–30	A	26.61	663.21	27.73	662.09	24.83	664.99	25.99	663.83	17.58	672.24	26.84	662.98
5GW16	687.27	688.29	41.4–70.4	B	24.94	663.35	26.03	662.26	23.72	664.57	23.48	664.81	16.45	671.84	25.32	662.97
5GW17	674.81	676.34	9–24	A	14.52	661.82	15.17	661.17	13.47	662.87	13.18	663.16	6.51	669.83	14.63	661.71
5GW18	672.41	674.72	10–25	A	11.95	662.77	12.36	662.36	11.52	663.20	10.60	664.12	3.60	671.12	11.41	663.31
5GW19	672.58	674.48	12–22	A	NA	NA	NA	NA	NA	NA	15.45	659.03	13.82	660.66	16.76	657.72
5GW20	672.59	674.47	25–35	A	NA	NA	NA	NA	NA	NA	15.76	658.71	13.42	660.05	16.51	657.96
5GW21	666.89	669.22	25–35	A	NA	NA	NA	NA	NA	NA	9.85	659.37	6.43	662.79	10.61	658.61
5GW22	672.38	674.29	11–21	A	NA	NA	NA	NA	NA	NA	13.75	660.54	9.52	664.77	15.21	659.08
5GW23	670.52	672.71	10–20	A	NA	NA	NA	NA	NA	NA	9.20	663.51	3.42	669.29	10.64	662.07
5GW24	666.27	667.66	13–23	A	NA	NA	NA	NA	NA	NA	4.90	662.76	4.95	662.71	6.81	660.85

Notes:

[a] The top of measuring point is identified as the top of the surface casing for wells without a PVC well casing.
NA: Not applicable; well was not installed at time data was collected.

TABLE 3–3
Long-Term Monitoring Program Water Quality Parameters
Final Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

	Well ID:	**5GW01**			**5GW02**			**5GW03**			**5GW06**			**5GW07**			**5GW09**		
	Date Sampled:	08/08/2000	4/10/2001	01/31/2002	08/03/2000	4/11/2001	01/31/2002	08/07/2000	4/11/2001	01/31/2002	08/09/2000	4/20/2001	01/31/2002	08/07/2000	04/11/2001	01/31/2002	08/03/2000	4/17/2001	01/31/2002
Parameter	**Unit**																		
Total Volume Purged	gallons	3.04	-	-	2.77	-	-	3.04	-	-	4.36	-	-	3.3	-	-	2.51	-	-
pH[a, b]	unitless	5.67	6.52	6.28	5.36	6.00	6.69	5.8	6.45	5.99	6.66	NM	NM	5.46	5.98	5.75	5.46	6.18	6.69
Conductivity[a, b]	mS/m	19.2	0.121	0.193	74.5	1.542	0.835	63.6	0.459	0.776	81	NM	NM	55.2	0.393	0.636	77	0.662	0.609
Turbidity[a, b]	NTU	>999	>999	621	11.1	1.4	25.3	58.9	152	26.9	33.5	NM	N/A	193	50.0	45.6	26.5	0.5	4.6
Dissolved Oxygen[a, b]	mg/L	8.4	6.79	8.17	0.37	0.00	2.87	0.97	2.39	1.48	2.41	NM	NM	0.25	0.00	1.32	0.33	0.00	1.96
Eh[a, b]	mV	216	199	104	100	132	76	123	192	137	-71	NM	NM	49	33	40	118	189	80
Temperature[a, b]	Celsius	12.7	15.8	9	13.8	12.8	14.1	14.9	11.4	13.5	14.8	NM	NM	13.2	13.5	14.3	13.7	12.9	15.5
Sulfide[a]	mg/L	0	NM	N/A	0.5	0.00	N/A	0.2	0.00	N/A	0	NM	N/A	1.1	0.00	N/A	1.4	0.00	N/A
Ferrous Iron[a]	mg/L	0	Nm	N/A	0.8	0.00	N/A	0.6	0.00	N/A	0	NM	N/A	1.8	6.4	N/A	1.1	0.00	N/A
Alkalinity	mg/L	94	74	87	110	120	130	240	180	210	NA	360	390	85	65	70	120	170	82
Chloride	mg/L	1.2	2.2	5	42	36	55	5.2	12	19	NA	2.9	2.9	30	29	44	24	35	45
Methane	mg/L	1	0.02	0.002	59.6	0.002	0.007	1	0.002	0.002	NA	ND	0.002	12.8	0.012	0.01	63.9	0.144	0.11
Nitrate	mg/L	0.93	1.6	0.8	0.5	0.55	0.5	1.1	1.5	2.8	NA	ND	0.5	0.5	0.55	0.5	0.74	1.4	0.5
Sulfate	mg/L	40	8	8	190	280	210	77	210	140	NA	36	67	150	190	160	210	360	160
Total Organic Carbon	mg/L	1	1.9	1.2	2.3	4.5	0.84	1.7	ND	0.4	NA	2.4	7.3	1	1.7	1.1	2.4	2.5	3.2

	Well ID:	**5GW10**			**5GW11**			**5GW13**			**5GW14**			**5GW16**			**5GW17**		
	Date Sampled:	08/02/2000	4/11/2001	01/31/2002	08/02/2000	4/11/2001	01/31/2002	08/09/2000	4/18/2001	01/31/2002	08/03/2000	4/13/2001	01/31/2002	08/03/2000	4/13/2001	01/31/2002	08/10/2000	4/6/2001	01/31/2002
Parameter	**Unit**																		
Total Volume Purged	gallons	2.77	-		1.98	-		4.36	-										
pH[a, b]	unitless	6.45	7.52	7.01	4.8	6.18	NM	5.85	6.30	7.02	5.97	7.03	6.23	8.1	7.56	6.73	5.4	5.83	5.36
Conductivity[a, b]	mS/m	43.1	0.323	0.475	37.1	0.270	NM	160	1.77	1.23	88.6	0.699	0.975	30.6	0.724	1.05	52.1	0.365	0.56
Turbidity[a, b]	NTU	19.3	0.1	N/A	26	59.8	N/A	28.1	2.8	N/A	21	8.9	14	19.1	37.9	N/A	169	31.7	26.4
Dissolved Oxygen[a, b]	mg/L	0.25	0.00	1.2	0.45	0.40	NM	0.32	0.49	2.2	0.22	0.00	1.49	0.51	0.00	1.89	0.24	2.51	2.56
Eh[a, b]	mV	–61	-114	-117	187	93	NM	102	198	47	-104	-152	-67	-271	-179	-90	183	269	183
Temperature[a, b]	Celsius	13.5	13.5	13.9	14.2	12.5	NM	14.1	13.2	14.5	13	12.7	14.6	13.7	12.6	13.8	13	11.1	13.8
Sulfide[a]	mg/L	0.8	0.02	N/A	0.3	0.03	N/A	2.7	0.00	N/A	3.1	0.06	N/A	1.7	0.00	N/A	2.5	0.00	N/A
Ferrous Iron[a]	mg/L	0.7	0.2	N/A	0.3	0.3	N/A	3.4	0.00	N/A	2.6	>10	N/A	1.9	6.8	N/A	3.1	0.00	N/A
Alkalinity	mg/L	220	310	230	52	89	56	260	210	240	180	200	180	55	310	260	NA	69	86
Chloride	mg/L	4.6	7.3	4	6	5.5	7.9	35	42	42	31	22	44	19	22	32	NA	14	19
Methane	mg/L	NA	0.008	0.012	NA	ND	0.002	NA	ND	0.13	335.6	0.34	1.7	21.2	0.33	0.4	NA	ND	0.14
Nitrate	mg/L	0.5	0.55	0.5	0.83	1.4	2.2	0.5	ND	0.5	0.71	ND	0.5	0.5	ND	0.5	NA	ND	0.5
Sulfate	mg/L	16	19	13	110	98	89	NA	800	320	140	160	220	54	130	220	NA	180	160
Total Organic Carbon	mg/L	1	1	1.1	2.5	3.9	8.7	3	3.2	2.1	1	ND	4.2	1	2	1.2	NA	27	0.95

TABLE 3–3
Long-Term Monitoring Program Water Quality Parameters
Final Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

	Well ID:	**5GW18**				**5GW19**			**5GW20**			**5GW21**			**5GW22**			**5GW23**			**5GW24**	
	Date Sampled:	08/10/2000	4/19/2001	01/31/2002	08/09/2000	4/5/2001	01/31/2002	08/09/2000	4/4/2001	01/31/2002	08/08/2000	4/4/2001	01/31/2002	08/08/2000	4/19/2001	01/31/2002	08/08/2000	4/4/2001	01/31/2002	08/07/2000	4/9/2001	01/31/2002
Parameter	**Unit**																					
pH[a, b]	unitless	5.83	6.59	7.79	5.28	NM	5.38	5.48	6.33	5.45	5.54	NM	5.65	5.62	6.43	5.78	5.98	NM	8.61	6.49	7.55	6.04
Conductivity[a, b]	mS/m	80.1	0.476	0.642	22.3	NM	0.238	33.1	0.249	0.428	44.7	NM	0.47	37.2	0.295	0.452	44	NM	0.525	79.9	0.500	0.814
Turbidity[a, b]	NTU	508	5.1	14.4	>999	NM	115	>999	31.3	35.2	423	NM	16.1	>999	67.6	0.452	373	NM	54.5	163	0.1	14.6
Dissolved Oxygen[a, b]	mg/L	1.65	0.63	1.71	6.61	NM	5.13	2.15	4.65	3.67	3.5	NM	3.87	6.28	6.02	5.56	0.39	NM	1.56	0.97	2.49	7.71
Eh[a, b]	mV	49	150	19	264	NM	175	251	215	182	217	NM	156	203	387	141	–2	NM	-57	129	285	133
Temperature[a, b]	Celsius	14.7	9.9	12.4	14.4	NM	11.9	13.2	11.5	12.8	14.2	NM	10.2	14.6	10	12.7	13.7	NM	9.9	16.6	9.2	5.9
Sulfide[a]	mg/L	2.8	0.00	N/A	0.1	NM	N/A	0	0.02	N/A	0.1	NM	N/A	0.7	0.00	N/A	0.3	NM	N/A	0.9	0.00	N/A
Ferrous Iron[a]	mg/L	3.3	0.00	N/A	0.3	NM	N/A	0	NM	N/A	0.1	NM	N/A	0.4	0.00	N/A	1.4	NM	N/A	1.3	0.00	N/A
Alkalinity	mg/L	NA	130	160	NA	45	46	NA	63	70	100	110	100	83	77	100	180	190	220	350	287	230
Chloride	mg/L	NA	16	23	NA	3.5	5	NA	7.7	13	28	28	34	20	18	17	10	13	9	10	28	24
Methane	mg/L	NA	ND	0.8	NA	ND	0.014	NA	ND	0.002	1	ND	0.002	1.2	ND	0.002	1	ND	0.011	1.1	0.02	0.002
Nitrate	mg/L	NA	ND	0.5	NA	0.88	0.5	NA	0.61	0.5	0.5	ND	0.5	1.3	ND	0.5	0.5	ND	0.5	1.8	1.5	0.5
Sulfate	mg/L	NA	200	160	NA	51	450	NA	110	96	62	75	80	71	99	110	33	50	10	77	88	73
Total Organic Carbon	mg/L	NA	1.2	0.89	1	10	1.3	NA	ND	0.8	1	1.3	1.2	1	1	1.7	1.3	1.5	0.9	1.2	1.1	1.5

Notes:

[a] Parameter measured in the field.
[b] Concentration equals the stabilized value defined as the last of three readings that were within 10% of each other.
NM – No measurement
ND – Below Detection Limit

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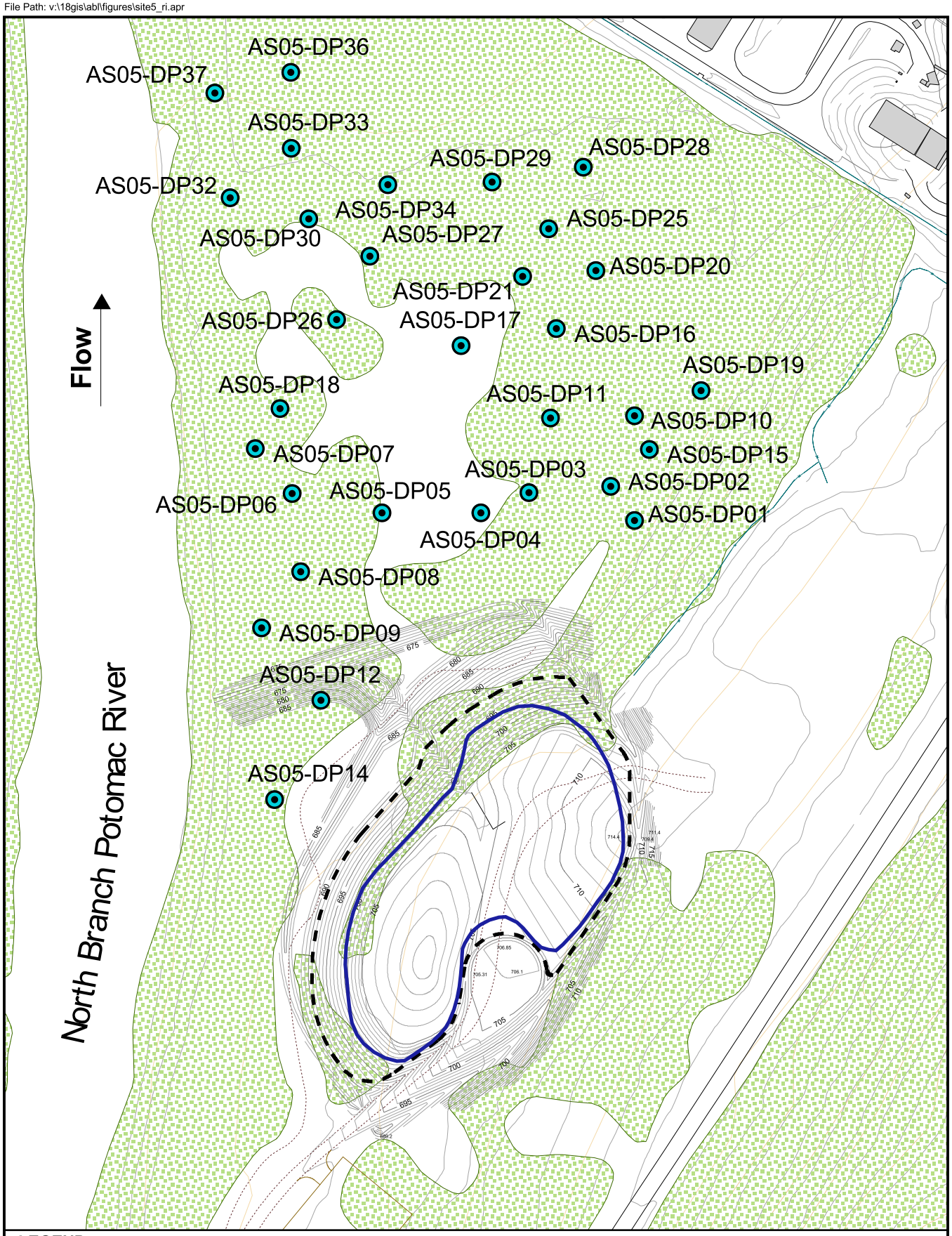

LEGEND

- Direct Push - Groundwater Sampling Location
- Edge of Waste
- Edge of Landfill Cap
- Vegetation

N

70 0 70 140 Feet

Figure 3-1
Direct Push Groundwater Sampling Locations
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

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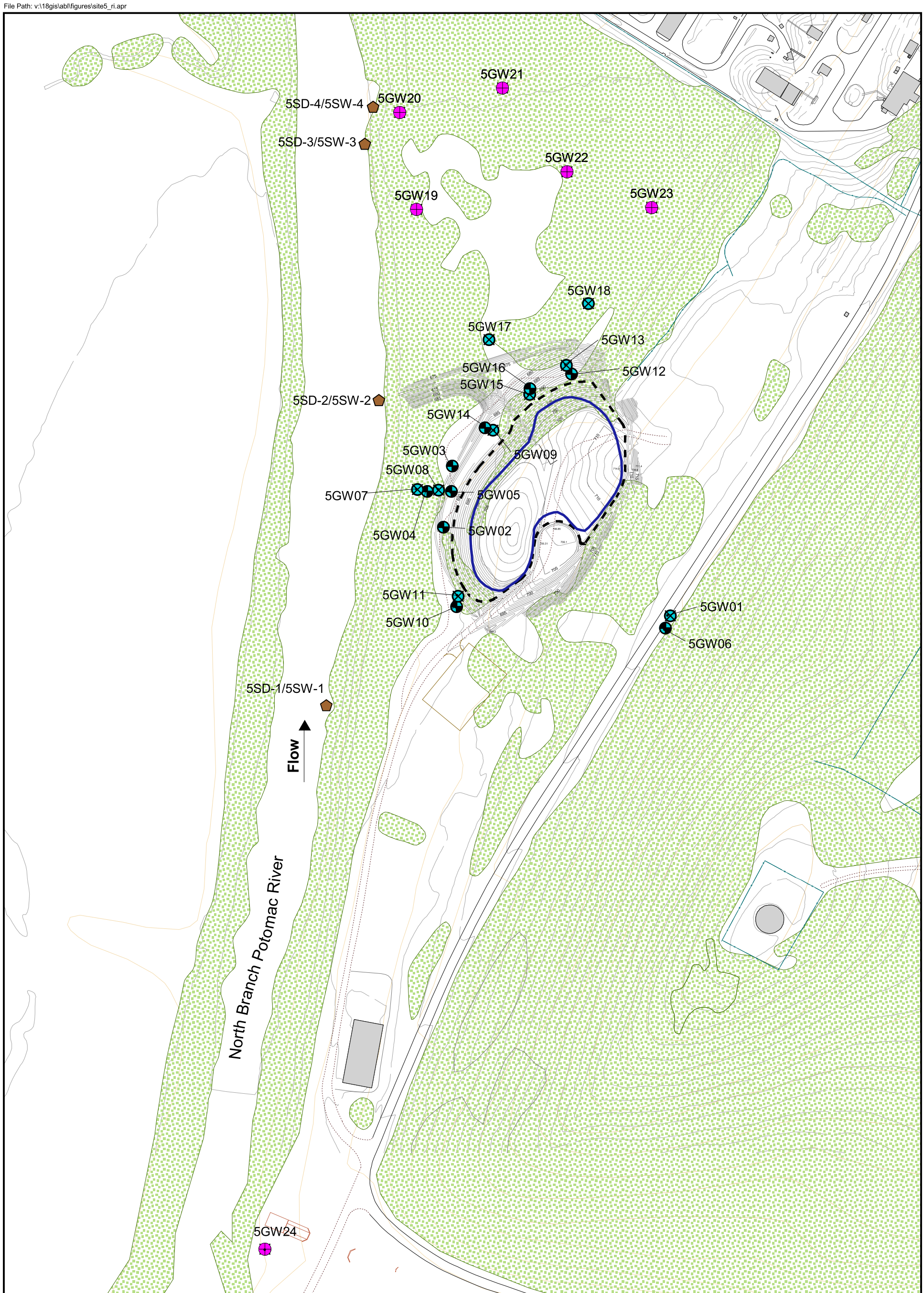

LEGEND

- Focused RI Monitoring Well - Alluvial
- Existing Monitoring Well - Alluvial
- Sediment/Surface Water
- Monitoring Well - Bedrock
- Edge of Waste
- Edge of Landfill Cap
- Vegetation

N

100 0 100 200 Feet

Figure 3-2
Monitoring Well, Surface Water, and Sediment Sampling Locations
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

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SECTION 4

Geology and Hydrogeology

The Site 5 geology and hydrogeology have been characterized during previous investigations through literature research and a number of project-specific activities. These activities included drilling, soil sampling, rock coring, geophysical investigations (ground penetrating radar [GPR] and magnetometer surveys), water-level measurements, and aquifer testing.

Detailed descriptions of the Site 5 geology and hydrogeology are presented in the *Remedial Investigation of the Allegany Ballistics Laboratory* Report (CH2M HILL, 1996a), the *Phase II Remedial Investigation at Allegany Ballistics Laboratory* Report (CH2M HILL, 1996b), and the *Final Phase I Aquifer Testing at Allegany Ballistics Superfund* Site Report (CH2M HILL, 1998b).

Observations made during the Site 5 Focused RI (Appendix A) do not alter the understanding of the site geology and hydrogeology, as presented in previous reports. The reader is referred to the previous reports for more detail on the local geology and hydrogeology to supplement information presented in this report.

4.1 Geology

Two interpretive geologic cross-sections of Site 5 have been prepared and provide a basis of the conceptual model of the Site 5 geology. Figure 4-1 presents the locations of the cross-section alignments. Figures 4-2 and 4-3 present cross-sections for the alignments A–A' and B–B', respectively.

4.1.1 Unconsolidated Deposits

At the 37 DPT locations and 6 monitoring wells installed during the Focused RI (Section 3 and Figures 3-1 and 3-2), which are mostly located northwest of the landfill in lower lying areas, about 15 to 20 feet of unconsolidated material (fill, silty clay, and alluvium) overlies the bedrock. Representative DPT boring logs are presented in Appendix A. Although the overburden is thinner at the DPT sampling locations, the overall soil stratigraphy in this area is similar to that of previous investigation results.

It is likely that, in the vicinity of wells 5GW01 and 5GW06 (both are located east and uphill of the landfill), no alluvium is present and the unconsolidated materials are composed of weathered bedrock. Well 5GW01 is screened in the weathered bedrock while 5GW06 is screened in the underlying bedrock. Therefore, the clayey gravel alluvium is shown in Figure 4-3 to "pinch out" at the distance from the river where the natural surface topography becomes very steep.

4.1.2 Bedrock

The bedrock underlying the alluvium between the river and the northwest face of the landfill consists of dark gray to black calcareous shale with trace calcite veins of Devonian age. Bedrock cutting descriptions from well location 5GW06 (southeast of the landfill) indicate the bedrock in that area is composed of interbedded black shale and sandstone.

Figure 4-4 is an interpretative contour map of the bedrock surface elevation. The elevation of the top of the bedrock surface at Site 5 ranges from a high of approximately 695 feet above msl, southeast of the landfill, to a low of approximately 647 feet above msl west and northwest of the landfill. Although there are several bedrock peaks and depressions, the bedrock surface slopes from southeast to northwest across Site 5, following the general surface topography.

4.2 Hydrogeology

The conceptual hydrogeologic model of the alluvium and bedrock aquifers at Site 5 has been developed based on the review and interpretation of data gathered during LTM activities, the Phase II RI, Phase I aquifer testing, and previous investigations.

Synoptic water-level measurements collected from the 6 wells installed during the Focused RI and all existing Site 5 wells were used to refine the potentiometric-surface maps of the alluvial and bedrock aquifers.

4.2.1 Alluvial Aquifer

An alluvial aquifer, consisting of 6 to 8 feet of clayey gravel, is present on the north and south sides of the landfill and between the landfill and the river. Water-level data indicate the water table occurs in the silty clay or clayey gravel alluvium on the north, west, and south sides of the landfill.

Table 3-2 presents groundwater elevation measurements from the 6 most recent monitoring events of the LTM program. Figure 4-5 presents a potentiometric surface map for the alluvial aquifer produced from data collected on January 31, 2002, during the February 2002 monitoring event. While the figure indicates that the primary direction of groundwater flow in the alluvial aquifer in the vicinity of the landfill is toward the river, it also shows a north to northwest component of groundwater flow, sub-parallel to the river. No definitive potentiometric contours are shown between well 5GW01 and the landfill because of the absence of water-level data in this area and due to the absence of alluvium at well 5GW01.

The horizontal hydraulic gradient in the vicinity of the landfill ranged from 0.02 to 0.05 and averaged approximately 0.035 west of the landfill during the February 2002 monitoring event. The horizontal gradient flattens to about 0.02 north of the landfill. The estimated hydraulic conductivities between the landfill and the river in the alluvial aquifer range from 1.4 feet/day (ft/day) to 9.4 ft/day, with an average of 4.6 ft/day. The hydraulic conductivity values were estimated from slug tests performed on Site 5 alluvial wells 5GW07, 5GW08, and 5GW09 during the Phase II RI.

Using the range of hydraulic conductivities and hydraulic gradients presented above and an effective porosity of 20 percent, the average linear velocity of alluvial groundwater west of the landfill is estimated to be between 51 and 857 feet/year (ft/year). Table 4-1 presents the maximum, minimum, and mean average linear velocities calculated for the alluvial aquifer in the vicinity of the Site 5 landfill.

Table 4-1 shows that alluvial groundwater velocity downgradient of the landfill has an average of 0.81 ft/day, or 293 ft/yr. It should be noted that slug tests performed on Site 5

alluvial wells indicate the alluvium had lower hydraulic conductivity values than those demonstrated by the constant rate pump tests performed on two alluvial wells during Phase I Aquifer Testing. Therefore, the actual hydraulic conductivity, and subsequently the linear groundwater velocity, in the alluvial aquifer at Site 5 may be greater than the calculated value based on slug test data.

4.2.2 Bedrock Aquifer

Table 3-2 presents groundwater elevation measurements from the 6 most recent monitoring events of the LTM program. Figure 4-6 presents potentiometric surface maps for the bedrock aquifer produced from data collected during the February 2002 monitoring event. Figure 4-6 indicates that the presence of the landfill may have resulted in the development of a component of radial groundwater flow at the northern end of the landfill.

The bedrock and alluvial potentiometric surfaces display similar patterns indicating a connection between the two aquifers. The bedrock groundwater potentiometric surface indicates that the primary direction of groundwater flow in the bedrock aquifer in the vicinity of the landfill is toward the river. However, as with the alluvial aquifer, there is a north to northwest component of groundwater flow, sub-parallel to the river. No definitive potentiometric contours are shown between well 5GW06 and the landfill because of the absence of water-level data in this area.

Based on the February 2002 data, the horizontal hydraulic gradient in the bedrock aquifer ranges between 0.03 and 0.07. The estimated hydraulic conductivities between the landfill and the river in the bedrock aquifer range from 52 ft/day to 177 ft/day, with an average of 81.5 ft/day. The hydraulic conductivity values were estimated from slug tests performed on Site 5 bedrock wells 5GW02, 5GW03, and 5GW05 during the Phase II RI.

Assuming a lower porosity, as is common in calcareous shale, the average bedrock groundwater velocity at Site 5 is believed to be at least an order of magnitude higher than the alluvial groundwater velocity. The estimated transmissivity of the bedrock aquifer ranges from approximately 50 square feet/day (ft^2/day) to 180 ft^2/day, with a geometric mean of approximately 75 ft^2/day.

Water-level measurements collected during the Phase I aquifer testing and the August 2000 and February 2002 monitoring events have been compared for the seven alluvial/bedrock paired wells to determine the direction and magnitude of the vertical hydraulic gradient between the alluvial and bedrock aquifers. The vertical hydraulic gradients were downward at all well-pair locations except 5GW08/5GW05, 5GW13/5GW12 and 5GW15/5GW16 during the Phase I aquifer testing and 5GW08/5GW05 and 5GW15/5GW16 during the August 2000 monitoring event. The vertical hydraulic gradients were downward for all wells during the February 2002 monitoring event (Table 4-2). The fluctuation of vertical hydraulic gradients over time within the small areas observed reflects the complex hydrogeologic qualities of the aquifers and indicates that the bedrock and alluvial aquifers are well connected.

TABLE 4-1
Estimated Linear Groundwater Velocities in the Alluvial Aquifer
Final Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

	Hydraulic Conductivity[a] (K_h) (ft/day)	Hydraulic Gradient[b] (dh/dl)	Effective Porosity[c] (n) (%)	Average Linear Velocity[d] (V_x) (ft/day)	Average Linear Velocity[d] (V_x) (ft/yr)
Maximum	9.4	0.05	20	2.35	857
Minimum	1.4	0.02	20	0.14	51
Average	4.6	0.035	20	0.81	294

Notes:

[a] Calculated from slug tests on Site 5 alluvial wells (CH2M HILL, 1996b)
[b] Determined from water levels measured in Site 5 wells in February 2002
[c] Estimated effective porosity for silty sand and gravel (Freeze and Cherry, 1979)
[d] = $(K_h/n)(dh/dl)$

TABLE 4-2
Vertical Hydraulic Gradient for Alluvial/Bedrock Well Pairs (February 2002)
Final Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Well Pair, Alluvial/Bedrock	Distance Between Well Screens, Max/Min (ft)	Measured Difference in Water-Level Elevations (ft)	Vertical Component of Hydraulic Gradient, Max/Min (ft)	Direction of Vertical Component of Flow
5GW01/5GW06	40/20	-36.69	1.8345/0.9172	Down
5GW07/5GW04	57/37	-1.74	0.04702/0.0305	Down
5GW08/5GW05	50/30	-0.17	0.0057/0.0034	Down
5GW09/5GW14	46/6	-0.05	0.0083/0.0011	Down
5GW11/5GW10	63/38	-1.50	0.0395/0.0238	Down
5GW13/5GW12	74/39	-0.10	0.0026/0.0014	Down
5GW15/5GW16	52/8	-0.01	0.0012/0.0002	Down

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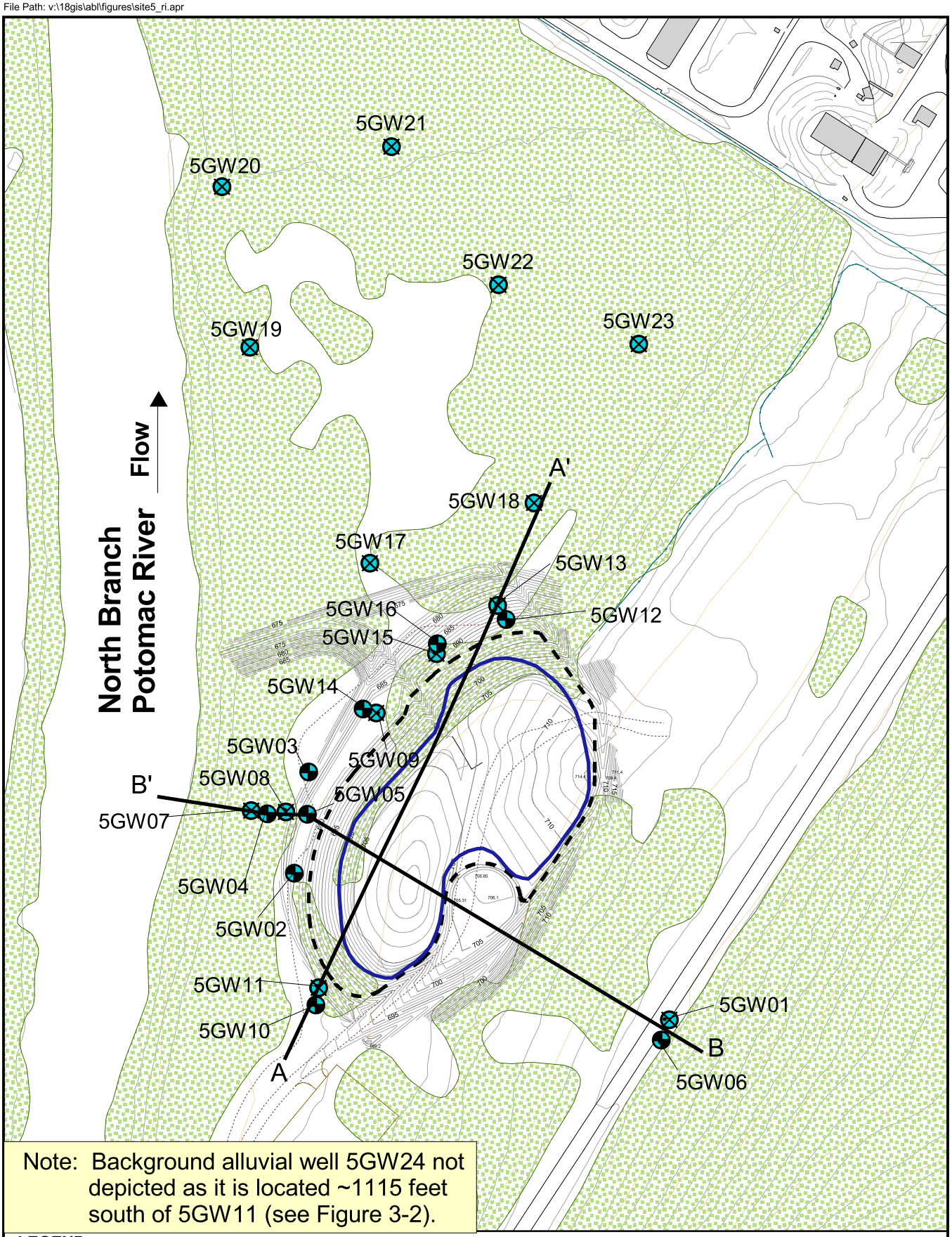

Note: Background alluvial well 5GW24 not depicted as it is located ~1115 feet south of 5GW11 (see Figure 3-2).

LEGEND

- Monitoring Well - Alluvial
- Monitoring Well - Bedrock
- Transects
- Edge of Waste
- Edge of Landfill Cap
- Vegetation

N

100 0 100 200 Feet

Figure 4-1

Cross Section Alignments
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

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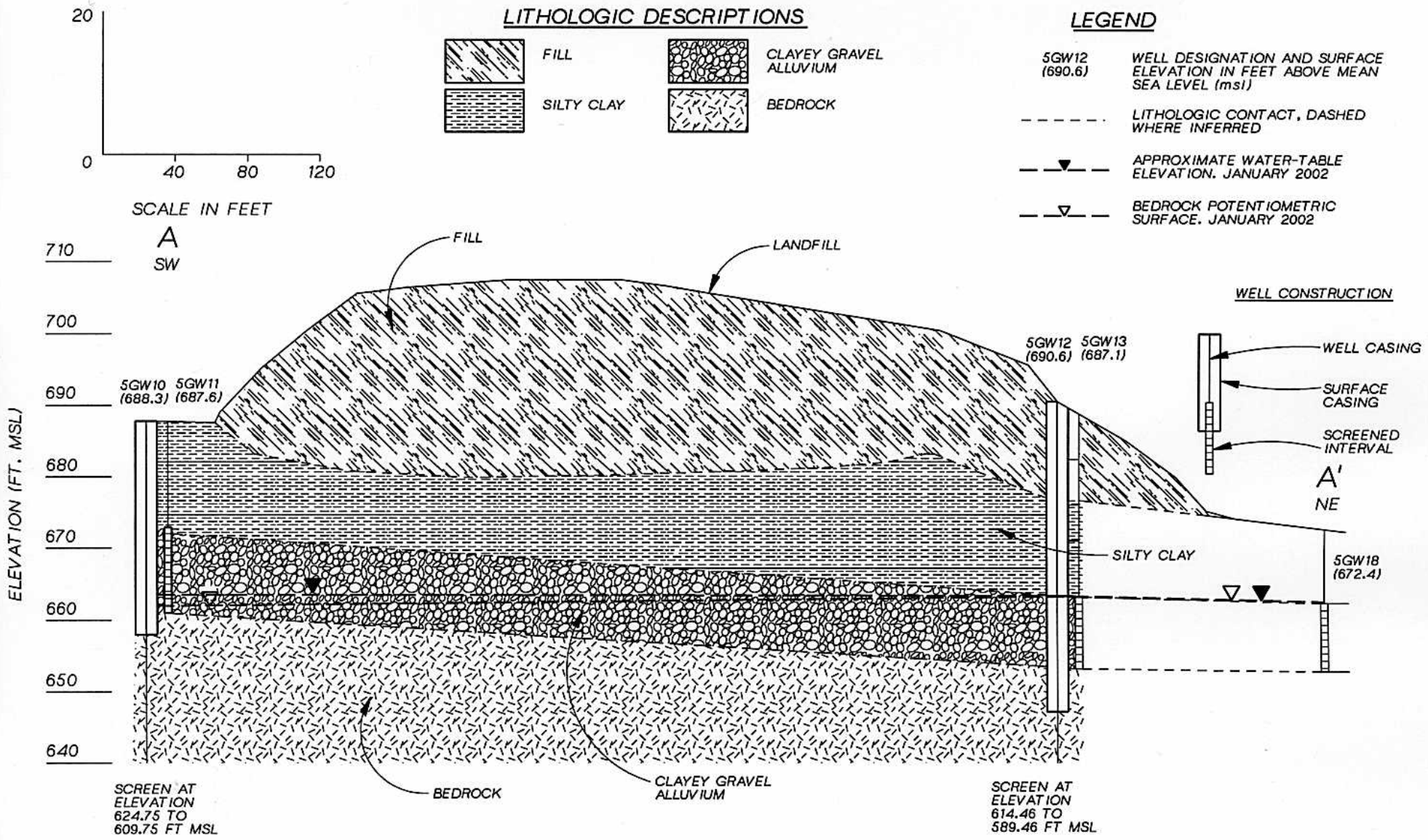

NOTES:

THIS CROSS SECTION WAS INTERPOLATED BETWEEN MONITORING WELL LOCATIONS. ACTUAL CONDITIONS MAY DIFFER FROM THOSE SHOWN HERE. CROSS SECTION LOCATION IS SHOWN IN FIGURE 2-1.

FIGURE 4-2
CROSS SECTION A-A'
FOCUSED RI/FS
SITE 5, ALLEGANY BALLISTICS LABORATORY
ROCKET CENTER, WEST VIRGINIA

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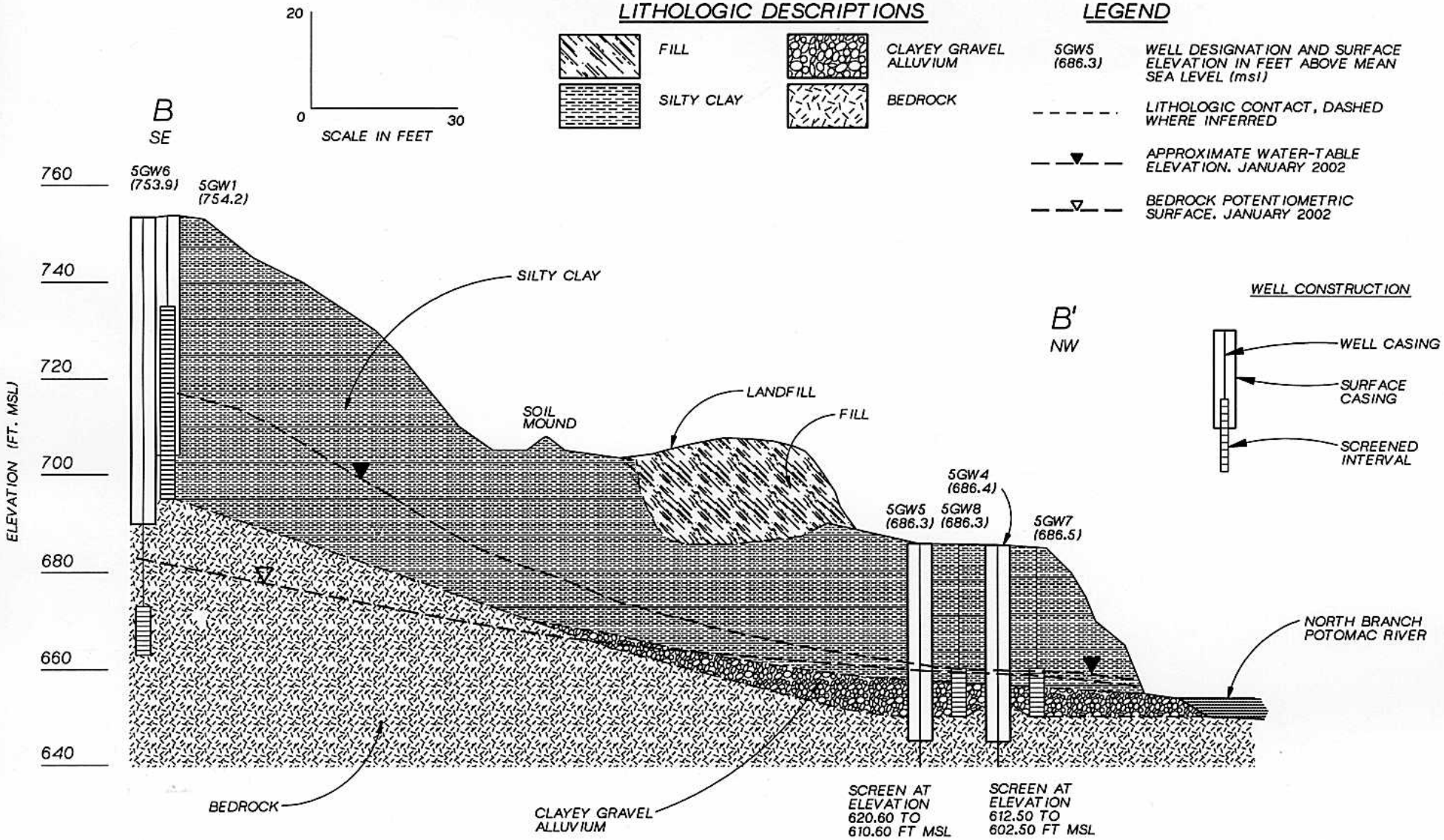

NOTES:

THIS CROSS SECTION WAS INTERPOLATED BETWEEN MONITORING WELL LOCATIONS. ACTUAL CONDITIONS MAY DIFFER FROM THOSE SHOWN HERE. CROSS SECTION LOCATION IS SHOWN IN FIGURE 2-1.

FIGURE 4-3
CROSS SECTION B-B'
FOCUSED RI/FS
SITE 5, ALLEGANY BALLISTICS LABORATORY
ROCKET CENTER, WEST VIRGINIA

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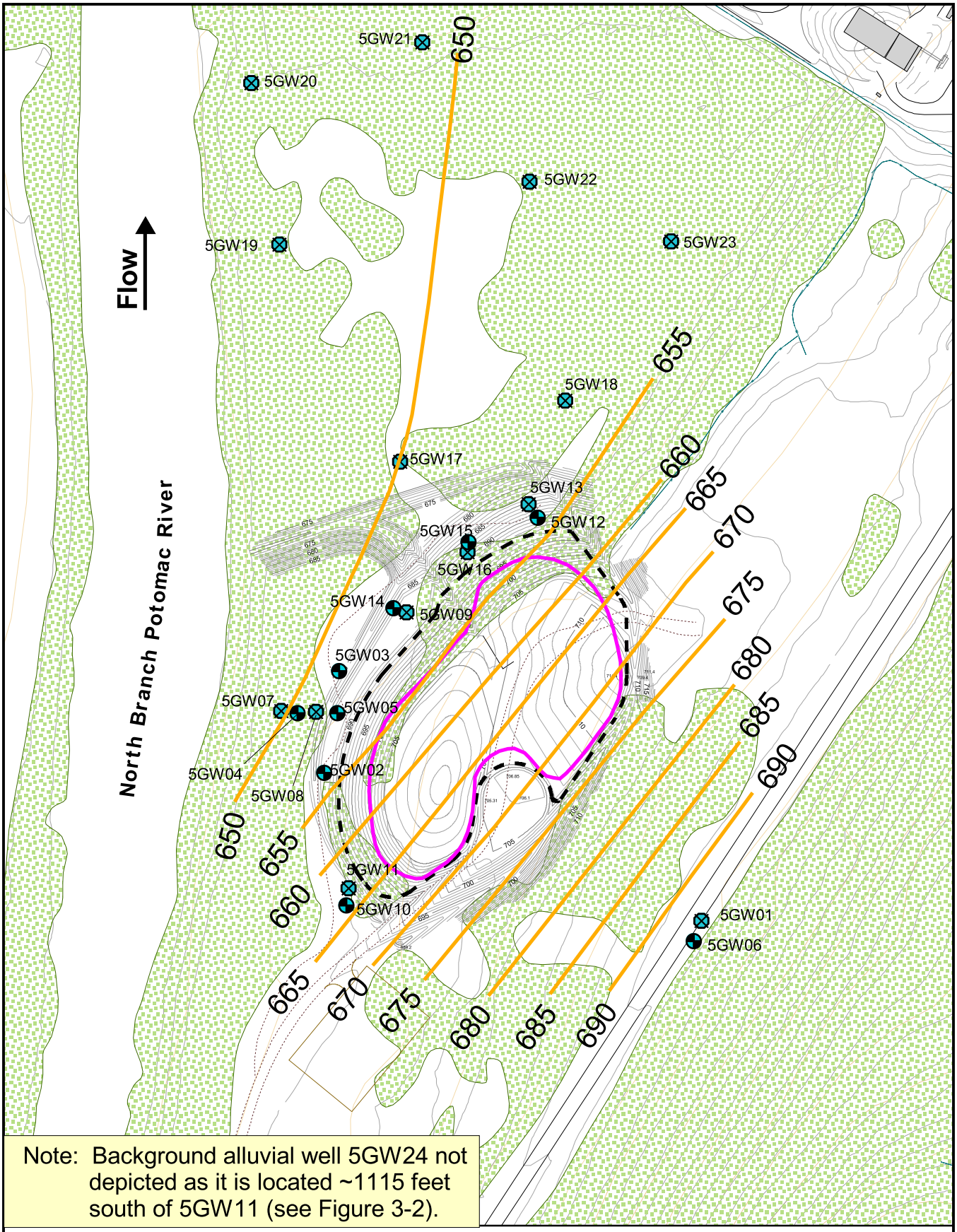

Note: Background alluvial well 5GW24 not depicted as it is located ~1115 feet south of 5GW11 (see Figure 3-2).

LEGEND

- Monitoring Well - Bedrock
- Monitoring Well - Alluvial
- Vegetation
- Estimated Bedrock Surface Contour
- Edge of Waste
- Edge of Landfill Cap

N

90 0 90 180 Feet

Figure 4-4

Bedrock Surface Elevations
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

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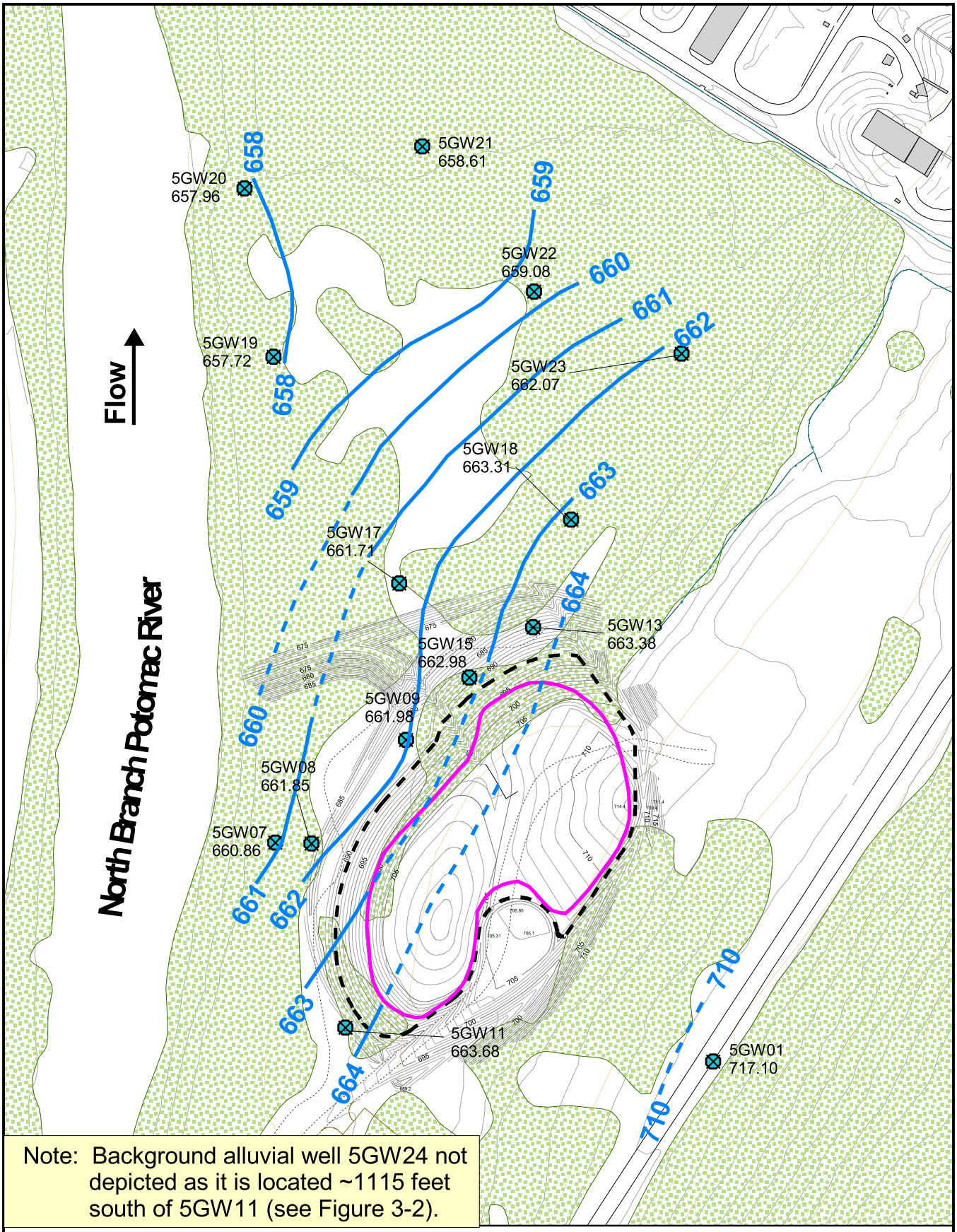

Note: Background alluvial well 5GW24 not depicted as it is located ~1115 feet south of 5GW11 (see Figure 3-2).

LEGEND

Alluvial Water Level Contours (1ft interval)

Monitoring Wells - Alluvial

657.96 Groundwater Elevation (ft above MSL)

N

40 0 40 80 120 160 Feet

Figure 4-5
Potentiometric Surface Map for Alluvial Aquifer (1/31/2002)
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

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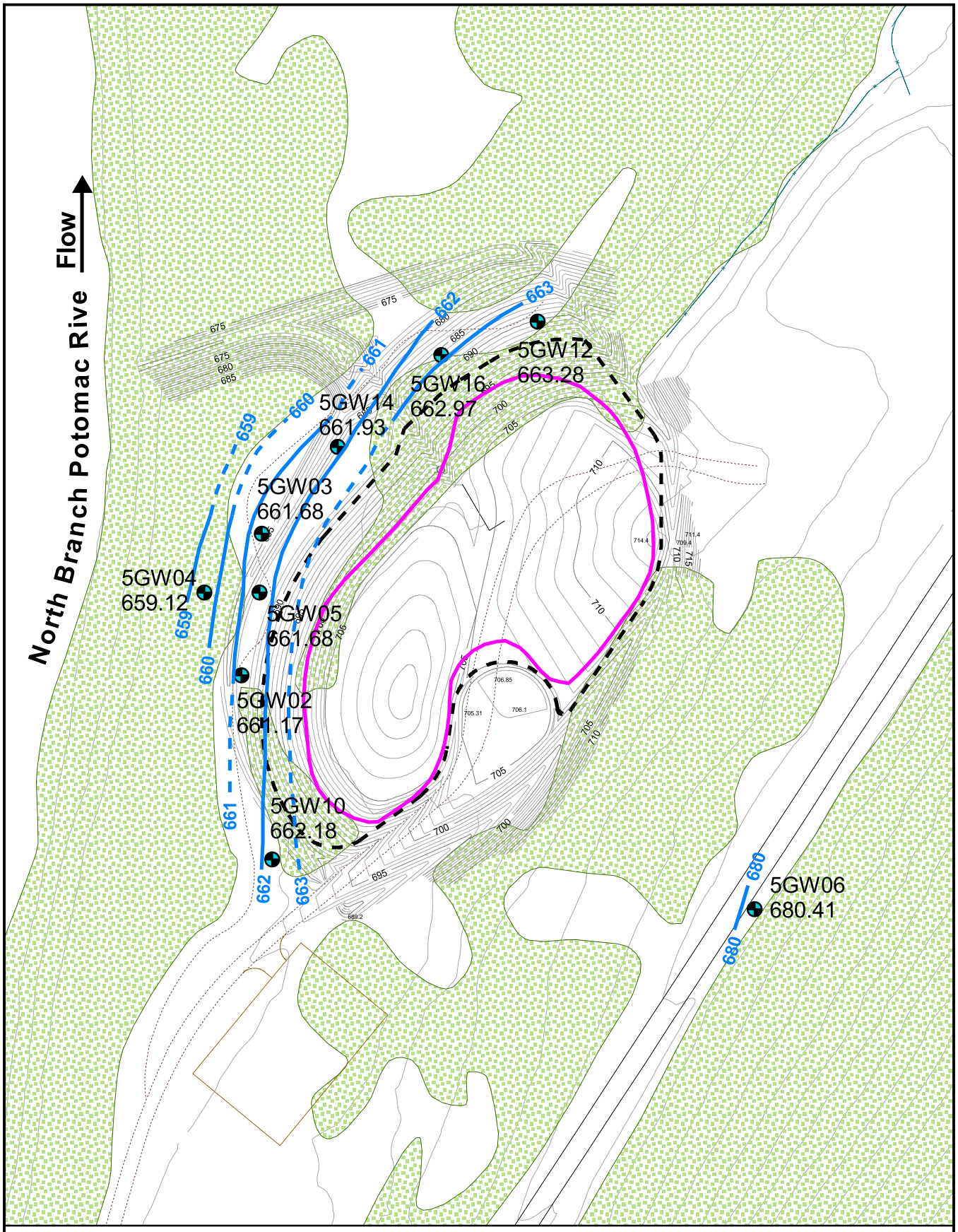

LEGEND

Bedrock Water Level Contours (1 ft interval)

Monitoring Wells - Bedrock

659.12 Groundwater Elevation (ft above MSL)

N

30 0 30 60 90 120 Feet

Figure 4-6
Potentiometric Surface Map for Bedrock Aquifer (1/31/2002)
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

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SECTION 5

Nature and Extent of Contamination

This section describes the nature and extent of Site 5 groundwater contamination and surface water and sediment contamination of the North Branch Potomac River adjacent to Site 5. The following discussion comprises an evaluation of the groundwater, surface water, and sediment data collected during the 1992 RI, the 1994 Phase II RI, the 1996 Phase I Aquifer Testing, LTM events (May 1998, October 1999, December 1999, August 2000, April 2001, and February 2002). Data from the August 2000, April 2001, and February 2002 events were collected specifically for evaluations performed in the Focused RI to determine the potential risks present at the site. Data collected subsequent to the February 2002, during routine LTM events, were not included in the scope of the RI. The LTM data collected subsequent to the Focused RI sampling events are consistent with the earlier data. As such, the conclusions from the data evaluation and risk assessments remain current.

The discussion emphasizes the COCs identified in the HHRA for Site 5 groundwater, surface water and sediment. Detailed risk assessment processes and results are provided in Section 7 (Human Health) and Section 8 (Ecological).

Appendix C presents the analytical data for constituents that were detected in groundwater samples from Site 5 prior to the sampling events included in the Focused RI. Appendix D presents the raw analytical data for the groundwater samples collected during the August 2000, April 2001, and February 2002, as well as surface water and sediment samples collected between May 1998 and February 2002. Appendix E presents the raw analytical data for groundwater samples collected during the May 2000 and June 2000 DPT investigation, which were also used in the Focused RI.

Table 5-1 provides the surveyed coordinates for each DPT sampling point and the results of TCE analyses for each DPT groundwater sample. Table 5-2 presents the groundwater quality parameters measured during the DPT groundwater investigation. Table 5-3 presents the constituents that were detected in groundwater samples collected from alluvial monitoring wells during the three Focused RI/LTM events. Table 5-4 presents the constituents that were detected in groundwater samples collected from bedrock monitoring wells during the three Focused RI/LTM events. Table 5-5 presents the constituents that were detected in surface water samples collected during each LTM event to date. Table 5-6 presents the constituents that were detected in sediment samples collected during each LTM event to date.

5.1 Groundwater

During the Phase II RI in 1994, groundwater samples were collected from monitoring wells 5GW01 through 5GW13 and analyzed for TCL VOCs and SVOCs, pesticides and PCBs, and TAL total and dissolved inorganics. The monitoring wells installed in 1996, during Phase I Aquifer Testing, (5GW14 through 5GW17) were sampled for TCL VOCs and TAL total and dissolved inorganics to fill data gaps remaining after the Phase II RI. One additional well

(5GW18) was installed following installation of the landfill cap. This well, and wells 5GW01, 5GW02, 5GW03, 5GW06, 5GW07, 5GW09, 5GW10, 5GW11, 5GW13, 5GW14, 5GW16, and 5GW17, have been sampled on a periodic basis during the LTM program since 1998.

Well 5GW01, upgradient of Site 5, was originally intended to be the background alluvial well. As discussed in Sections 4.1.1 and 4.2.1, 5GW01 is screened in the weathered bedrock and therefore is not representative of background alluvial groundwater. The weathered bedrock is not believed to be the source of alluvial groundwater at Site 5. Therefore, its data are not included in the evaluation of the nature and extent of contamination. Well 5GW24, installed in the alluvial aquifer south of Site 5 during the Focused RI, is considered to be the background alluvial well.

In May and June 2000, 31 DPT groundwater samples were collected at Site 5 and analyzed for VOCs (see Figure 3-1 for DPT locations). Based on the results of the DPT samples, 6 additional wells were installed in July 2000 (5GW19 through 5GW24). As part of the modified LTM program, the 6 new wells plus the 13 wells included in the previous LTM program were sampled in August 2000, April 2001, and February 2002 (see Figure 3-2 for well locations). Groundwater samples from these 19 wells were analyzed for VOCs, SVOCs, TAL inorganics, wet chemistry parameters, and additional parameters used to evaluate the effectiveness of biodegradation processes in Site 5 groundwater.

The nature and extent of groundwater contamination, with respect to each constituent type, is discussed below. The discussion emphasizes the analytical results from the LTM program, as this data was collected after the landfill cap was installed (i.e., leaching of soil contaminants to groundwater should be minimized after the landfill cap was installed). Data from the LTM events conducted in August 2000, April 2001, and February 2002, are particularly emphasized because these data are most representative of current conditions. Because TCE, iron, and manganese were identified as COCs for groundwater in the HHRA (see Section 7), the discussion of the nature and extent of groundwater contamination focuses on these chemicals.

5.1.1 Volatile Organic Compounds

The extent of VOCs in Site 5 groundwater has been well defined and VOC concentrations over time have been fairly stable. As discussed later in Section 7, TCE was the only VOC identified by the HHRA as a COC in groundwater (both alluvial and bedrock).

TCE is the VOC that has been detected most frequently and at the highest concentrations in Site 5 groundwater. It has been detected consistently in the same monitoring wells at concentrations that have varied within a fairly narrow range. In the alluvial aquifer wells, the concentration of TCE has varied from below detection limits to a maximum of 150 µg/L. In the bedrock aquifer wells, the concentration of TCE has varied from below detection limits to a maximum of 19 µg/L. These data are discussed in greater detail below.

5.1.1.1 Direct-Push Technology Sample Results

The only VOCs detected in the 31 DPT groundwater samples were TCE and toluene. As shown in Appendix E, toluene, a common laboratory artifact, was detected in three samples (i.e., DP20, DP21, and DP26) at low concentrations. As shown in Figure 3-1, a substantial number of DPT samples were collected upgradient (i.e., closer to the landfill) of these three

DPT samples, none of which contained toluene. Further, toluene was not detected in any of the Site 5 monitoring wells, two of which (i.e., 5GW19 and 5GW22) are located in the vicinity of the three DPT samples listed above, during the three recent LTM events.

TCE results from the DPT groundwater samples are presented in Appendix E and Table 5-1. TCE was detected in 16 of the 31 DPT groundwater samples. At five of these locations, TCE was detected at concentrations less than its Maximum Contaminant Limit (MCL) of 5 µg/L. At the remaining 11 locations, TCE was detected at concentrations ranging from 6.6 µg/L to 63 µg/L.

The data generated from the DPT sampling activities facilitated better delineation of the VOC plume in the alluvial aquifer and were used to determine the location of the alluvial monitoring wells installed during the Focused RI. DPT groundwater data are primarily used as a screening tool for constituent concentrations. Based on the DPT data, monitoring wells were installed in strategic locations to provide data more representative of aquifer quality and to evaluate potential risk from groundwater exposure. Because the LTM data suggest the VOC plume in the bedrock aquifer has been adequately delineated, no additional bedrock monitoring wells were installed during the Site 5 Focused RI.

5.1.1.2 Monitoring Well Sample Results

Since periodic sampling began in 1984, 13 VOCs have been detected in Site 5 groundwater: 1,1,1-trichloroethane (TCA), 1,2-dichloroethane (1,2-DCA), 1,2-dichloroethene (1,2-DCE; cis- and total-), acetone, benzene, carbon disulfide, carbon tetrachloride, chloroform, MC, toluene, TCE, and vinyl chloride (VC). Of these 13 VOCs, four (1,1,1-TCA, acetone, carbon disulfide, and MC) have been detected sporadically and at low concentrations, suggesting that their detections may have been the result of laboratory contamination. These four constituents also were detected periodically in field QA/QC blanks that were collected during the LTM program. Toluene, another common laboratory contaminant, was detected in only one sample at a concentration below the instrument quantitation limit. Similarly, carbon tetrachloride was only detected once at a concentration below the instrument quantitation limit and below the MCL.

Benzene and chloroform each were detected once in 1994 in 5GW06, the upgradient bedrock well, both at an estimated concentration of 1 µg/L. These VOCs have not been detected in any of the downgradient wells at Site 5. It should be noted that well 5GW06 is located near a drainage ditch along Magazine Road, which may have served as a source for these compounds. Neither compound has been detected in the five samples collected from 5GW06 since 1994. Cis-1,2-DCE in the alluvial groundwater was sporadically detected at low concentrations (i.e., maximum concentration was 24 µg/L).

Of the remaining VOCs detected, TCE was detected at concentrations greater than the MCL in 11 of the 21 monitoring wells sampled, during one or more sampling events. Of these 11 wells, 7 are alluvial (5GW09, 5GW13, 5GW15, 5GW17, 5GW18, 5GW20, and 5GW22) and four are bedrock (5GW02, 5GW03, 5GW04 and 5GW14). TCE was only detected in well 5GW04 during a single sampling event in 1992. The MCL for TCE was exceeded in only two of the six new alluvial wells installed in July 2000 (5GW20 and 5GW22). The extent of TCE in Site 5 groundwater is discussed in more detail below.

TCE in the Alluvial Aquifer. Figure 5-1 graphically displays TCE concentrations detected in groundwater samples collected from the alluvial monitoring wells since 1994. TCE has not been detected in background groundwater (5GW24), or along the southern (5GW11) or western (5GW07 and 5GW08) boundaries of the landfill (Figure 5-1). In fact, no VOCs (excluding likely laboratory contaminants) have been detected in wells 5GW07, 5GW08, 5GW11, and 5GW24 during the LTM program.

The MCL for TCE has been exceeded only in alluvial wells located along the northern side of the landfill (5GW09, 5GW13, 5GW15, 5GW17, 5GW18, 5GW20, and 5GW22). TCE was detected at 56 µg/L in the single sample collected from 5GW15 in 1996. The highest concentration of TCE in Site 5 groundwater (150 µg/L) was detected in a duplicate sample collected from 5GW22 in February 2002.

Of the alluvial wells sampled during LTM, wells 5GW13, 5GW18, and 5GW22 have contained the highest concentrations of TCE, ranging from 20 to 150 µg/L. These three wells are located along an approximate north-south line extending roughly 400 feet north from the landfill. TCE has also been detected in wells 5GW09, 5GW17 and 5GW20 at concentrations ranging from 3.6 µg/L to 65 µg/L.

Based on historical data, the concentrations of TCE in the alluvial aquifer appear to be relatively stable. TCE has consistently been detected in the same monitoring wells and the concentrations of TCE in these wells have varied within a fairly narrow range.

As displayed on the isoconcentration maps generated from the August 2000, April 2001, and February 2002 LTM data (Figures 5-2, 5-3, and 5-4, respectively), the extent of TCE in the alluvial aquifer has been well defined. All three figures suggest that the alluvial TCE plume has a crescent shape, initially migrating northward from the landfill before adopting a more westerly flow direction and approaching or discharging to the North Branch Potomac River in the vicinity of well 5GW20. Contaminant migration in the more permeable material of a former river channel may be responsible for this plume configuration.

TCE in the Bedrock Aquifer. Figure 5-5 graphically displays TCE concentrations detected in groundwater samples collected from bedrock monitoring wells since 1994. TCE has not been detected in the bedrock aquifer upgradient (5GW06), or along the southern (5GW10) or northern (5GW12 and 5GW16) boundaries of the landfill (Figure 5-5). TCE has been detected in the bedrock aquifer along the western boundary of the landfill (5GW02, 5GW03, and 5GW14) at concentrations between 4 µg/L and 19 µg/L. However, TCE has consistently been detected only in wells 5GW02 and 5GW03, and concentrations have been near or just above the MCL. This information suggests TCE is not really extensive in the bedrock aquifer.

5.1.2 Semivolatile Organic Compounds in Groundwater

Bis(2-ethylhexyl)phthalate was the only SVOC detected in groundwater at Site 5 during the 1994 Phase II RI and was detected only in upgradient bedrock well 5GW06. The samples collected from the wells installed during Phase I Aquifer Testing were not analyzed for SVOCs because no SVOCs were detected in the wells adjacent to the landfill during the Phase II RI. Similarly, SVOCs are not included as analytes in the LTM program; one sample collected from well 5GW18 in May 1998 was analyzed for SVOCs, but none were detected.

5.1.3 Pesticides and PCBs in Groundwater

No pesticides or PCBs were detected in groundwater samples during the Phase II RI. Therefore, these parameters have not been included in any of the subsequent investigations or in the LTM program.

5.1.4 Inorganics in Groundwater

To facilitate the discussion of the nature and extent of inorganic constituents in Site 5 groundwater, this subsection focuses on the inorganic COCs identified in the HHRA (Section 7).

Iron and manganese were the only inorganics identified as HHRA COCs in groundwater (both alluvial and bedrock). The detected levels of these constituents are compared to the detected concentrations in the background wells. Well 5GW24 is the background alluvial monitoring well and well 5GW06 is the background bedrock monitoring well for Site 5.

The concentrations of iron and manganese are discussed below relative to USEPA Region III tap water risk-based concentrations (RBCs) because there are no established MCLs for these constituents.

5.1.4.1 Inorganics in the Alluvial Aquifer

Iron. Figure 5-6 displays historical iron concentrations in the alluvial aquifer at Site 5. The background concentration for total iron (261 µg/L in 5GW24 during the February 2002 sampling event) was exceeded in groundwater from all of the alluvial wells included in the LTM program and from wells 5GW08 and 5GW15. For total iron, the tap water RBC for iron (11,000 µg/L) was exceeded in groundwater from 8 wells during one or more LTM events. The 8 wells and their corresponding maximum total iron concentrations were 5GW07 (27,400 µg/L), 5GW09 (64,000 µg/L), 5GW11 (13,800 µg/L), 5GW17 (31,200 µg/L), 5GW18 (14,100 µg/L), 5GW19 (28,500J µg/L), 5GW20 (14,500J µg/L), and 5GW22 (11,900J µg/L). The total iron concentration in well 5GW08 (15,400J µg/L) also exceeded the tap water RBC for iron in the single sample collected during the Phase II RI.

It is important to note that total iron has not been detected consistently at levels exceeding its tap water RBC in wells included in the LTM program. In fact, total iron concentrations in 10 of the 12 LTM wells have been below the tap water RBC in at least 50 percent of the sampling events. This suggests the iron concentrations are more a function of sample quality than groundwater quality. Since turbidity measurements began in August 2000, the highest total iron concentrations detected in wells 5GW19 through 5GW24 have coincided with the highest turbidity readings (163 to greater than 999 nephelometric turbidity units [NTU]) measured in these wells. When the measured turbidity is lower (e.g., February 2002), the total iron concentrations in 8 of 11 wells sampled were below the tap water RBC. Based on this information, the dissolved iron concentrations are considered more representative of alluvial groundwater conditions than total iron concentrations.

For dissolved iron, the tap water RBC was exceeded only in groundwater from alluvial wells 5GW07 and 5GW08, which are located adjacent to each other, roughly 100 feet downgradient of the west-central edge of the landfill. The tap water RBC for iron was only slightly exceeded in groundwater from well 5GW07 during three LTM events (October 1998, January 1999, and

April 2001 at concentrations ranging from 11,400 to 12,100 µg/L) and from well 5GW08 (13,600 µg/L in the single sampling event conducted during the Phase II RI).

The highest iron concentrations in the alluvial aquifer were generally detected in wells located immediately downgradient of the landfill. The iron concentrations tend to decrease to the northwest, in the general direction of groundwater flow. Although this trend indicates the buried debris within the landfill or groundwater chemistry beneath the landfill may have contributed iron to alluvial groundwater downgradient of the landfill, the concentrations of dissolved iron are generally at or below RBCs, as noted above.

Manganese. Figure 5-7 displays historical manganese concentrations in the alluvial aquifer at Site 5. The background concentration for total manganese (17 µg/L in well 5GW24 during the February 2002 sampling event) was exceeded in groundwater from all of the alluvial monitoring wells included in the LTM program and from wells 5GW08 and 5GW15. The tap water RBC for manganese (730 µg/L) was exceeded in groundwater from 6 wells during one or more LTM events. The 6 wells and their corresponding maximum total manganese concentrations were 5GW07 (1,260 µg/L), 5GW09 (2,200 µg/L), 5GW13 (4,510 µg/L), 5GW17 (901 µg/L), 5GW19 (2,900 µg/L), and 5GW22 (1,350 µg/L). Groundwater from wells 5GW08 (1,010 µg/L) and 5GW15 (826 µg/L) also exceeded the tap water RBC for manganese in the single sampling event conducted during the Phase II RI or Phase I Aquifer Testing.

Similar to iron, manganese has not been detected consistently at levels exceeding its tap water RBC in all of the LTM wells. In fact, total manganese concentrations in 9 of the 12 LTM wells have been below the tap water RBC in at least 50 percent of the sampling events. Further, and again similar to iron, the highest total manganese concentrations correspond to the highest turbidity measurements, which suggests the manganese concentrations are more a function of sample quality than groundwater quality. Based on this information, the dissolved manganese concentrations are considered more representative of alluvial groundwater conditions than total manganese concentrations.

The background concentration for dissolved manganese (16.2 µg/L) was exceeded in groundwater from all of the alluvial monitoring wells included in the LTM program. The tap water RBC for dissolved manganese was exceeded in groundwater from four wells. These four wells and their corresponding maximum dissolved manganese concentrations were 5GW07 (1,100 µg/L), 5GW09 (2,110 µg/L), 5GW13 (8,030 µg/L), and 5GW18 (967 µg/L). Groundwater from wells 5GW08 (1,040J µg/L) and 5GW15 (752 µg/L) also exceeded the tap water RBC for dissolved manganese in the single sampling event conducted during the Phase II RI or Phase I Aquifer Testing.

The highest manganese concentrations in the alluvial aquifer were detected generally in wells located along the immediate downgradient side of the landfill. The manganese concentrations tend to decrease to the northwest, in the general direction of groundwater flow. Although this trend indicates the buried debris within the landfill or groundwater chemistry beneath the landfill may have contributed manganese to alluvial groundwater downgradient of the landfill, the concentrations of dissolved manganese generally decline to below RBCs as groundwater migrates away from the landfill.

5.1.4.2 Inorganics in the Bedrock Aquifer

Iron. Figure 5-8 displays historical iron concentrations in the bedrock aquifer at Site 5. Turbidity in the bedrock groundwater was found to be significantly lower than that of the alluvial aquifer; therefore, total and dissolved iron concentrations generally were similar. The background concentrations for total and dissolved iron were exceeded in groundwater from all bedrock wells included in the LTM program except well 5GW10 (also 5GW03 for dissolved iron). However, groundwater from only one well (5GW14) consistently exceeded the tap water RBC iron concentration during the LTM program. Similar to the alluvial groundwater, the bedrock groundwater iron concentrations suggest the buried debris within the landfill or groundwater chemistry beneath the landfill may have contributed iron to the bedrock aquifer immediately downgradient of the landfill.

Manganese. Figure 5-9 displays historical manganese concentrations in the bedrock aquifer at Site 5. Similar to iron, total and dissolved manganese concentrations generally were similar. The background concentrations for total and dissolved manganese were exceeded in groundwater from all of the bedrock monitoring wells included in the LTM program. However, the tap water RBC for manganese (730 µg/L) was consistently exceeded in groundwater from only well 5GW02. Similar to the alluvial groundwater, the bedrock groundwater manganese concentrations suggest the buried debris within the landfill or groundwater chemistry beneath the landfill may have contributed manganese to the bedrock aquifer immediately downgradient of the landfill.

5.2 Surface Water

As discussed in Section 3, surface water samples have been collected from locations upstream, adjacent to, and downstream from the Site 5 landfill. See Figure 3-2 for surface water and sediment sampling locations. No constituents were identified as COCs in surface water in either the ERA or HHRA.

During the Phase II RI, two surface water samples were collected from the North Branch Potomac River and analyzed for VOCs and SVOCs. One sample (5SW-1) was collected upstream of the Site 5 landfill and the other (5SW-2) was collected adjacent to the Site 5 landfill, just downstream of the stormwater outfall. No VOCs or SVOCs were detected in either surface water sample.

In December 1999, perchlorate was analyzed for but not detected in surface water samples collected at the same two locations.

Four surface water samples (5SW-1 through 5SW-4) were collected in August 2000, June 2001, and February 2002 along the eastern shore of the North Branch Potomac River as part of the Site 5 LTM program. Each sample was analyzed for VOCs, explosives, and inorganics. Table 5-5 presents the constituents that were detected and Appendix D presents raw analytical data for surface water samples collected in December 1999, August 2000, June 2001, and February 2002.

No VOCs or explosives were detected at these four surface water sample locations. Sixteen dissolved and total inorganic constituents have been detected in the surface water samples. However, none were identified as COCs in the HHRA or ERA.

5.3 Sediment

As presented in Section 3, sediment has been collected from the North Branch Potomac River at locations upstream, adjacent to, and downstream from the Site 5 landfill (Figure 3-2). No constituents were identified as COCs in sediment in the HHRA. Mercury was the only constituent identified as a potential COC in sediment (for benthic communities) in the ERA. Fish samples were subsequently collected to further evaluate this potential risk, and the data indicate that the mercury in sediment has limited bioavailability and that Site 5 is not a likely source of this constituent (see Section 8).

During the Phase II RI, two sediment samples, 5SD-1 and 5SD-2, were collected from the North Branch Potomac River at the same locations as surface water samples 5SW-1 and 5SW-2, respectively. All detected VOCs and SVOCs were reported as estimated concentrations below the quantitation limit. The only VOC detected in the sediment samples was 2-butanone.

In May 1998 and October 1999, sediment samples were collected at locations 5SD-1 and 5SD-2 and analyzed for VOCs, SVOCs, explosives, and inorganics. Acetone and MC, common laboratory artifacts, were the only VOCs detected. Several SVOCs, comprised mainly of PAHs, were detected during the May 1998 LTM event. No SVOCs were detected during the October 1999 event. No explosives were detected in either event. Several inorganics were detected in both events.

Four sediment samples (5SD-1 through 5SD-4) were collected in August 2000, April 2001, and February 2002 along the eastern shore of the North Branch Potomac River, at the same locations as surface water samples 5SW-1 through 5SW-4 (Figure 3-2), respectively. Each sample was analyzed for VOCs, SVOCs, explosives, and inorganics. Table 5-6 presents the constituents that were detected and Appendix D presents raw analytical data for sediment samples collected in May 1998, October 1999, August 2000, June 2001, and February 2002.

No VOCs or explosives were detected in any of the four samples during the latest three LTM events. Several SVOCs, mainly PAHs, and inorganics were detected in the four sediment locations. Generally, the same SVOCs and inorganics were detected in each sample. However, no constituents were identified as COCs in the HHRA or ERA.

Each of the 4 LTM locations adjacent to Site 5 (i.e. locations 1, 2, 3, and 4) have consistently been sampled for VOCs. Selected sediment samples (i.e. some samples collected in February 2002), collected for purposes of the ecological risk assessment were not analyzed for VOCs since it was determined previously that VOCs were not an ecological risk driver.

TABLE 5-1
TCE and Survey Results for June 2000 Alluvial Aquifer DPT Investigation
Final Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Direct Push Boring ID	Date Installed	West Virginia North (NAD 1983)	West Virginia East (NAD 1983)	TCE Concentration (μg/L)	Comments
DP01	05/30/00	385713.26	2152045.68	1.9 U	
DP02	05/30/00	385751.12	2152019.18	63	
DP03	05/30/00	385744.35	2151928.18	41	
DP04	05/30/00	385721.87	2151875.01	2.2	
DP05	05/31/00	385721.94	2151764.88	2.7	
DP06	05/31/00	385743.32	2151664.98	1.9 U	
DP07	05/31/00	385793.49	2151623.87	1.9 U	
DP08	05/31/00	385656.28	2151674.24	1.9 U	
DP09	05/31/00	385593.72	2151630.65	2.6	
DP10	06/01/00	385830.01	2152045.68	1.9 U	
DP11	06/01/00	385827.40	2151952.64	28	
DP12	06/02/00	385513.16	2151696.62	1.9 U	
DP14	06/02/00	385402.90	2151645.51	1.9 U	
DP15	06/02/00	385792.29	2152062.33	14	
DP16	06/02/00	385926.91	2151959.08	51	
DP17	06/02/00	385907.56	2151852.70	6.6	
DP18	06/02/00	385837.67	2151651.12	1.9 U	
DP19	06/05/00	385857.68	2152120.05	1.9 U	
DP20	06/05/00	385991.37	2152003.16	4.6	
DP21	06/05/00	385984.94	2151921.20	57	
DP22	06/05/00	N/A	N/A	N/A	Dry
DP23	06/05/00	N/A	N/A	N/A	Refusal
DP24	06/05/00	N/A	N/A	N/A	Dry
DP25	06/08/00	386037.72	2151950.39	11	
DP26	06/08/00	385936.89	2151714.43	1.9 U	
DP27	06/08/00	386007.35	2151751.50	24	
DP28	06/08/00	386106.32	2151988.94	1.9 U	
DP29	06/09/00	386089.72	2151887.44	1.9	
DP30	06/09/00	386048.73	2151683.10	14	
DP32	06/12/00	386072.32	2151595.59	9.6	
DP33	06/12/00	386127.46	2151663.67	1.9 U	
DP34	06/12/00	386086.69	2151771.28	3.6	
DP36	06/12/00	386211.63	2151663.55	1.9 U	
DP37	06/12/00	386189.02	2151578.67	1.9 U	

N/A: Not applicable as no sample was collected.

Table 5-2
Water Quality Parameters for June 2000 Alluvial Aquifer DPT Investigation
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Station ID	**DP01**	**DP01**	**DP02**	**DP03**	**DP04**	**DP05**	**DP06**	**DP07**
Sample ID	**AS05-DP01**	**AS05-DP01A**	**AS05-DP02**	**AS05-DP03**	**AS05-DP04**	**AS05-DP05**	**AS05-DP06**	**AS05-DP07**
Sample Date	**5/30/00**	**5/31/00**	**5/30/00**	**5/30/00**	**5/30/00**	**5/31/00**	**5/31/00**	**5/31/00**
Parameter								
pH	7.24	6.70	6.66	6.67	6.69	5.35	6.48	6.07
Conductivity (ms/cm^2)	0.318	0.285	0.383	0.215	0.284	0.216	0.155	0.158
Turbidity (NTU)	>999	860	>999	>999	>999	>999	>999	>999
Dissolved Oxygen (mg/L)	10.93	11.24	11.10	12.30	12.05	11.22	10.22	9.44
Temperature (^{o}C)	16.6	12.1	17.6	15.4	15.6	12.5	18.0	20.4
Salinity (ppm)	0.01	0.01	0.01	0	0.01	0	0	0
eH (mv)	105	10	20	10	10	0	-35	5

Station ID	**DP08**	**DP09**	**DP10**	**DP11**	**DP12**	**DP14**	**DP15**	**DP16**
Sample ID	**AS05-DP08**	**AS05-DP09**	**AS05-DP10**	**AS05-DP11**	**AS05-DP12**	**AS05-DP14**	**AS05-DP15**	**AS05-DP16**
Sample Date	**5/31/00**	**5/31/00**	**6/01/00**	**6/01/00**	**6/02/00**	**6/02/00**	**6/02/00**	**6/02/00**
Parameter								
pH	6.09	6.14	6.77	6.67	6.81	7.11	6.84	6.85
Conductivity (ms/cm^2)	0.227	0.327	0.332	0.440	0.379	0.456	0.415	0.308
Turbidity (NTU)	>999	>999	>999	>999	>999	>999	>999	>999
Dissolved Oxygen (mg/L)	11.06	9.82	10.11	9.53	11.06	11.11	11.25	10.61
Temperature (^{o}C)	18.4	19.5	18.2	19.7	20.2	20.5	17.6	19.0
Salinity (ppm)	0	0.01	0.01	0.01	0.01	0.01	0.01	0.01
eH (mv)	20	155	10	1240	140	155	135	55

Station ID	**DP17**	**DP18**	**DP19**	**DP20**	**DP21**	**DP25**	**DP26**	**DP27**
Sample ID	**AS05-DP17**	**AS05-DP18**	**AS05-DP19**	**AS05-DP20**	**AS05-DP21**	**AS05-DP25**	**AS05-DP26**	**AS05-DP27**
Sample Date	**6/02/00**	**6/02/00**	**6/05/00**	**6/05/00**	**6/05/00**	**6/08/00**	**6/08/00**	**6/08/00**
Parameter								
pH	6.61	7.29	7.16	6.37	6.53	692.00	6.74	6.83
Conductivity (ms/cm^2)	0.201	0.150	0.365	0.224	0.199	0.240	0.235	0.280
Turbidity (NTU)	>999	>999	>999	>999	>999	>999	>999	>999
Dissolved Oxygen (mg/L)	12.27	13.95	11.24	11.31	10.47	12.91	1.84	12.19
Temperature (^{o}C)	18.6	16.9	13.7	13.4	16.4	15.3	16.1	17.0
Salinity (ppm)	0	0	0.01	0	0	0	0	0.01
eH (mv)	50	145	-40	50	180	-80	235	210

Station ID	**DP28**	**DP29**	**DP30**	**DP33**	**DP34**	**DP35**	**DP36**	**DP37**
Sample ID	**AS05-DP28**	**AS05-DP29**	**AS05-DP30**	**AS05-DP33**	**AS05-DP34**	**AS05-DP35**	**AS05-DP36**	**AS05-DP37**
Sample Date	**6/08/00**	**6/09/00**	**6/09/00**	**6/12/00**	**6/12/00**	**6/12/00**	**6/12/00**	**6/12/00**
Parameter								
pH	7.63	5.90	6.22	6.37	6.08	7.30	7.46	7.70
Conductivity (ms/cm^2)	0.272	0.236	0.226	0.337	0.261	0.342	0.348	0.395
Turbidity (NTU)	>999	>999	>999	>999	>999	>999	>999	>999
Dissolved Oxygen (mg/L)	12.11	12.40	11.27	11.57	11.24	13.75	13.12	12.63
Temperature (^{o}C)	16.1	15.2	18.1	17.8	17.9	17.6	17.7	17.7
Salinity (ppm)	0.01	0	0	0.01	0.01	0.01	0.01	0.01
eH (mv)	195	290	285	-80	NM	-40	-80	45

Notes:
ms/cm^2 = millisiemens per centimeter^2
NTU = nephelometric turbidity units
mg/L = milligrams per liter
^{o}C = degrees Celcius
ppm = parts per million
mv = millivolts
NM = not measured
Water quality parameters were measured in a flow-through cell

Table 5-3
Chemicals Detected in Groundwater from Alluvial Monitoring Wells
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Station ID	5GW01				5GW07		
Sample ID	AS05-5GW01-R05	AS05-5GW01P-R05	AS05-5GW01-R06	AS05-5GW01-R07	AS05-5GW07-R05	AS05-5GW07-R06	AS05-5GW07-R07
Sample Date	08/08/00	08/08/00	04/10/01	02/04/02	08/07/00	04/11/01	02/01/02
Chemical Name							
Volatile Organic Compounds (UG/L)							
1,1,1-Trichloroethane	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,2-Dichloroethane	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,2-Dichloroethene (total)	NA	NA	NA	NA	NA	NA	NA
Carbon disulfide	1 UJ	1 UJ	1 U	1 U	1 U	1 U	1 U
Methylene chloride	1.6 B	1.6 B	1.9 B	0.8 B	0.7 B	0.6 B	1.4 B
Trichloroethene	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Vinyl chloride	1 U	1 U	1 U	1 U	1 U	1 U	1 U
cis-1,2-Dichloroethene	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Semivolatile Organic Compounds (UG/L)							
No Detections							
Pesticide/Polychlorinated Biphenyls (UG/L)							
No Detections							
Herbicides (UG/L)							
No Detections							
Explosives (UG/L)							
No Detections							
Total Metals (UG/L)							
Aluminum	68,900	61,000	NA	2,070	22.6 B	NA	63.6 J
Antimony	4.9 U	4.9 U	NA	5 U	4.9 U	NA	5 U
Arsenic	60.9	52.9	NA	5.1 U	4.3 B	NA	5.1 U
Barium	432	442	NA	42.1 J	63.6 J	NA	78.3 J
Beryllium	5.4	5.5	NA	0.26 J	0.1 U	NA	0.1 U
Boron	NA	NA	NA	10 U	NA	NA	40.4 J
Calcium	49,000	52,600	NA	30,100	47,000	NA	56,800
Chromium	122	111	NA	182	0.96 B	NA	1.4 J
Cobalt	53.6	54.3	NA	3.3 J	31.5 J	NA	40.3 J

NA - Not analyzed
B - Analyte not detected above associated blank
D - Result came from a diluted sample
E - Exceedance - Interference
J - Reported value is estimated
K -Biased high
L - Biased low
R - Rejected
U - Undetected

Table 5-3
Chemicals Detected in Groundwater from Alluvial Monitoring Wells
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Station ID	5GW01				5GW07		
Sample ID	AS05-5GW01-R05	AS05-5GW01P-R05	AS05-5GW01-R06	AS05-5GW01-R07	AS05-5GW07-R05	AS05-5GW07-R06	AS05-5GW07-R07
Sample Date	08/08/00	08/08/00	04/10/01	02/04/02	08/07/00	04/11/01	02/01/02
Chemical Name							
Copper	113	114	NA	7.6 J	4 B	NA	1.5 U
Cyanide	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Iron	142,000 J	137,000 J	NA	5,080	10,600 J	NA	13,200
Lead	138	138	NA	6.9	5.4 B	NA	2.9 U
Magnesium	14,200	13,900	NA	4,080 J	21,300	NA	25,200
Manganese	977	1,010	NA	62	1,030	NA	1,260
Mercury	0.1 U	0.1 U	NA	0.2 U	0.1 U	NA	0.2 UL
Nickel	118	114	NA	135	84.4	NA	91.8
Potassium	9,280 J	7,970 J	NA	1,090 J	2,730 J	NA	2,430 J
Silver	0.6 U	0.6 U	NA	0.6 U	0.6 U	NA	0.6 U
Sodium	1,800 B	2,480 B	NA	1,850 J	16,500	NA	17,100
Thallium	13.2 B	14.4 B	NA	5 U	2.3 UL	NA	5 U
Tin	NA	NA	NA	NA	NA	NA	NA
Vanadium	146	137	NA	5.5 J	1 U	NA	0.8 U
Zinc	524	512	NA	49.2 B	121	NA	121 B
Dissolved Metals (UG/L)							
Aluminum	19.2 U	19.2 U	99,800	NA	19.2 U	70.3 B	NA
Antimony	4.9 U	4.9 U	5.5 J	NA	4.9 U	3.1 U	NA
Arsenic	3.8 U	3.8 U	81.1	NA	7.6 B	3.5 B	NA
Barium	16.3 J	16.1 J	675	NA	63.3 J	74 B	NA
Beryllium	0.1 U	0.1 U	8	NA	0.1 U	0.36 B	NA
Boron	NA	NA	50.2	NA	NA	98.1	NA
Cadmium	0.4 U	0.4 UL	0.4 U	NA	0.4 U	0.6 B	NA
Calcium	31,000	31,400	48,800	NA	49,700	51,200	NA
Chromium	0.7 U	0.7 U	206	NA	0.7 U	0.8 U	NA
Cobalt	1.1 U	1.1 U	77.4	NA	33.5 J	37.2 J	NA
Copper	0.7 UL	0.7 U	183	NA	0.7 UL	2.7 J	NA
Iron	15.9 U	15.9 U	201,000	NA	10,600	12,100	NA
Lead	2 U	2 U	203	NA	2 U	2.5 U	NA
Magnesium	4,270 J	4,200 J	17,400	NA	22,200	23,500	NA
Manganese	0.94 B	1.1 B	1,290	NA	1,080	1,100	NA
Mercury	0.1 U	0.1 U	0.2 UL	NA	0.1 U	1 B	NA
Molybdenum	NA	NA	10.3 J	NA	NA	10 U	NA

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K -Biased high
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Table 5-3
Chemicals Detected in Groundwater from Alluvial Monitoring Wells
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Station ID	5GW01				5GW07		
Sample ID	AS05-5GW01-R05	AS05-5GW01P-R05	AS05-5GW01-R06	AS05-5GW01-R07	AS05-5GW07-R05	AS05-5GW07-R06	AS05-5GW07-R07
Sample Date	08/08/00	08/08/00	04/10/01	02/04/02	08/07/00	04/11/01	02/01/02
Chemical Name							
Nickel	2 U	3 B	174	NA	88.6	95.3	NA
Potassium	1,150 J	923 J	11,900	NA	3,850 J	3,250 J	NA
Selenium	2.2 UL	2.2 U	15.3	NA	2.2 UL	3.2 U	NA
Silver	0.6 U	0.78 B	7.1 J	NA	0.6 U	1.3 U	NA
Sodium	1,500 J	2,170 B	2,270 J	NA	18,800	19,300	NA
Thallium	2.3 UL	2.3 U	10.9 B	NA	2.3 UL	3.9 U	NA
Vanadium	1 U	1.3 B	192	NA	1 U	34.9 U	NA
Zinc	9.1 J	4.9 B	802 J	NA	105	139 B	NA
Wet Chemistry (MG/L)							
Alkalinity	94	90	74	87	85	65	70
Ammonia	0.2 U	0.2 U	NA	0.2 U	0.2 U	NA	0.2 U
BOD-5day (total)	NA	NA	6.1	6.5	NA	8.6	2 U
Bicarbonate	94	90	74	87	85	65	70
Biological oxygen demand	82	2 U	NA	NA	2 U	NA	NA
Chemical oxygen demand	230	9	14	5 U	5 U	50	5 U
Chloride	1.2	1.1	2.2	5	30	29	44
Ethane	1.00E-03 U	1.00E-03 U	0.004	0.004 U	1.00E-03 U	0.004 U	0.004 U
Ethene	1.00E-03 U	1.00E-03 U	0.004	0.004 U	1.00E-03 U	0.004 U	0.004 U
Hardness	180	190	190	92	210	225	250
Methane	1.00E-03 U	1.00E-03 U	0.02	0.002 U	0.0128	0.012	0.01 B
Nitrate	0.93	1.5	NA	0.8	0.5 U	NA	0.5 U
Nitrate/Nitrite	NA	NA	1.6	NA	NA	0.55 U	NA
Nitrite	0.36	0.05 U	NA	0.05 U	0.05 U	NA	0.05 U
Nitrogen	NA	NA	0.2 U	NA	NA	0.37	NA
Oil and Grease	NA	NA	NA	NA	NA	NA	NA
Sulfate	40	3	8	8	150	190	160
Total dissolved solids (TDS)	94	92	160 L	540	NA	300	410
Total organic carbon (TOC)	1 U	1 U	1.9	1.2	1 U	1.7	1.1
Total recoverable phenolics	0.03 U	0.03 U	0.025 U	0.025 U	0.03 U	0.029	0.025 U
Reactivity (MG/L)							
No Detections							

NA - Not analyzed
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E - Exceedance - Interference
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K -Biased high
L - Biased low
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Table 5-3
Chemicals Detected in Groundwater from Alluvial Monitoring Wells
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Station ID	5GW09			5GW11		
Sample ID	AS05-5GW09-R05	AS05-5GW09-R06	AS05-5GW09-R07	AS05-5GW11-R05	AS05-5GW11-R06	AS05-5GW11-R07
Sample Date	08/03/00	04/17/01	02/06/02	08/02/00	04/11/01	02/07/02
Chemical Name						
Volatile Organic Compounds (UG/L)						
1,1,1-Trichloroethane	0.5 J	1 U	1 U	1 U	1 U	1 U
1,2-Dichloroethane	1 U	1 U	1 U	1 U	1 U	1 U
1,2-Dichloroethene (total)	NA	NA	NA	NA	NA	NA
Carbon disulfide	1 UJ	1 U	1 U	1 U	1 U	1 U
Methylene chloride	1.2 B	2 U	0.6 B	2 U	0.5 B	2 U
Trichloroethene	48	46	26	1 U	1 U	1 U
Vinyl chloride	1 UJ	1 U	1 U	1 U	1 U	1 U
cis-1,2-Dichloroethene	7.1	4	3.5	1 U	1 U	1 U
Semivolatile Organic Compounds (UG/L)						
No Detections						
Pesticide/Polychlorinated Biphenyls (UG/L)						
No Detections						
Herbicides (UG/L)						
No Detections						
Explosives (UG/L)						
No Detections						
Total Metals (UG/L)						
Aluminum	136 B	NA	17.2 U	83.7 B	NA	5,260
Antimony	4.9 U	NA	5 U	4.9 U	NA	5 U
Arsenic	4.1 B	NA	5.1 U	3.8 U	NA	6.9 J
Barium	32.8 J	NA	47.2 J	25.4 J	NA	305
Beryllium	0.1 U	NA	0.1 U	0.1 U	NA	0.46 J
Boron	83.6	NA	36.9 J	50 R	NA	28.4 J
Calcium	90,700	NA	55,200	33,300	NA	39,000
Chromium	0.7 UL	NA	2.7 B	0.7 UL	NA	20.5 B
Cobalt	8.8 J	NA	72.3	8.3 J	NA	4.8 J

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L - Biased low
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Table 5-3
Chemicals Detected in Groundwater from Alluvial Monitoring Wells
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Station ID	5GW09			5GW11		
Sample ID	AS05-5GW09-R05	AS05-5GW09-R06	AS05-5GW09-R07	AS05-5GW11-R05	AS05-5GW11-R06	AS05-5GW11-R07
Sample Date	08/03/00	04/17/01	02/06/02	08/02/00	04/11/01	02/07/02
Chemical Name						
Copper	0.7 U	NA	2.3 J	13.6 L	NA	39
Cyanide	10 U	19	10 U	10 U	10 U	10 U
Iron	562	NA	9,400	15.9 U	NA	13,800
Lead	2 U	NA	3.3	2 U	NA	17.4
Magnesium	32,400	NA	22,000	13,600	NA	14,400
Manganese	1,990	NA	2,200	214	NA	65.1
Mercury	0.1 U	NA	0.2 U	0.14 B	NA	0.2 U
Nickel	23.6 J	NA	24.2 J	36.6 J	NA	43.7
Potassium	3,980 K	NA	2,940 J	1,920 J	NA	4,820 J
Silver	0.6 UL	NA	0.6 U	0.6 UL	NA	1.3 J
Sodium	16,700	NA	14,000	7,190	NA	6,840
Thallium	2.3 U	NA	5 U	2.3 UL	NA	5 U
Tin	NA	NA	NA	NA	NA	NA
Vanadium	1 U	NA	1.2 B	1 U	NA	11.8 J
Zinc	39 B	NA	47.8	133	NA	79.3 B
Dissolved Metals (UG/L)						
Aluminum	92 B	79.6 B	NA	NA	110 B	NA
Antimony	4.9 U	3.1 U	NA	NA	3.4 J	NA
Arsenic	4.1 B	2.5 U	NA	NA	2.9 B	NA
Barium	35.1 J	33.4 J	NA	NA	38.7 J	NA
Beryllium	0.1 U	0.1 U	NA	NA	0.43 B	NA
Boron	57.5	112	NA	NA	71	NA
Cadmium	0.4 U	0.4 U	NA	NA	0.73 B	NA
Calcium	96,100	122,000	NA	NA	40,800	NA
Chromium	0.7 U	0.8 U	NA	NA	0.8 U	NA
Cobalt	8.9 J	5.3 J	NA	NA	5 J	NA
Copper	0.7 UL	1.7 J	NA	NA	8.9 J	NA
Iron	461	464	NA	NA	298	NA
Lead	4.2 B	2.5 U	NA	NA	2.5 U	NA
Magnesium	30,800	36,300	NA	NA	13,400	NA
Manganese	2,110	1,990	NA	NA	43.8	NA
Mercury	0.1 U	0.2 U	NA	NA	0.2 UL	NA
Molybdenum	10 U	10 U	NA	NA	10 U	NA

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L - Biased low
R - Rejected
U - Undetected

Table 5-3
Chemicals Detected in Groundwater from Alluvial Monitoring Wells
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Station ID	5GW09			5GW11		
Sample ID	AS05-5GW09-R05	AS05-5GW09-R06	AS05-5GW09-R07	AS05-5GW11-R05	AS05-5GW11-R06	AS05-5GW11-R07
Sample Date	08/03/00	04/17/01	02/06/02	08/02/00	04/11/01	02/07/02
Chemical Name						
Nickel	29.1 J	24.1 J	NA	NA	11.6 J	NA
Potassium	4,050 J	4,550 J	NA	NA	2,270 J	NA
Selenium	16.3 B	3.2 U	NA	NA	3.2 U	NA
Silver	1.3 B	1.3 U	NA	NA	1.3 U	NA
Sodium	17,600 J	19,500 J	NA	NA	13,000	NA
Thallium	2.3 U	3.9 U	NA	NA	6 B	NA
Vanadium	1 U	34.9 U	NA	NA	34.9 U	NA
Zinc	33.3 B	46.7 J	NA	NA	77.1 B	NA
Wet Chemistry (MG/L)						
Alkalinity	120	170	82	52	89	56
Ammonia	0.22	NA	0.2 U	0.2 U	NA	0.2 U
BOD-5day (total)	NA	2 U	2 U	NA	9.3	17
Bicarbonate	120	170	82	52	88	56
Biological oxygen demand	2 U	NA	NA	NA	NA	NA
Chemical oxygen demand	5	38	10	5 U	40	28
Chloride	24	35	45	6	5.5	7.9
Ethane	1.00E-03 U	0.004 U	0.004 U	NA	0.004 U	0.004 U
Ethene	1.00E-03 U	0.004 U	0.004 U	NA	0.004 U	0.004 U
Hardness	360	454	230	140	157	160
Methane	0.0639 U	0.144	0.11	NA	0.002 U	0.002 U
Nitrate	0.74	NA	0.5 U	0.83	NA	2.2
Nitrate/Nitrite	NA	1.4	NA	NA	1.4	NA
Nitrite	0.05 U	NA	0.05 U	NA	NA	0.05 U
Nitrogen	NA	0.2 U	NA	NA	0.2 U	NA
Oil and Grease	NA	NA	NA	NA	NA	NA
Sulfate	210	360	160	110	98	89
Total dissolved solids (TDS)	370	630	390	180	270	780
Total organic carbon (TOC)	2.4	2.5	3.2	2.5	3.9	8.7
Total recoverable phenolics	0.03 U	0.025 U	0.025 U	0.025 U	0.025 U	0.025 U
Reactivity (MG/L)						
No Detections						

NA - Not analyzed
B - Analyte not detected above associated blank
D - Result came from a diluted sample
E - Exceedance - Interference
J - Reported value is estimated
K -Biased high
L - Biased low
R - Rejected
U - Undetected

Table 5-3
Chemicals Detected in Groundwater from Alluvial Monitoring Wells
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Station ID	5GW13			5GW17			
Sample ID	AS05-5GW13-R05	AS05-5GW13-R06	AS05-5GW13-R07	AS05-5GW17-R05	AS05-5GW17P-R05	AS05-5GW17-R06	AS05-5GW17-R07
Sample Date	08/09/00	04/18/01	02/07/02	08/10/00	08/10/00	04/06/01	02/06/02
Chemical Name							
Volatile Organic Compounds (UG/L)							
1,1,1-Trichloroethane	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,2-Dichloroethane	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,2-Dichloroethene (total)	NA	NA	NA	NA	NA	NA	NA
Carbon disulfide	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Methylene chloride	3.6	4.1 B	0.6 B	2 UJ	2 UJ	0.6 B	0.6 B
Trichloroethene	81	62	62	10	11	17	27
Vinyl chloride	0.6 J	1 U	1 U	1 U	1 U	1 U	1 U
cis-1,2-Dichloroethene	5.2	3.2	22	1.3	1.3	0.9 J	1.8
Semivolatile Organic Compounds (UG/L)							
No Detections							
Pesticide/Polychlorinated Biphenyls (UG/L)							
No Detections							
Herbicides (UG/L)							
No Detections							
Explosives (UG/L)							
No Detections							
Total Metals (UG/L)							
Aluminum	29.3 B	NA	50.4 B	412	348	NA	61.4 J
Antimony	4.9 B	NA	5 U	4.9 U	4.9 U	NA	5 U
Arsenic	3.8 U	NA	5.1 U	3.8 U	3.8 U	NA	5.1 U
Barium	21.7 J	NA	25.7 J	99.8 J	87.7 J	NA	38.9 J
Beryllium	0.12 B	NA	0.1 J	0.1 U	0.1 U	NA	0.1 U
Boron	59.2	NA	47.8 J	50 U	50 U	NA	27.7 J
Calcium	196,000	NA	167,000	58,700	60,600	NA	66,100
Chromium	6.2 B	NA	7.3 B	7.1 J	6.4 B	NA	3.4 B
Cobalt	8.8 K	NA	7.8 J	4 B	3.5 B	NA	2.1 J

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E - Exceedance - Interference
J - Reported value is estimated
K -Biased high
L - Biased low
R - Rejected
U - Undetected

Table 5-3
Chemicals Detected in Groundwater from Alluvial Monitoring Wells
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Station ID	5GW13			5GW17			
Sample ID	AS05-5GW13-R05	AS05-5GW13-R06	AS05-5GW13-R07	AS05-5GW17-R05	AS05-5GW17P-R05	AS05-5GW17-R06	AS05-5GW17-R07
Sample Date	08/09/00	04/18/01	02/07/02	08/10/00	08/10/00	04/06/01	02/06/02
Chemical Name							
Copper	3.2 B	NA	1.5 U	1.5 B	2.2 B	NA	1.5 U
Cyanide	10 U	100	10 U	10 U	10 U	10 U	10 U
Iron	920 J	NA	3,890	786 J	609 J	NA	50.6 B
Lead	2 U	NA	2.9 U	2 U	2 U	NA	2.9 U
Magnesium	42,800	NA	31,300	15,100	15,600	NA	17,400
Manganese	4,510	NA	2,840	579	597	NA	535
Mercury	0.1 U	NA	0.2 U	0.1 U	0.1 U	NA	0.2 U
Nickel	31.7 K	NA	28.2 J	16 J	15.3 J	NA	9.4 J
Potassium	1,890 J	NA	1,400 J	926 J	902 J	NA	698 J
Silver	0.82 B	NA	0.6 U	0.6 U	0.96 B	NA	0.6 U
Sodium	14,600	NA	13,800	7,630	7,970	NA	9,780
Thallium	2.3 UL	NA	5 U	2.3 UL	2.3 UL	NA	5 U
Tin	NA	NA	NA	NA	NA	NA	NA
Vanadium	1 U	NA	0.8 U	1 U	1 U	NA	1.5 B
Zinc	50.7	NA	48.6 B	28.6	30.6	NA	15.2 B
Dissolved Metals (UG/L)							
Aluminum	19.2 U	47.8 J	NA	19.2 U	19.2 U	50.8 B	NA
Antimony	4.9 U	3.1 U	NA	4.9 U	4.9 U	3.1 U	NA
Arsenic	4.9 B	2.5 U	NA	3.8 U	3.8 U	3.4 B	NA
Barium	20.6 J	23.7 J	NA	67.9 J	67.3 J	57.1 J	NA
Beryllium	0.1 U	0.12 J	NA	0.1 U	0.1 U	0.33 B	NA
Boron	50 U	50 U	NA	50 U	50 U	50 U	NA
Cadmium	0.4 UL	1.5 J	NA	0.4 UL	0.4 UL	0.65 B	NA
Calcium	189,000	237,000	NA	64,100	63,700	71,000	NA
Chromium	1.6 B	0.8 U	NA	2.3 B	2.7 B	0.8 U	NA
Cobalt	9.1 K	14.2 J	NA	2.9 B	3.3 B	1.8 J	NA
Copper	1.2 B	2.3 J	NA	0.7 U	0.7 U	0.8 U	NA
Iron	1,350	1,130	NA	15.9 U	15.9 U	46.2 J	NA
Lead	2.9 K	2.5 U	NA	2 U	2 U	2.5 U	NA
Magnesium	39,400	54,300	NA	16,400	16,200	19,500	NA
Manganese	4,050	8,030	NA	636	644	502	NA
Mercury	0.13 B	0.2 U	NA	0.1 U	0.17 B	0.2 UL	NA
Molybdenum	10 U	10 U	NA	10 U	10 U	10 U	NA

NA - Not analyzed
B - Analyte not detected above associated blank
D - Result came from a diluted sample
E - Exceedance - Interference
J - Reported value is estimated
K -Biased high
L - Biased low
R - Rejected
U - Undetected

Table 5-3
Chemicals Detected in Groundwater from Alluvial Monitoring Wells
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Station ID	5GW13			5GW17			
Sample ID	AS05-5GW13-R05	AS05-5GW13-R06	AS05-5GW13-R07	AS05-5GW17-R05	AS05-5GW17P-R05	AS05-5GW17-R06	AS05-5GW17-R07
Sample Date	08/09/00	04/18/01	02/07/02	08/10/00	08/10/00	04/06/01	02/06/02
Chemical Name							
Nickel	29.5 K	32 J	NA	11.7 K	11.8 K	12.1 K	NA
Potassium	1,990 J	2,460 J	NA	913 J	928 J	885 B	NA
Selenium	8.3 B	3.2 U	NA	4.4 B	4.5 B	3.2 U	NA
Silver	0.64 B	1.3 U	NA	0.6 U	0.7 B	1.3 U	NA
Sodium	16,200	20,000	NA	8,600	8,780	10,100	NA
Thallium	2.3 U	3.9 U	NA	2.3 UL	2.3 UL	5.2 K	NA
Vanadium	1 U	34.9 U	NA	1 U	1 U	34.9 U	NA
Zinc	38.7	56.3	NA	16.2 J	16.9 J	40.3 B	NA
Wet Chemistry (MG/L)							
Alkalinity	260	210	240	98	99	69	86
Ammonia	0.2 U	NA	0.2 U	0.2 U	0.2 U	NA	0.2 U
BOD-5day (total)	NA	2 U	6.1	NA	NA	2 U	2 U
Bicarbonate	260	210	240	98	99	69	86
Biological oxygen demand	2 U	NA	NA	2 U	2.6	NA	NA
Chemical oxygen demand	5 U	12	6	5 U	5 U	26	7
Chloride	35	42	42	20	20	14	19
Ethane	NA	0.004 U	0.008	NA	NA	0.004 U	0.006
Ethene	NA	0.004 U	0.005	NA	NA	0.004 U	0.004
Hardness	670	810	555	210	220	258	240
Methane	NA	0.002 U	0.13 B	NA	NA	0.002 U	0.14
Nitrate	0.5 U	NA	0.5 U	0.5 U	0.5 U	NA	0.5 U
Nitrate/Nitrite	NA	0.55 U	NA	NA	NA	0.55 U	NA
Nitrite	0.05 U	NA	0.05 U	0.05 U	0.05 U	NA	0.05 U
Nitrogen	NA	0.2 U	NA	NA	NA	0.2 U	NA
Oil and Grease	NA	NA	NA	NA	NA	NA	NA
Sulfate	NA	800	320	130	120	180	160
Total dissolved solids (TDS)	590	1,100	780	250	240	360	380
Total organic carbon (TOC)	3	3.2	2.1	1.1	1.1	27	0.95
Total recoverable phenolics	0.03 U	0.031	0.025 U	0.03 U	0.03 U	0.025 U	0.025 U
Reactivity (MG/L)							
No Detections							

NA - Not analyzed
B - Analyte not detected above associated blank
D - Result came from a diluted sample
E - Exceedance - Interference
J - Reported value is estimated
K -Biased high
L - Biased low
R - Rejected
U - Undetected

Table 5-3
Chemicals Detected in Groundwater from Alluvial Monitoring Wells
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Station ID	5GW18				5GW19		
Sample ID	AS05-5GW18-R05	AS05-5GW18-R06	AS05-5GW18P-R06	AS05-5GW18-R07	AS05-5GW19-R05	AS05-5GW19-R06	AS05-5GW19-R07
Sample Date	08/10/00	04/19/01	04/19/01	02/06/02	08/09/00	04/05/01	02/04/02
Chemical Name							
Volatile Organic Compounds (UG/L)							
1,1,1-Trichloroethane	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,2-Dichloroethane	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,2-Dichloroethene (total)	NA	NA	NA	NA	NA	NA	NA
Carbon disulfide	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Methylene chloride	2 UJ	2 U	2 U	0.9 B	4.1	0.7 B	0.7 B
Trichloroethene	77	48	46	44	1 U	1 U	2
Vinyl chloride	1 U	1 U	1 U	1 U	1 U	1 U	1 U
cis-1,2-Dichloroethene	9.9	11	9.6	24	1 U	1 U	1 U
Semivolatile Organic Compounds (UG/L)							
No Detections							
Pesticide/Polychlorinated Biphenyls (UG/L)							
No Detections							
Herbicides (UG/L)							
No Detections							
Explosives (UG/L)							
No Detections							
Total Metals (UG/L)							
Aluminum	19.2 U	34.3 B	48 B	17.2 U	16,300	NA	447
Antimony	4.9 B	3.1 U	3.1 U	5 U	4.9 U	NA	5 U
Arsenic	5.5 B	2.5 U	2.5 U	5.1 U	7.4 B	NA	5.1 U
Barium	36 J	26.8 B	25.1 B	76 J	366	NA	101 J
Beryllium	0.1 U	0.73 B	0.72 J	0.1 U	1.1 J	NA	0.1 U
Boron	50 U	50 R	50 R	13.8 J	50 U	NA	17.5 J
Calcium	111,000	110,000	106,000	93,600	31,400	NA	25,900
Chromium	5.2 B	0.8 U	0.8 U	1.5 B	33.8	NA	3 J
Cobalt	1.1 U	1 U	1.3 B	1.3 U	41.4 J	NA	1.3 U

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J - Reported value is estimated
K -Biased high
L - Biased low
R - Rejected
U - Undetected

Table 5-3
Chemicals Detected in Groundwater from Alluvial Monitoring Wells
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Station ID	5GW18				5GW19		
Sample ID	AS05-5GW18-R05	AS05-5GW18-R06	AS05-5GW18P-R06	AS05-5GW18-R07	AS05-5GW19-R05	AS05-5GW19-R06	AS05-5GW19-R07
Sample Date	08/10/00	04/19/01	04/19/01	02/06/02	08/09/00	04/05/01	02/04/02
Chemical Name							
Copper	1.7 B	0.8 U	3.1 J	1.5 U	37.2	NA	1.5 U
Cyanide	10 U	11	11	10 U	10 U	1	10 U
Iron	1,470 J	1,740	1,690	4,280	28,500 J	NA	730
Lead	2 U	2.5 U	2.5 U	3.3	29.9	NA	2.9 U
Magnesium	15,600	15,900	15,200	12,900	8,710	NA	5,780
Manganese	91.8	394	371	448	2,900	NA	145
Mercury	0.1 U	0.2 U	0.2 U	0.2 U	0.21 B	NA	0.2 U
Nickel	10.5 J	3.3 B	1.7 U	2.1 U	61.2	NA	3 J
Potassium	468 J	504 J	457 J	451 J	2,840 J	NA	548 J
Silver	0.92 B	1.3 U	1.3 U	0.6 U	0.84 B	NA	0.6 U
Sodium	9,640	10,700	10,200	8,470	3,470 B	NA	3,320 J
Thallium	2.3 UL	3.9 U	3.9 U	5 U	2.3 UL	NA	5 U
Tin	NA	NA	NA	NA	NA	NA	NA
Vanadium	1 U	34.9 U	34.9 U	0.89 B	32.9 J	NA	0.89 J
Zinc	30.6	61 R	26.7 R	8.9 B	150	NA	34.2 B
Dissolved Metals (UG/L)							
Aluminum	19.2 U	34.3 B	48 B	NA	19.2 U	58.1 B	NA
Antimony	4.9 U	3.1 U	3.1 U	NA	6.2 B	3.1 U	NA
Arsenic	4.1 B	2.5 U	2.5 U	NA	3.8 U	3.4 K	NA
Barium	33.3 J	26.8 B	25.1 B	NA	75.6 J	78.5 J	NA
Beryllium	0.1 U	0.73 B	0.72 J	NA	0.1 U	0.21 B	NA
Boron	50 U	50 R	50 R	NA	50 U	50 U	NA
Cadmium	0.4 UL	0.4 U	0.4 U	NA	0.4 UL	0.4 U	NA
Calcium	122,000	110,000	106,000	NA	26,900	29,200	NA
Chromium	2.7 B	0.8 U	0.8 U	NA	1.7 B	0.8 U	NA
Cobalt	1.1 U	1 U	1.3 B	NA	1.1 B	1 U	NA
Copper	0.7 U	0.8 U	3.1 J	NA	0.7 U	1.8 J	NA
Iron	495	1,740	1,690	NA	15.9 U	41.5 J	NA
Lead	2 U	2.5 U	2.5 U	NA	2 U	2.5 U	NA
Magnesium	17,100	15,900	15,200	NA	5,800	5,990	NA
Manganese	99.7	394	371	NA	117	13.4 J	NA
Mercury	0.1 U	0.2 U	0.2 U	NA	0.1 U	0.2 UL	NA
Molybdenum	10 U	10 R	10 R	NA	10 U	10 U	NA

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J - Reported value is estimated
K -Biased high
L - Biased low
R - Rejected
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Table 5-3
Chemicals Detected in Groundwater from Alluvial Monitoring Wells
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Station ID	5GW18				5GW19		
Sample ID	AS05-5GW18-R05	AS05-5GW18-R06	AS05-5GW18P-R06	AS05-5GW18-R07	AS05-5GW19-R05	AS05-5GW19-R06	AS05-5GW19-R07
Sample Date	08/10/00	04/19/01	04/19/01	02/06/02	08/09/00	04/05/01	02/04/02
Chemical Name							
Nickel	6.4 B	3.3 B	1.7 U	NA	8.3 B	2.4 J	NA
Potassium	578 J	504 J	457 J	NA	637 J	585 J	NA
Selenium	2.2 U	3.2 U	3.2 U	NA	2.2 U	3.2 U	NA
Silver	0.79 B	1.3 U	1.3 U	NA	0.6 U	1.3 U	NA
Sodium	11,700	10,700	10,200	NA	3,940 B	3,540 J	NA
Thallium	2.3 UL	3.9 U	3.9 U	NA	2.3 UL	5.8 K	NA
Vanadium	1 U	34.9 U	34.9 U	NA	1.1 B	34.9 U	NA
Zinc	17.3 J	61 R	26.7 R	NA	14.5 B	35 B	NA
Wet Chemistry (MG/L)							
Alkalinity	120	130	130	160	43	45	46
Ammonia	0.2 U	NA	NA	0.2 U	0.2 U	0.2 U	0.2 U
BOD-5day (total)	NA	2 U	2	2 U	NA	2 U	2 U
Bicarbonate	120	130	130	160	43	45	46
Biological oxygen demand	2 U	NA	NA	NA	2 U	NA	NA
Chemical oxygen demand	5 U	23	18	5 U	5 U	56	5 U
Chloride	21	16	16	23	4	3.5	5
Ethane	NA	0.004 U	0.004 U	0.004 U	NA	0.004 U	0.005
Ethene	NA	0.004 U	0.004 U	0.011	NA	0.004 U	0.004 U
Hardness	340	340	330	290	110	100	88
Methane	NA	0.02 U	0.02 U	0.8	NA	0.002 U	0.014
Nitrate	0.5 U	NA	NA	0.5 U	0.58	NA	0.5 U
Nitrate/Nitrite	NA	0.55 U	0.55 U	NA	NA	0.88	NA
Nitrite	0.05 U	NA	NA	0.05 U	0.05	NA	0.05 U
Nitrogen	NA	0.2 U	0.2 U	NA	NA	NA	NA
Oil and Grease	NA	NA	NA	NA	NA	NA	NA
Sulfate	250	200	220	160	NA	51	450
Total dissolved solids (TDS)	370	390	380	390	100	170 L	210
Total organic carbon (TOC)	1.3	1.2	1.2	0.89	1 U	10	1.3
Total recoverable phenolics	0.03 U	0.025 U	0.025 U	0.025 U	0.03 U	0.025 U	0.025 U
Reactivity (MG/L)							
No Detections							

NA - Not analyzed
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D - Result came from a diluted sample
E - Exceedance - Interference
J - Reported value is estimated
K -Biased high
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R - Rejected
U - Undetected

Table 5-3
Chemicals Detected in Groundwater from Alluvial Monitoring Wells
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Station ID	5GW20			5GW21		
Sample ID	AS05-5GW20-R05	AS05-5GW20-R06	AS05-5GW20-R07	AS05-5GW21-R05	AS05-5GW21-R06	AS05-5GW21-R07
Sample Date	08/09/00	04/04/01	02/06/02	08/08/00	04/04/01	02/04/02
Chemical Name						
Volatile Organic Compounds (UG/L)						
1,1,1-Trichloroethane	1 U	1 U	1 U	1 U	1 U	1 U
1,2-Dichloroethane	1 U	1 U	1 U	1 U	1 U	1 U
1,2-Dichloroethene (total)	NA	NA	NA	NA	NA	NA
Carbon disulfide	1 U	1 U	1 U	1 UJ	1 U	1 U
Methylene chloride	3.6	0.6 B	0.6 B	1.9 B	0.6 B	0.9 B
Trichloroethene	3.6	14	28	1 U	1 U	4.7
Vinyl chloride	1 U	1 U	1 U	1 U	1 U	1 U
cis-1,2-Dichloroethene	0.7 J	0.9 J	2.3	1 U	1 U	1 U
Semivolatile Organic Compounds (UG/L)						
No Detections						
Pesticide/Polychlorinated Biphenyls (UG/L)						
No Detections						
Herbicides (UG/L)						
No Detections						
Explosives (UG/L)						
No Detections						
Total Metals (UG/L)						
Aluminum	7,090	NA	185 J	1,930	NA	88.8 B
Antimony	5.7 B	NA	5 U	4.9 U	NA	5 U
Arsenic	4.8 B	NA	5.1 U	6.4 B	NA	5.1 U
Barium	185 J	NA	103 J	117 J	NA	102 J
Beryllium	0.54 J	NA	0.1 U	0.24 B	NA	0.1 U
Boron	50 U	NA	27.7 J	NA	NA	17.5 J
Calcium	42,900	NA	58,100	55,000	NA	68,300
Chromium	15.9	NA	2.6 B	6.3 B	NA	3.2 J
Cobalt	15.2 J	NA	1.3 U	2.5 B	NA	1.3 U

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D - Result came from a diluted sample
E - Exceedance - Interference
J - Reported value is estimated
K -Biased high
L - Biased low
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U - Undetected

Table 5-3
Chemicals Detected in Groundwater from Alluvial Monitoring Wells
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Station ID	5GW20			5GW21		
Sample ID	AS05-5GW20-R05	AS05-5GW20-R06	AS05-5GW20-R07	AS05-5GW21-R05	AS05-5GW21-R06	AS05-5GW21-R07
Sample Date	08/09/00	04/04/01	02/06/02	08/08/00	04/04/01	02/04/02
Chemical Name						
Copper	15 J	NA	1.5 U	7.7 B	NA	1.5 U
Cyanide	10 U	1	10 U	10 U	1	20
Iron	14,500 J	NA	218	6,030 J	NA	239
Lead	10.2	NA	2.9 U	4.9 B	NA	2.9 U
Magnesium	10,200	NA	7,760	6,970	NA	8,090
Manganese	672	NA	19	108	NA	18.8
Mercury	0.1 U	NA	0.2 U	0.1 U	NA	0.2 U
Nickel	27.2 J	NA	2.1 U	13.8 B	NA	2.1 U
Potassium	2,160 J	NA	347 J	866 J	NA	173 J
Silver	0.6 U	NA	0.6 U	0.6 U	NA	0.6 U
Sodium	4,480 B	NA	6,380	7,000	NA	6,710
Thallium	2.3 UL	NA	5 U	3.5 B	NA	5 U
Tin	NA	NA	NA	NA	NA	NA
Vanadium	12.4 J	NA	1.1 B	4.6 B	NA	0.8 U
Zinc	72.4	NA	12.5 B	43.5	NA	28.1 B
Dissolved Metals (UG/L)						
Aluminum	19.2 U	259	NA	19.2 U	49.7 B	NA
Antimony	4.9 U	3.1 U	NA	4.9 U	3.1 U	NA
Arsenic	3.8 U	2.6 K	NA	7.7 B	2.5 U	NA
Barium	82.9 J	92.6 J	NA	89.4 J	106 J	NA
Beryllium	0.1 U	0.26 B	NA	0.1 U	0.28 B	NA
Boron	50 U	50 U	NA	NA	50 U	NA
Cadmium	0.4 UL	0.58 B	NA	0.4 U	0.56 B	NA
Calcium	38,200	51,000	NA	61,800	67,200	NA
Chromium	2.2 B	4.6 J	NA	0.8 B	1 J	NA
Cobalt	1.8 B	1	NA	1.1 U	1.6 J	NA
Copper	0.7 U	4.7 B	NA	0.7 UL	3.2 J	NA
Iron	15.9 U	455	NA	15.9 U	79.5 J	NA
Lead	2 U	2.5 U	NA	2 U	2.5 U	NA
Magnesium	8,480	6,680	NA	7,430	8,340	NA
Manganese	46.6	29.7	NA	24.7	18.2	NA
Mercury	0.1 U	0.2 UL	NA	0.1 U	0.2 UL	NA
Molybdenum	10 U	10 U	NA	NA	10 U	NA

NA - Not analyzed
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K -Biased high
L - Biased low
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U - Undetected

Table 5-3
Chemicals Detected in Groundwater from Alluvial Monitoring Wells
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Station ID	5GW20			5GW21		
Sample ID	AS05-5GW20-R05	AS05-5GW20-R06	AS05-5GW20-R07	AS05-5GW21-R05	AS05-5GW21-R06	AS05-5GW21-R07
Sample Date	08/09/00	04/04/01	02/06/02	08/08/00	04/04/01	02/04/02
Chemical Name						
Nickel	6.2 B	6.1 J	NA	4 B	3.6 J	NA
Potassium	853 J	388 J	NA	256 B	277 J	NA
Selenium	2.2 U	3.2 U	NA	2.4 B	3.2 U	NA
Silver	0.6 U	1.3 U	NA	0.6 U	1.3 U	NA
Sodium	5,320	5,170	NA	7,870	9,150	NA
Thallium	2.3 U	4.7 K	NA	2.3 UL	4.1 K	NA
Vanadium	1 U	34.9 U	NA	1 U	34.9 U	NA
Zinc	11.3 B	34 B	NA	21	44.9	NA
Wet Chemistry (MG/L)						
Alkalinity	74	63	70	100	110	100
Ammonia	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
BOD-5day (total)	NA	2 U	2 U	NA	2 U	2 U
Bicarbonate	74	63	70	100	110	100
Biological oxygen demand	3.9	NA	NA	2 U	NA	NA
Chemical oxygen demand	5 U	30	5 U	5 U	33	5 U
Chloride	12	7.7	13	28	28	34
Ethane	NA	0.004 U	0.004 U	1.00E-03 U	0.004 U	0.004 U
Ethene	NA	0.004 U	0.004 U	1.00E-03 U	0.004 U	0.004 U
Hardness	150	160	180	170	200	200
Methane	NA	0.002 U	0.002 U	1.00E-03 U	0.002 U	0.002 U
Nitrate	0.51	NA	0.5 U	0.5 U	NA	0.5 U
Nitrate/Nitrite	NA	0.61	NA	NA	0.55 U	NA
Nitrite	0.05 U	NA	0.05 U	0.09	NA	0.05 U
Nitrogen	NA	NA	NA	NA	NA	NA
Oil and Grease	NA	NA	NA	NA	NA	NA
Sulfate	NA	110	96	62	75	80
Total dissolved solids (TDS)	150	200 L	280	210	260 L	1,300
Total organic carbon (TOC)	1 U	1 U	0.8	1 U	1.3	1.2
Total recoverable phenolics	0.03 U	0.025 U	0.025 U	0.03 U	0.025 U	0.025 U
Reactivity (MG/L)						
No Detections						

NA - Not analyzed
B - Analyte not detected above associated blank
D - Result came from a diluted sample
E - Exceedance - Interference
J - Reported value is estimated
K -Biased high
L - Biased low
R - Rejected
U - Undetected

Table 5-3
Chemicals Detected in Groundwater from Alluvial Monitoring Wells
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Station ID	5GW22				5GW23		
Sample ID	AS05-5GW22-R05	AS05-5GW22-R06	AS05-5GW22-R07	AS05-5GW22P-R07	AS05-5GW23-R05	AS05-5GW23-R06	AS05-5GW23-R07
Sample Date	08/08/00	04/19/01	02/07/02	02/07/02	08/08/00	04/04/01	02/05/02
Chemical Name							
Volatile Organic Compounds (UG/L)							
1,1,1-Trichloroethane	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,2-Dichloroethane	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,2-Dichloroethene (total)	NA	NA	NA	NA	NA	NA	NA
Carbon disulfide	1 UJ	1 U	1 U	1 U	1 UJ	1 U	1 U
Methylene chloride	1.6 B	2 U	0.5 B	0.6 B	1.8 B	0.7 B	2.7 B
Trichloroethene	82	96	130	150	4.2	3.9	3.7
Vinyl chloride	1 U	1 U	1 U	1 U	1 U	1 U	1 U
cis-1,2-Dichloroethene	13	14	20	20	1 U	1 U	1 U
Semivolatile Organic Compounds (UG/L)							
No Detections							
Pesticide/Polychlorinated Biphenyls (UG/L)							
No Detections							
Herbicides (UG/L)							
No Detections							
Explosives (UG/L)							
No Detections							
Total Metals (UG/L)							
Aluminum	6,060	52.6 J	360	567	1,070	NA	387
Antimony	4.9 U	3.1 U	5.3 J	5 U	4.9 U	NA	5 U
Arsenic	3.8 U	2.5 U	5.1 U	5.1 U	3.8 U	NA	5.1 U
Barium	233	110 J	89.5 J	107 J	346	NA	733
Beryllium	0.5 B	0.75 B	0.1 U	0.1 U	0.1 B	NA	0.1 U
Boron	NA	50 U	10 U	10 U	NA	NA	17.5 J
Calcium	44,800	64,000	55,900	62,100	58,400	NA	85,100
Chromium	12.2 B	0.8 U	4.4 B	5.1 B	5.1 B	NA	3.8 B
Cobalt	27 J	1 U	2.7 J	2.9 J	2.8 B	NA	1.8 J

NA - Not analyzed
B - Analyte not detected above associated blank
D - Result came from a diluted sample
E - Exceedance - Interference
J - Reported value is estimated
K -Biased high
L - Biased low
R - Rejected
U - Undetected

Table 5-3
Chemicals Detected in Groundwater from Alluvial Monitoring Wells
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Station ID	5GW22				5GW23		
Sample ID	AS05-5GW22-R05	AS05-5GW22-R06	AS05-5GW22-R07	AS05-5GW22P-R07	AS05-5GW23-R05	AS05-5GW23-R06	AS05-5GW23-R07
Sample Date	08/08/00	04/19/01	02/07/02	02/07/02	08/08/00	04/04/01	02/05/02
Chemical Name							
Copper	7.5 B	0.8 U	1.5 U	1.5 U	3.2 B	NA	3 J
Cyanide	10 U	11	10 U	10 U	10 U	1	10 U
Iron	11,900 J	14.7 U	668	1,130	4,590 J	NA	4,400
Lead	14	2.5 U	2.9 U	2.9 U	6.2 B	NA	2.9 U
Magnesium	7,030	8,670	7,810	8,740	6,860	NA	9,980
Manganese	1,350	65.1	154	177	338	NA	337
Mercury	0.22 B	0.2 U	0.2 U	0.2 U	0.1 U	NA	0.2 U
Nickel	33 J	2.2 B	4.6 B	5.7 B	15.9 J	NA	2.1 U
Potassium	1,690 J	372 J	458 J	504 J	1,840 J	NA	877 J
Silver	0.6 U	1.3 U	0.6 U	0.6 U	0.6 U	NA	0.6 U
Sodium	5,240	7,450	6,140	6,460	5,680	NA	5,800 J
Thallium	2.3 UL	3.9 U	5 U	5 U	4.7 B	NA	5 U
Tin	NA	NA	NA	NA	NA	NA	NA
Vanadium	11.6 J	34.9 U	0.8 U	0.8 U	3.9 B	NA	1.1 J
Zinc	85.7	46.6 R	20.1 B	22.2 B	63.2	NA	21 B
Dissolved Metals (UG/L)							
Aluminum	19.2 U	52.6 J	NA	NA	19.2 U	30.8 B	NA
Antimony	4.9 U	3.1 U	NA	NA	4.9 U	3.7 J	NA
Arsenic	3.8 U	2.5 U	NA	NA	5.6 B	3.5 K	NA
Barium	82.9 J	110 J	NA	NA	353	380	NA
Beryllium	0.1 U	0.75 B	NA	NA	0.1 U	0.26 B	NA
Boron	NA	50 U	NA	NA	NA	50 U	NA
Cadmium	0.4 U	0.4 U	NA	NA	0.4 U	0.56 B	NA
Calcium	49,400	64,000	NA	NA	65,200	64,400	NA
Chromium	0.96 B	0.8 U	NA	NA	0.7 U	0.8 U	NA
Cobalt	3.4 B	1 U	NA	NA	1.6 B	1.3 J	NA
Copper	0.7 UL	0.8 U	NA	NA	0.7 UL	1.5 B	NA
Iron	15.9 U	14.7 U	NA	NA	1,720	3,640	NA
Lead	2 U	2.5 U	NA	NA	2 U	2.5 U	NA
Magnesium	6,920	8,670	NA	NA	7,390	7,740	NA
Manganese	284	65.1	NA	NA	331	294	NA
Mercury	0.1 U	0.2 U	NA	NA	0.1 U	0.22 L	NA
Molybdenum	NA	10 R	NA	NA	NA	10 U	NA

NA - Not analyzed
B - Analyte not detected above associated blank
D - Result came from a diluted sample
E - Exceedance - Interference
J - Reported value is estimated
K -Biased high
L - Biased low
R - Rejected
U - Undetected

Table 5-3
Chemicals Detected in Groundwater from Alluvial Monitoring Wells
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Station ID	5GW22				5GW23		
Sample ID	AS05-5GW22-R05	AS05-5GW22-R06	AS05-5GW22-R07	AS05-5GW22P-R07	AS05-5GW23-R05	AS05-5GW23-R06	AS05-5GW23-R07
Sample Date	08/08/00	04/19/01	02/07/02	02/07/02	08/08/00	04/04/01	02/05/02
Chemical Name							
Nickel	8.3 B	2.2 B	NA	NA	4.5 B	2.3 J	NA
Potassium	754 B	372 J	NA	NA	1,320 J	1,220 J	NA
Selenium	2.2 UL	3.2 U	NA	NA	2.2 UL	3.2 U	NA
Silver	0.6 U	1.3 U	NA	NA	0.6 U	1.3 U	NA
Sodium	6,270	7,450	NA	NA	5,630	6,740	NA
Thallium	2.3 UL	3.9 U	NA	NA	2.3 UL	5.3 K	NA
Vanadium	1 U	34.9 U	NA	NA	1 U	34.9 U	NA
Zinc	29.7	46.6 R	NA	NA	18.4 J	37.1 B	NA
Wet Chemistry (MG/L)							
Alkalinity	83	77	100	98	180	190	220
Ammonia	0.2 U	NA	0.2 U	0.2 U	0.39	0.2 U	0.2 U
BOD-5day (total)	NA	2.1	2 U	2 U	NA	2 U	7.9
Bicarbonate	83	77	100	98	180	190	220
Biological oxygen demand	2 U	NA	NA	NA	2 U	NA	NA
Chemical oxygen demand	5 U	18	6	5	5 U	41	5 U
Chloride	20	18	17	18	10	13	9
Ethane	1.00E-03 U	0.004 U	0.004 U	0.004 U	1.00E-03 U	0.004 U	0.004 U
Ethene	1.00E-03 U	0.004 U	0.004 U	0.004 U	1.00E-03 U	0.004 U	0.004 U
Hardness	140	200	170	190	170	200	250
Methane	0.0012	0.002 U	0.002 U	0.002 U	1.00E-03 U	0.002 U	0.011
Nitrate	1.3	NA	0.5 U	0.5 U	0.5 U	NA	0.5 U
Nitrate/Nitrite	NA	0.55 U	NA	NA	NA	0.55 U	NA
Nitrite	0.17	NA	0.05 U	0.05 U	0.05 U	NA	0.05 U
Nitrogen	NA	0.2 U	NA	NA	NA	NA	NA
Oil and Grease	NA	NA	NA	NA	NA	NA	NA
Sulfate	71	99	110	100	33	50	10
Total dissolved solids (TDS)	170	260	290	290	200	280 L	340
Total organic carbon (TOC)	1 U	1 U	1.7	2.2	1.3	1.5	0.9
Total recoverable phenolics	0.03 U	0.025 U	0.025 U	0.025 U	0.03 U	0.025	0.025 U
Reactivity (MG/L)							
No Detections							

NA - Not analyzed
B - Analyte not detected above associated blank
D - Result came from a diluted sample
E - Exceedance - Interference
J - Reported value is estimated
K -Biased high
L - Biased low
R - Rejected
U - Undetected

Table 5-3
Chemicals Detected in Groundwater from Alluvial Monitoring Wells
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Station ID	5GW24		
Sample ID	AS05-5GW24-R05	AS05-5GW24-R06	AS05-5GW24-R07
Sample Date	08/07/00	04/09/01	02/05/02
Chemical Name			
Volatile Organic Compounds (UG/L)			
1,1,1-Trichloroethane	1 U	1 U	1 U
1,2-Dichloroethane	1 U	1 U	1 U
1,2-Dichloroethene (total)	NA	NA	NA
Carbon disulfide	2.1 B	1 U	1 U
Methylene chloride	0.6 B	1.8 B	2.6 B
Trichloroethene	1 U	1 U	1 U
Vinyl chloride	1 U	1 U	1 U
cis-1,2-Dichloroethene	1 U	1 U	1 U
Semivolatile Organic Compounds (UG/L)			
No Detections			
Pesticide/Polychlorinated Biphenyls (UG/L)			
No Detections			
Herbicides (UG/L)			
No Detections			
Explosives (UG/L)			
No Detections			
Total Metals (UG/L)			
Aluminum	94.1 B	NA	134 J
Antimony	4.9 U	NA	5 U
Arsenic	5 B	NA	5.1 U
Barium	72.3 J	NA	62.5 J
Beryllium	0.11 B	NA	0.1 U
Boron	NA	NA	26.3 J
Calcium	124,000	NA	115,000
Chromium	0.96 B	NA	0.92 B
Cobalt	1.1 U	NA	1.3 U

NA - Not analyzed
B - Analyte not detected above associated blank
D - Result came from a diluted sample
E - Exceedance - Interference
J - Reported value is estimated
K -Biased high
L - Biased low
R - Rejected
U - Undetected

Table 5-3
Chemicals Detected in Groundwater from Alluvial Monitoring Wells
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Station ID	5GW24		
Sample ID	AS05-5GW24-R05	AS05-5GW24-R06	AS05-5GW24-R07
Sample Date	08/07/00	04/09/01	02/05/02
Chemical Name			
Copper	3.3 B	NA	2.2 J
Cyanide	10 U	10 U	10 U
Iron	405 J	NA	261
Lead	2.1 B	NA	2.9 U
Magnesium	21,200	NA	26,800
Manganese	44.3	NA	17
Mercury	0.1 U	NA	0.2 U
Nickel	2.8 B	NA	2.1 U
Potassium	2,980 J	NA	1,150 J
Silver	0.6 U	NA	0.6 U
Sodium	6,070	NA	5,420 J
Thallium	2.3 UL	NA	5 U
Tin	NA	NA	NA
Vanadium	1 U	NA	0.8 U
Zinc	31.4	NA	22.1 B
Dissolved Metals (UG/L)			
Aluminum	19.2 U	26.6 B	NA
Antimony	4.9 U	3.1 U	NA
Arsenic	3.8 U	3.2 B	NA
Barium	72.7 J	72.9 B	NA
Beryllium	0.1 U	0.1 U	NA
Boron	NA	51.4	NA
Cadmium	0.4 U	0.4 U	NA
Calcium	132,000	121,000	NA
Chromium	0.7 U	0.8 U	NA
Cobalt	1.1 U	1 U	NA
Copper	0.7 UL	1.4 B	NA
Iron	15.9 U	14.7 U	NA
Lead	3.5	2.5 U	NA
Magnesium	22,500	19,800	NA
Manganese	16.2	2.6 B	NA
Mercury	0.11 B	1.2 L	NA
Molybdenum	NA	10 U	NA

NA - Not analyzed
B - Analyte not detected above associated blank
D - Result came from a diluted sample
E - Exceedance - Interference
J - Reported value is estimated
K -Biased high
L - Biased low
R - Rejected
U - Undetected

Table 5-3
Chemicals Detected in Groundwater from Alluvial Monitoring Wells
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Station ID	5GW24		
Sample ID	AS05-5GW24-R05	AS05-5GW24-R06	AS05-5GW24-R07
Sample Date	08/07/00	04/09/01	02/05/02
Chemical Name			
Nickel	2 U	1.8 B	NA
Potassium	4,330 J	4,160 J	NA
Selenium	2.3 B	3.2 U	NA
Silver	0.6 U	1.3 U	NA
Sodium	6,600	11,400	NA
Thallium	2.3 UL	5.5 B	NA
Vanadium	1 U	34.9 U	NA
Zinc	8.9 J	27 B	NA
Wet Chemistry (MG/L)			
Alkalinity	350	287	230
Ammonia	0.2 U	NA	0.2 U
BOD-5day (total)	NA	4.5	2 U
Bicarbonate	340	290	230
Biological oxygen demand	2 U	NA	NA
Chemical oxygen demand	5 U	31	5 U
Chloride	10	28	24
Ethane	1.00E-03 U	0.004	0.004 U
Ethene	1.00E-03 U	0.004	0.004 U
Hardness	400	380	400
Methane	0.0011	0.02	0.002 U
Nitrate	1.8	NA	0.5 U
Nitrate/Nitrite	NA	1.5	NA
Nitrite	0.05 U	NA	0.05 U
Nitrogen	NA	0.2 U	NA
Oil and Grease	NA	NA	NA
Sulfate	77	88	73
Total dissolved solids (TDS)	NA	450	540
Total organic carbon (TOC)	1.2	1.1	1.5
Total recoverable phenolics	0.03 U	0.025 U	0.025 U
Reactivity (MG/L)			
No Detections			

NA - Not analyzed
B - Analyte not detected above associated blank
D - Result came from a diluted sample
E - Exceedance - Interference
J - Reported value is estimated
K -Biased high
L - Biased low
R - Rejected
U - Undetected

Table 5-4
Chemicals Detected in Groundwater from Bedrock Monitoring Wells
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Station ID	5GW02				5GW03		
Sample ID	AS05-5GW02-R05	AS05-5GW02-R06	AS05-5GW02-R07	AS05-5GW02P-R07	AS05-5GW03-R05	AS05-5GW03-R06	AS05-5GW03-R07
Sample Date	08/03/00	04/11/01	02/05/02	02/05/02	08/07/00	04/11/01	02/05/02
Chemical Name							
Volatile Organic Compounds (UG/L)							
Acetone	5 R	23 L	5 U	5 U	5 R	5 R	5 U
Carbon tetrachloride	1 U	0.7 J	1 U	1 U	1 U	1 U	1 U
Methylene chloride	1.1 B	0.5 B	2.7 B	0.7 B	0.7 B	2 U	0.7 B
Trichloroethene	8.2	7.2	7.1	6.5	4.4	6.3	11
cis-1,2-Dichloroethene	1 J	0.8 J	0.8 J	0.5 J	0.7 J	0.6 J	0.8 J
Semivolatile Organic Compounds (UG/L)							
No Detections							
Pesticide/Polychlorinated Biphenyls (UG/L)							
No Detections							
Herbicides (UG/L)							
No Detections							
Explosives (UG/L)							
No Detections							
Total Metals (UG/L)							
Aluminum	19.2 U	NA	17.2 U	24.4 J	19.2 U	NA	53.2 J
Antimony	4.9 U	NA	5 U	5 U	4.9 U	NA	5 U
Arsenic	3.8 U	NA	5.1 U	5.1 U	3.8 U	NA	5.1 U
Barium	19.3 J	NA	25.5 J	25.9 J	34.8 J	NA	25 J
Beryllium	0.1 U	NA	0.1 U	0.1 U	0.1 U	NA	0.1 U
Boron	207	NA	237	246	NA	NA	70.2
Cadmium	0.4 UL	NA	1.7 U	1.7 U	0.4 U	NA	2.4 J
Calcium	71,900	NA	84,700	85,100	88,800	NA	105,000
Chromium	0.7 UL	NA	1.2 B	1.5 B	0.7 U	NA	1.1 B
Cobalt	8.6 J	NA	6.8 J	5.9 J	1.1 U	NA	1.3 U

NA - Not analyzed
B - Analyte not detected above associated blank
E - Exceedance - Interference
J - Reported value is estimated
K - Biased high
L - Biased low
R - Unreliable result
U - Undetected

Table 5-4
Chemicals Detected in Groundwater from Bedrock Monitoring Wells
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Station ID	5GW02				5GW03		
Sample ID	AS05-5GW02-R05	AS05-5GW02-R06	AS05-5GW02-R07	AS05-5GW02P-R07	AS05-5GW03-R05	AS05-5GW03-R06	AS05-5GW03-R07
Sample Date	08/03/00	04/11/01	02/05/02	02/05/02	08/07/00	04/11/01	02/05/02
Chemical Name							
Copper	4.8 B	NA	1.5 U	1.7 J	2.7 B	NA	1.5 U
Cyanide	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Iron	1,780	NA	2,280	2,080	168 B	NA	16.9 B
Lead	2 U	NA	2.9 U	2.9 U	2 UL	NA	2.9 U
Magnesium	24,700	NA	29,500	29,900	16,100	NA	26,100
Manganese	1,540	NA	942	885	69.3	NA	554
Molybdenum	10 U	NA	10 U	10 U	NA	NA	10 U
Nickel	27.2 J	NA	25.4 J	25.2 J	6 B	NA	90.2
Potassium	3,700 J	NA	3,320 J	3,450 J	2,640 J	NA	2,590 J
Selenium	2.2 U	NA	4 U	4 U	2.2 UL	NA	4 U
Silver	0.6 UL	NA	0.6 U	0.6 U	0.6 U	NA	0.6 U
Sodium	34,500	NA	34,400 J	35,200 J	4,440 J	NA	11,200 J
Thallium	2.3 U	NA	5 U	5 U	2.3 UL	NA	5 U
Zinc	49.7	NA	35.2 B	42.6 B	34.1	NA	42.4 B
Dissolved Metals (UG/L)							
Aluminum	71.6 B	67.4 B	NA	NA	19.2 U	61.5 B	NA
Antimony	4.9 U	3.1 U	NA	NA	4.9 U	3.1 U	NA
Arsenic	3.8 U	2.5 U	NA	NA	6.2 B	3.1 B	NA
Barium	20.4 J	30.3 J	NA	NA	36.1 J	29.6 J	NA
Beryllium	0.1 U	0.34 B	NA	NA	0.1 U	0.5 B	NA
Boron	185	50 U	NA	NA	NA	124	NA
Calcium	76,600	73,600	NA	NA	99,100	99,900	NA
Chromium	0.7 U	0.8 U	NA	NA	0.7 U	1.3 J	NA
Cobalt	9.9 J	6.1 J	NA	NA	1.1 U	1.7 J	NA
Copper	2.3 B	3.6 B	NA	NA	0.7 UL	2.8 J	NA
Iron	2,120	55.7 B	NA	NA	15.9 U	42.1 J	NA
Lead	2 U	2.5 U	NA	NA	2 U	4.6 B	NA
Magnesium	25,900	27,300	NA	NA	17,800	21,600	NA
Manganese	1,620	3,930	NA	NA	7.7 J	71.2	NA
Mercury	0.1 U	0.83 L	NA	NA	0.1 U	0.2 UL	NA
Molybdenum	10 U	10 U	NA	NA	NA	10 U	NA
Nickel	34.1 J	18.1 J	NA	NA	4.4 B	9.2 J	NA
Potassium	3,750 J	4,320 J	NA	NA	4,250 J	3,240 J	NA

NA - Not analyzed
B - Analyte not detected above associated blank
E - Exceedance - Interference
J - Reported value is estimated
K - Biased high
L - Biased low
R - Unreliable result
U - Undetected

Table 5-4
Chemicals Detected in Groundwater from Bedrock Monitoring Wells
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Station ID	5GW02				5GW03		
Sample ID	AS05-5GW02-R05	AS05-5GW02-R06	AS05-5GW02-R07	AS05-5GW02P-R07	AS05-5GW03-R05	AS05-5GW03-R06	AS05-5GW03-R07
Sample Date	08/03/00	04/11/01	02/05/02	02/05/02	08/07/00	04/11/01	02/05/02
Chemical Name							
Selenium	2.2 B	3.2 U	NA	NA	4.4 B	3.2 U	NA
Silver	0.91 B	1.5 J	NA	NA	0.6 U	1.3 U	NA
Sodium	36,300 J	45,000	NA	NA	5,860	11,700	NA
Thallium	2.3 U	3.9 U	NA	NA	2.3 UL	3.9 B	NA
Vanadium	1 U	34.9 U	NA	NA	1 U	34.9 U	NA
Zinc	33.7 B	45.4 B	NA	NA	18.6 J	44.6 B	NA
Wet Chemistry (MG/L)							
Alkalinity	110	120	130	130	240	180	210
Ammonia	0.2 U	NA	0.2 U	0.2 U	0.2 U	NA	0.2 U
BOD-5day (total)	NA	6.8	2.7	6.3	NA	7.2	7.5
Bicarbonate	110	120	130	130	240	180	210
Biological oxygen demand	2 U	NA	NA	NA	2 U	NA	NA
Chemical oxygen demand	8	42	5 U	5 U	5 U	36	5 U
Chloride	42	36	55	55	5.2	12	19
Ethane	1.00E-03 U	0.004 U	0.004 U	0.004 U	1.00E-03 U	0.004 U	0.004 U
Hardness	280	296	330	340	290	338	370
Methane	0.0596	0.002 U	0.007	0.002 U	1.00E-03 U	0.002 U	0.002 U
Nitrate	0.5 U	NA	0.5 U	0.5 U	1.1	NA	2.8
Nitrate/Nitrite	NA	0.55 U	NA	NA	NA	1.5	NA
Nitrite	0.05 U	NA	0.05 U	0.05 U	0.05 U	NA	0.05 U
Nitrogen	NA	0.25	NA	NA	NA	0.2 U	NA
Oil and Grease	NA	NA	NA	NA	NA	NA	NA
Sulfate	190	280	210	210	77	210	140
Total dissolved solids (TDS)	360	560	550	530	NA	460	550
Total organic carbon (TOC)	2.3	4.5	0.84	0.98	1.7	1 U	0.4 U
Total recoverable phenolics	0.03 U	0.025 U	0.025 U	0.025 U	0.03 U	0.025 U	0.025 U
Reactivity (MG/L)							
No Detections							

NA - Not analyzed
B - Analyte not detected above associated blank
E - Exceedance - Interference
J - Reported value is estimated
K - Biased high
L - Biased low
R - Unreliable result
U - Undetected

Table 5-4
Chemicals Detected in Groundwater from Bedrock Monitoring Wells
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Station ID	5GW06			5GW10			
Sample ID	AS05-5GW06-R05	AS05-5GW06-R06	AS05-5GW06-R07	AS05-5GW10-R05	AS05-5GW10-R06	AS05-5GW10P-R06	AS05-5GW10-R07
Sample Date	08/10/00	04/20/01	02/07/02	08/02/00	04/11/01	04/11/01	02/01/02
Chemical Name							
Volatile Organic Compounds (UG/L)							
Acetone	5 R	5 R	5 U	5 R	5 R	5 R	5 U
Carbon tetrachloride	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Methylene chloride	2 UJ	2 U	0.6 B	2 U	0.5 B	0.6 B	1.7 B
Trichloroethene	1 U	1 U	1 U	1 U	1 U	1 U	1 U
cis-1,2-Dichloroethene	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Semivolatile Organic Compounds (UG/L)							
No Detections							
Pesticide/Polychlorinated Biphenyls (UG/L)							
No Detections							
Herbicides (UG/L)							
No Detections							
Explosives (UG/L)							
No Detections							
Total Metals (UG/L)							
Aluminum	19.2 U	45.4 B	93.2 B	60.3 B	NA	NA	17.2 U
Antimony	6.3 B	6.7 J	6.1 J	4.9 U	NA	NA	5 U
Arsenic	3.8 U	3.8 K	5.7 J	3.8 UL	NA	NA	5.1 U
Barium	156 J	198 J	163 J	165 J	NA	NA	200 J
Beryllium	0.22 B	0.8 B	0.1 U	0.1 U	NA	NA	0.1 U
Boron	104	148	85.1	50 R	NA	NA	26.9 J
Cadmium	0.4 UL	0.42 B	1.7 U	0.4 U	NA	NA	1.7 U
Calcium	98,000	114,000	106,000	77,000	NA	NA	82,400
Chromium	12.6	0.8 U	16.7 B	0.7 U	NA	NA	0.6 U
Cobalt	2.8 B	3.3 J	1.8 J	1.1 U	NA	NA	1.3 U

NA - Not analyzed
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E - Exceedance - Interference
J - Reported value is estimated
K - Biased high
L - Biased low
R - Unreliable result
U - Undetected

Table 5-4
Chemicals Detected in Groundwater from Bedrock Monitoring Wells
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Station ID	5GW06			5GW10			
Sample ID	AS05-5GW06-R05	AS05-5GW06-R06	AS05-5GW06-R07	AS05-5GW10-R05	AS05-5GW10-R06	AS05-5GW10P-R06	AS05-5GW10-R07
Sample Date	08/10/00	04/20/01	02/07/02	08/02/00	04/11/01	04/11/01	02/01/02
Chemical Name							
Copper	6.8 J	1.1 J	4.7 J	3.5 B	NA	NA	1.5 U
Cyanide	10 U	11	10 U	10 U	10 U	110	10 U
Iron	5,770 J	83.1 J	3,180	890	NA	NA	939
Lead	2 U	2.5 U	2.9 U	2 U	NA	NA	2.9 U
Magnesium	26,600	30,700	26,500	7,500	NA	NA	7,900
Manganese	129	86.6	93.7	122	NA	NA	131
Molybdenum	10 U	11.9 J	10 U	10 U	NA	NA	10 U
Nickel	21.4 J	13.4 J	22.2 J	2 U	NA	NA	2.1 U
Potassium	4,710 J	6,040 J	3,720 J	371 B	NA	NA	309 J
Selenium	7.1	3.2 U	4 U	2.2 UL	NA	NA	4 U
Silver	0.6 U	1.3 U	0.6 U	0.6 UL	NA	NA	0.6 U
Sodium	12,000	16,100 J	11,500	3,880 B	NA	NA	5,080
Thallium	3.9 B	5 B	5 U	2.3 U	NA	NA	5 U
Zinc	32.7	47 B	23.2 B	30.3 B	NA	NA	11.9 B
Dissolved Metals (UG/L)							
Aluminum	19.2 U	92.8 J	NA	NA	50 B	78.2 B	NA
Antimony	4.9 U	3.1 U	NA	NA	3.1 U	3.1 U	NA
Arsenic	7.1 B	2.7 J	NA	NA	3 B	3.1 B	NA
Barium	177 J	202 E	NA	NA	202	203	NA
Beryllium	0.1 U	0.76 J	NA	NA	0.45 B	0.3 B	NA
Boron	104	50 U	NA	NA	74.4	50 U	NA
Calcium	103,000	118,000	NA	NA	82,200	81,600	NA
Chromium	3 B	2.2 J	NA	NA	0.8 U	0.8 U	NA
Cobalt	1.7 B	2.7 J	NA	NA	1 U	1 U	NA
Copper	0.7 U	1.3 J	NA	NA	0.98 B	1.4 B	NA
Iron	6,430	2,960	NA	NA	1,000	1,100	NA
Lead	2 U	2.5 U	NA	NA	2.5 U	80.9	NA
Magnesium	30,500	31,600	NA	NA	8,060	8,080	NA
Manganese	138	72.2	NA	NA	134	135	NA
Mercury	0.4 B	0.2 U	NA	NA	0.2 UL	0.2 UL	NA
Molybdenum	10 U	10 R	NA	NA	10 U	10 U	NA
Nickel	10.5 K	5.2 J	NA	NA	1.7 U	1.7 U	NA
Potassium	5,330	6,100	NA	NA	428 J	487 K	NA

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J - Reported value is estimated
K - Biased high
L - Biased low
R - Unreliable result
U - Undetected

Table 5-4
Chemicals Detected in Groundwater from Bedrock Monitoring Wells
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Station ID	5GW06			5GW10			
Sample ID	AS05-5GW06-R05	AS05-5GW06-R06	AS05-5GW06-R07	AS05-5GW10-R05	AS05-5GW10-R06	AS05-5GW10P-R06	AS05-5GW10-R07
Sample Date	08/10/00	04/20/01	02/07/02	08/02/00	04/11/01	04/11/01	02/01/02
Chemical Name							
Selenium	2.2 U	3.2 U	NA	NA	3.2 U	3.2 U	NA
Silver	0.6 U	1.3 U	NA	NA	1.3 U	1.3 U	NA
Sodium	14,200	16,700	NA	NA	5,750	5,620	NA
Thallium	2.3 UL	3.9 U	NA	NA	4.4 B	3.9 U	NA
Vanadium	1 U	34.9 U	NA	NA	34.9 U	34.9 U	NA
Zinc	13.9 B	39.6	NA	NA	63.5 B	49 B	NA
Wet Chemistry (MG/L)							
Alkalinity	400	360	390	220	210	210	230
Ammonia	0.2 U	NA	0.2 U	0.2 U	NA	NA	0.2 U
BOD-5day (total)	NA	2.4	29	NA	9.4	5.6	2 U
Bicarbonate	400	360	390	220	208	210	230
Biological oxygen demand	10	NA	NA	NA	NA	NA	NA
Chemical oxygen demand	5	14	21	5 U	31	23	5 U
Chloride	3.2	2.9	2.9	4.6	7.3	7.2	4
Ethane	NA	0.004 U	0.004 U	NA	0.004	0.002	0.004 U
Hardness	350	430	370	220	238	237	240
Methane	NA	0.02 U	0.002 U	NA	0.008	0.009	0.012 B
Nitrate	0.5 U	NA	0.5 U	0.5 U	NA	NA	0.5 U
Nitrate/Nitrite	NA	0.55 U	NA	NA	0.55 U	0.55 U	NA
Nitrite	0.05 U	NA	0.05 U	NA	NA	NA	0.05 U
Nitrogen	NA	0.2 U	NA	NA	0.2 U	0.2 U	NA
Oil and Grease	NA	NA	NA	NA	NA	NA	NA
Sulfate	50	36	67	16	19	19	13
Total dissolved solids (TDS)	370	450	470	220	280	420	280
Total organic carbon (TOC)	1.5	2.4	7.3	1 U	1 U	1 U	1.1
Total recoverable phenolics	0.03 U	0.025 U	0.025 U	0.025 U	0.025 U	0.025 U	0.025 U
Reactivity (MG/L)							
No Detections							

NA - Not analyzed
B - Analyte not detected above associated blank
E - Exceedance - Interference
J - Reported value is estimated
K - Biased high
L - Biased low
R - Unreliable result
U - Undetected

Table 5-4
Chemicals Detected in Groundwater from Bedrock Monitoring Wells
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Station ID	5GW14			5GW16		
Sample ID	AS05-5GW14-R05	AS05-5GW14-R06	AS05-5GW14-R07	AS05-5GW16-R05	AS05-5GW16-R06	AS05-5GW16-R07
Sample Date	08/03/00	04/13/01	02/01/02	08/03/00	04/13/01	02/01/02
Chemical Name						
Volatile Organic Compounds (UG/L)						
Acetone	5 R	5 R	5 U	5 R	5 R	5 U
Carbon tetrachloride	1 U	1 U	1 U	1 U	1 U	1 U
Methylene chloride	1.4 B	0.6 B	5.2 B	1.3 B	0.5 B	5.1 B
Trichloroethene	1 U	1 U	1 U	1 U	1 U	1 U
cis-1,2-Dichloroethene	1 U	1 U	1 U	1 U	1 U	1 U
Semivolatile Organic Compounds (UG/L)						
No Detections						
Pesticide/Polychlorinated Biphenyls (UG/L)						
No Detections						
Herbicides (UG/L)						
No Detections						
Explosives (UG/L)						
No Detections						
Total Metals (UG/L)						
Aluminum	137 B	NA	17.2 U	100 B	NA	17.2 U
Antimony	4.9 U	NA	5 U	4.9 U	NA	5 U
Arsenic	3.8 U	NA	5.1 U	3.8 U	NA	5.1 U
Barium	30.8 J	NA	33 J	23 J	NA	49.9 J
Beryllium	0.1 U	NA	0.1 U	0.1 U	NA	0.1 U
Boron	171	NA	13.5 J	50 U	NA	33.7 J
Cadmium	0.4 UL	NA	1.7 U	0.4 UL	NA	1.7 U
Calcium	65,400	NA	105,000	20,600	NA	160,000
Chromium	0.7 UL	NA	0.74 J	0.7 UL	NA	1.5 J
Cobalt	6.6 J	NA	8.7 J	1.1 U	NA	1.6 J

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L - Biased low
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U - Undetected

Table 5-4
Chemicals Detected in Groundwater from Bedrock Monitoring Wells
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Station ID	5GW14			5GW16		
Sample ID	AS05-5GW14-R05	AS05-5GW14-R06	AS05-5GW14-R07	AS05-5GW16-R05	AS05-5GW16-R06	AS05-5GW16-R07
Sample Date	08/03/00	04/13/01	02/01/02	08/03/00	04/13/01	02/01/02
Chemical Name						
Copper	0.7 U	NA	1.5 U	0.7 U	NA	1.5 U
Cyanide	10 U	10 U	10 U	10 U	10 U	10 U
Iron	71,300	NA	71,600	2,490	NA	17,200
Lead	2 U	NA	3.2	2 U	NA	2.9 U
Magnesium	24,300	NA	33,400	13,900	NA	31,900
Manganese	1,390	NA	1,680	282	NA	1,170
Molybdenum	10 U	NA	10 U	10 U	NA	10 U
Nickel	43.1	NA	33.9 J	2 U	NA	2.1 U
Potassium	1,950 J	NA	2,030 J	490 B	NA	636 J
Selenium	2.2 U	NA	4 U	2.2 U	NA	4 U
Silver	0.66 B	NA	0.6 U	0.6 UL	NA	0.6 U
Sodium	10,100	NA	12,800	7,370	NA	11,500
Thallium	18.7 B	NA	5 U	2.3 U	NA	5 U
Zinc	49.4	NA	28.9 B	16.5 B	NA	25.2 B
Dissolved Metals (UG/L)						
Aluminum	90.3 B	25.6 B	NA	89 B	129 B	NA
Antimony	4.9 U	6.5 B	NA	4.9 U	6.6 B	NA
Arsenic	3.8 UL	4 B	NA	3.8 UL	3.8 B	NA
Barium	32.2 J	35.6 J	NA	25 J	34.3 J	NA
Beryllium	0.1 U	0.65 B	NA	0.1 U	0.61 B	NA
Boron	50 U	50 U	NA	50 U	153	NA
Calcium	78,700	96,200	NA	22,600	172,000	NA
Chromium	0.7 U	0.8 U	NA	0.7 U	0.86 J	NA
Cobalt	6.9 J	9.9 B	NA	1.1 U	2.6 J	NA
Copper	0.7 UL	3.4 B	NA	0.7 UL	1.7 J	NA
Iron	79,800	111,000	NA	748	29,700	NA
Lead	2.4 B	2.5 U	NA	2 U	2.5 U	NA
Magnesium	26,400	33,400	NA	15,100	33,800	NA
Manganese	1,620	2,360	NA	288	1,130	NA
Mercury	0.1 U	0.2 U	NA	0.1 U	0.2 U	NA
Molybdenum	10 U	10 U	NA	12.7 J	10 U	NA
Nickel	15.4 J	24.8 K	NA	2 U	1.7 U	NA
Potassium	2,320 J	2,470 J	NA	556 B	888 J	NA

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J - Reported value is estimated
K - Biased high
L - Biased low
R - Unreliable result
U - Undetected

Table 5-4
Chemicals Detected in Groundwater from Bedrock Monitoring Wells
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Station ID	5GW14			5GW16		
Sample ID	AS05-5GW14-R05	AS05-5GW14-R06	AS05-5GW14-R07	AS05-5GW16-R05	AS05-5GW16-R06	AS05-5GW16-R07
Sample Date	08/03/00	04/13/01	02/01/02	08/03/00	04/13/01	02/01/02
Chemical Name						
Selenium	14.9 B	3.9 J	NA	3.3 B	3.2 U	NA
Silver	2.9 B	1.6 B	NA	1 B	1.3 U	NA
Sodium	12,900 J	15,900	NA	9,100 J	12,600	NA
Thallium	2.3 U	3.9 U	NA	2.3 U	3.9 U	NA
Vanadium	1.2 B	34.9 U	NA	1 U	34.9 U	NA
Zinc	25.7 B	38.9 B	NA	9.7 B	20 B	NA
Wet Chemistry (MG/L)						
Alkalinity	180	200	180	55	310	260
Ammonia	0.21	NA	0.2 U	0.38	NA	0.2 U
BOD-5day (total)	NA	16	4.5	NA	16	2 U
Bicarbonate	180	200	180	55	320	260
Biological oxygen demand	2 U	NA	NA	2 U	NA	NA
Chemical oxygen demand	15	25	10	5 U	29	5 U
Chloride	31	22	44	19	22	32
Ethane	1.00E-03 U	0.004 U	0.004 U	1.00E-03 U	0.093	0.004 U
Hardness	260	378	400	110	569	530
Methane	0.336 U	0.34	1.7 J	0.0212 U	0.334	0.4
Nitrate	0.71	NA	0.5 U	0.5 U	NA	0.5 U
Nitrate/Nitrite	NA	0.55 U	NA	NA	0.55 U	NA
Nitrite	0.05 U	NA	0.05 U	0.05 U	NA	0.05 U
Nitrogen	NA	0.54	NA	NA	0.35	NA
Oil and Grease	NA	NA	NA	NA	NA	NA
Sulfate	140	160	220	54	130	220
Total dissolved solids (TDS)	360	520	590	150	300	670
Total organic carbon (TOC)	1	1 U	4.2	1 U	2	1.2
Total recoverable phenolics	0.03 U	0.025 U	0.025 U	0.03 U	0.025 U	0.025 U
Reactivity (MG/L)						
No Detections						

NA - Not analyzed
B - Analyte not detected above associated blank
E - Exceedance - Interference
J - Reported value is estimated
K - Biased high
L - Biased low
R - Unreliable result
U - Undetected

Table 5-5
Chemicals Detected in Surface Water
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Station ID	5SD-1/5SW-1				
Sample ID	AS05-5SW01-AP	AS05-5SW01-R05	AS05-5SW01-R06	AS05-5SW01-R07	AS05-5SW01P-R07
Sample Date	12/03/99	08/03/00	06/20/01	02/26/02	02/26/02
Chemical Name					
Volatile Organic Compounds (UG/L)					
No Detections					
Explosives (UG/L)					
No Detections					
Total Metals (UG/L)					
Aluminum	NA	405	171 J	147 J	149 J
Arsenic	NA	3.8 U	5 U	5.1 U	5.1 U
Barium	NA	44.5 B	51.8 J	64.1 J	64.2 J
Calcium	NA	53,574	50,700	55,900	55,600
Chromium	NA	0.7 U	5 U	1.1 J	0.6 U
Cobalt	NA	2.23 B	1.8 U	1.3 J	1.4 J
Iron	NA	749	281	117	139
Lead	NA	2 U	3 U	3.4	2.9 U
Magnesium	NA	12,403	13,400	11,500	11,500
Manganese	NA	210	177	278	277
Mercury	NA	0.12 B	0.2 U	0.2 U	0.2 U
Nickel	NA	2.35 B	5.4 J	7.6 J	7.7 J
Potassium	NA	3,558 B	3,030 J	3,560 J	3,650 J
Sodium	NA	26,807	28,100	37,500 J	37,800 J
Zinc	NA	37.5	20.5	36 B	31.2 B
Dissolved Metals (UG/L)					
Barium	NA	NA	54.8 J	NA	NA
Beryllium	NA	NA	0.11 J	NA	NA
Calcium	NA	NA	54,700	NA	NA
Chromium	NA	NA	0.6 U	NA	NA
Copper	NA	NA	3.4 B	NA	NA
Iron	NA	NA	15.8 U	NA	NA
Magnesium	NA	NA	14,400	NA	NA
Potassium	NA	NA	3,640 J	NA	NA
Sodium	NA	NA	29,900	NA	NA
Zinc	NA	NA	39.9	NA	NA
Wet Chemistry (MG/L)					
Hardness	NA	NA	180	NA	NA

NA - Not analyzed
B - Not detected above associated blank
J - Estimated
K - Biased high
R - Rejected
U - Not detected

Table 5-5
Chemicals Detected in Surface Water
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Station ID	5SD-2/5SW-2					
Sample ID	AS05-5SW02-AP	AS05-5SW02-R05	AS05-5SW02P-R05	AS05-5SW02-R06	AS05-5SW02P-R06	AS05-5SW02-R07
Sample Date	12/03/99	08/03/00	08/03/00	06/20/01	06/20/01	02/25/02
Chemical Name						
Volatile Organic Compounds (UG/L)						
No Detections						
Explosives (UG/L)						
No Detections						
Total Metals (UG/L)						
Aluminum	NA	408 B	339 B	204	208	148 J
Arsenic	NA	3.8 U	3.8 U	5 U	5 U	5.1 U
Barium	NA	46 J	45 J	52.6 J	59.4 J	63.1 J
Calcium	NA	54,500	54,800	52,100	58,600	53,000
Chromium	NA	0.7 UL	0.7 UL	5 U	5 U	0.6 U
Cobalt	NA	2.5 J	1.2 J	1.8 U	1.8 U	1.3 U
Iron	NA	970	636	308	278	132
Lead	NA	3.2 K	4.8 K	3 U	3 U	2.9 U
Magnesium	NA	12,600	12,600	13,800	15,600	11,000
Manganese	NA	221	214	177	198	269
Mercury	NA	0.1 U	0.1 U	0.39	0.38	0.2 U
Nickel	NA	2 U	4.4 B	5.8 J	6.7 J	7 J
Potassium	NA	3,510 J	3,490 J	3,130 J	3,570 J	3,640 J
Sodium	NA	26,000 J	26,000 J	28,800	32,700	38,600 J
Zinc	NA	30 B	29.6 B	25.6	33.6	32.8
Dissolved Metals (UG/L)						
Barium	NA	NA	NA	54 J	52.5 J	NA
Beryllium	NA	NA	NA	0.1 U	0.1 U	NA
Calcium	NA	NA	NA	53,800	52,500	NA
Chromium	NA	NA	NA	0.6 U	1.7 J	NA
Copper	NA	NA	NA	3.5 B	4 J	NA
Iron	NA	NA	NA	44.8 J	61.1 B	NA
Magnesium	NA	NA	NA	14,400	14,000	NA
Potassium	NA	NA	NA	3,520 J	3,420 J	NA
Sodium	NA	NA	NA	30,100	29,200	NA
Zinc	NA	NA	NA	30.2	36.2	NA
Wet Chemistry (MG/L)						
Hardness	NA	NA	NA	190	210	NA

NA - Not analyzed
B - Not detected above associated blank
J - Estimated
K - Biased high
R - Rejected
U - Not detected

Table 5-5
Chemicals Detected in Surface Water
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Station ID	5SD-3/5SW-3			5SD-4/5SW-4		
Sample ID	AS05-5SW03-R05	AS05-5SW03-R06	AS05-5SW03-R07	AS05-5SW04-R05	AS05-5SW04-R06	AS05-5SW04-R07
Sample Date	08/03/00	06/20/01	02/26/02	08/03/00	06/20/01	02/25/02
Chemical Name						
Volatile Organic Compounds (UG/L)						
No Detections						
Explosives (UG/L)						
No Detections						
Total Metals (UG/L)						
Aluminum	419	214	170 J	414 B	192 J	246
Arsenic	3.8 U	5 U	5.1 U	3.8 U	5 U	5.1 J
Barium	50.4 J	55.8 J	65.9 J	45.6 J	54.8 J	65.8 J
Calcium	60,600	54,000	56,000	53,700	54,300	55,900
Chromium	0.7 UL	5 U	0.6 U	0.7 UL	5 U	1.3 J
Cobalt	1.7 J	1.8 U	2 J	2.4 J	1.8 U	2.2 J
Iron	878	383	219	801	310	355
Lead	2.4 K	3 U	4	3.9 K	3 U	2.9 U
Magnesium	14,000	14,400	11,600	12,300	14,500	11,700
Manganese	238	229	376	235	189	305
Mercury	0.1 U	0.2 U	0.2 U	0.1 U	0.2 U	0.2 U
Nickel	3 B	5.5 J	8.1 J	3.4 B	5.8 J	9.3 J
Potassium	4,010 J	3,180 J	3,670 J	3,530 J	3,280 J	3,850 J
Sodium	29,400 J	29,700	37,300 J	26,300 J	30,500	40,300 J
Zinc	39.4 B	18.2 J	39.2 B	34.7 B	17.8 J	47.7
Dissolved Metals (UG/L)						
Barium	NA	51.6 J	NA	NA	52 J	NA
Beryllium	NA	0.1 U	NA	NA	0.1 U	NA
Calcium	NA	52,000	NA	NA	53,800	NA
Chromium	NA	0.69 J	NA	NA	1.4 J	NA
Copper	NA	3.2 B	NA	NA	3.4 B	NA
Iron	NA	28.6 J	NA	NA	21.6 B	NA
Magnesium	NA	13,900	NA	NA	14,400	NA
Potassium	NA	3,330 J	NA	NA	3,470 J	NA
Sodium	NA	28,300	NA	NA	29,300	NA
Zinc	NA	27.9	NA	NA	29.6	NA
Wet Chemistry (MG/L)						
Hardness	NA	190	NA	NA	200	NA

NA - Not analyzed
B - Not detected above associated blank
J - Estimated
K - Biased high
R - Rejected
U - Not detected

Table 5-6
Chemicals Detected in Sediment
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Station ID	5SD-1/5SW-1							5SD-1A	5SD-1B	5SD-2/5SW-2									5SD-2A	5SD-2B	5SD-3/5SW-3		
Sample ID	AS05-5SD01-R01	AS05-5SD01-R04	AS05-5SD1P-R04	AS05-5SD01-R05	AS05-5SD01-R06	AS05-5SD01-R07	AS05-5SD01P-R07	AS05-5SD01A	AS05-5SD01B	AS05-5SD02-R01	AS05-5SD02P-R01	AS05-5SD02-R04	AS05-5SD02P-R04	AS05-5SD02-R05	AS05-5SD02P-R05	AS05-5SD02-R06	AS05-5SD02P-R06	AS05-5SD02-R07	AS05-5SD02A	AS05-5SD02B	AS05-5SD03-R05	AS05-5SD03-R06	AS05-5SD03-R07
Sample Date	05/08/98	10/28/99	10/28/99	08/03/00	06/20/01	02/26/02	02/26/02	02/27/02	02/27/02	05/08/98	05/08/98	10/28/99	10/28/99	08/03/00	08/03/00	06/20/01	06/20/01	02/25/02	02/27/02	02/27/02	08/03/00	06/20/01	02/26/02
Chemical Name																							
Volatile Organic Compounds (UG/KG)																							
Acetone	15 U	33	NA	15 UJ	19 U	27 U	30 U	NA	NA	17 U	18 U	25	18 J	23 UJ	21 UJ	17 U	17 U	18 U	NA	NA	50 UJ	25 U	19 U
Methylene chloride	15 U	1.8 J	NA	6.7 B	5.2 B	27 U	7.7 B	NA	NA	17 U	32	3.3 J	2.5 J	23 UJ	7.4 B	4.5 B	4.7 B	18 U	NA	NA	50 UJ	7.6 B	5.7 B
Semivolatile Organic Compounds (UG/KG)																							
1-Methylnaphthalene	NA	NA	NA	NA	NA	20	NA	7.10	4.00	NA	NA	NA	NA	NA	NA	NA	NA	17	5.20	6.30	NA	NA	22
2-Methylnaphthalene	52	500 U	NA	510 U	620 U	22	960 U	17.0	7.70	79	NA	630 U	600 U	760 U	710 U	570 U	560 U	85 J	12.0	17.0	1,700 U	810 U	110 J
3- and 4-Methylphenol	NA	500 U	NA	510 U	620 U	NA	NA	NA	NA	NA	NA	630 U	600 U	760 U	710 U	570 U	560 U	220 J	NA	NA	1,700 U	7,800	NA
4-Methylphenol	440 U	NA	NA	NA	NA	190 J	500 J	NA	NA	600 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	330 J
Acenaphthene	440 U	500 U	NA	510 U	620 U	89 J	960 U	2.30 J	1.80 J	600 UJ	NA	630 U	600 U	760 U	710 U	570 U	560 U	6.6	12.0	2.00 J	1,700 U	810 U	90 J
Acenaphthylene	440 U	500 U	NA	510 U	620 U	9.1	960 U	1.30 J	2.10 J	600 U	NA	630 U	600 U	760 U	710 U	570 U	560 U	9.7	0.69 J	2.30 J	1,700 U	810 U	15
Anthracene	440 U	500 U	NA	510 U	620 U	25	960 U	1.90 J	3.50	600 U	NA	630 U	600 U	760 U	710 U	570 U	560 U	15	25.0	2.80	1,700 U	810 U	31
Benzaldehyde	NA	NA	NA	NA	620 U	1,400	1,400	NA	NA	NA	NA	NA	NA	NA	NA	570 U	560 U	540 J	NA	NA	NA	810 U	680
Benzo(a)anthracene	63	500 U	NA	510 U	620 U	110	960 U	8.70	25.0	85	NA	630 U	600 U	760 U	710 U	570 U	560 U	82	43.0	6.60	1,700 U	810 U	200 J
Benzo(a)pyrene	49	500 U	NA	510 U	620 U	120	960 UJ	7.50	27.0	62	NA	630 U	600 U	760 U	710 U	570 U	560 U	77	43.0	10.0	1,700 U	810 U	170 J
Benzo(b)fluoranthene	110	500 U	NA	510 U	620 U	140 J	150 J	10.0	27.0	140	NA	630 U	600 U	760 U	710 U	570 U	560 U	83	38.0	12.0	1,700 U	810 U	260 J
Benzo(g,h,i)perylene	440 U	500 U	NA	510 U	620 U	96	960 UJ	5.80	21.0	600 U	NA	630 U	600 U	760 U	710 U	570 U	560 U	60	32.0	13.0	1,700 U	810 U	100
Benzo(k)fluoranthene	440 U	500 U	NA	510 U	620 U	120	960 UJ	7.30	26.0	600 U	NA	630 U	600 U	760 U	710 U	570 U	560 U	76	33.0	9.40	1,700 U	810 U	140
Caprolactam	NA	NA	NA	NA	71 L	890 U	960 U	NA	NA	NA	NA	NA	NA	NA	NA	570 R	560 R	590 U	NA	NA	NA	1,600 R	650 U
Chrysene	100	500 U	NA	510 U	79 J	180 J	160 J	11.0	28.0	150	NA	630 U	600 U	760 U	710 U	570 U	560 U	130 J	37.0	7.90	1,700 U	810 U	290 J
Di-n-butylphthalate	440 U	500 U	NA	100 J	330 J	890 U	960 U	NA	NA	600 U	NA	630 U	600 U	760 U	120 J	570 U	560 U	1,000	NA	NA	260 J	95 J	650 U
Dibenz(a,h)anthracene	440 U	500 U	NA	510 U	620 U	30	960 UJ	3.20	7.70	600 U	NA	630 U	600 U	760 U	710 U	570 U	560 U	20	9.30	5.70	1,700 U	810 U	36
Diethylphthalate	440 U	500 U	NA	510 U	160 J	260 J	200 J	NA	NA	600 U	NA	630 U	600 U	760 U	710 U	570 U	560 U	590 U	NA	NA	1,700 U	810 U	200 J
Fluoranthene	110	500 U	NA	510 U	170 J	160	160 J	11.0	36.0	160	NA	630 U	600 U	760 U	710 U	570 U	560 U	190 J	90.0	9.30	1,700 U	810 U	390 J
Fluorene	440 U	500 U	NA	510 U	620 U	22	960 U	6.20	5.30	600 U	NA	630 U	600 U	760 U	710 U	570 U	560 U	17	12.0	4.30	1,700 U	810 U	25
Indeno(1,2,3-cd)pyrene	440 U	500 U	NA	510 U	620 U	81	960 UJ	5.50	19.0	600 U	NA	630 U	600 U	760 U	710 U	570 U	560 U	52	26.0	12.0	1,700 U	810 U	90
Naphthalene	440 U	500 U	NA	510 U	620 U	14	960 U	7.90	5.30	600 U	NA	630 U	600 U	760 U	710 U	570 U	560 U	14	7.20	8.70	1,700 U	810 U	81 J
Phenanthrene	140	500 U	NA	510 U	63 J	160 J	170 J	22.0	22.0	250	NA	630 U	600 U	760 U	710 U	570 U	560 U	230 J	94.0	18.0	1,700 U	810 U	380 J
Phenol	440 U	500 U	NA	510 U	64 J	890 U	960 U	NA	NA	600 UJ	NA	630 U	600 U	760 U	710 U	570 U	560 U	590 U	NA	NA	1,700 U	510 J	650 U
Pyrene	88	500 U	NA	510 U	130 J	250 J	280 J	12.0	44.0	140 J	NA	630 U	600 U	760 U	710 U	570 U	560 U	170	110	9.90	1,700 U	810 U	420 J
bis(2-Ethylhexyl)phthalate	72	500 U	NA	510 U	620 U	670 B	330 B	NA	NA	83	NA	630 U	600 U	760 U	710 U	570 U	560 U	370 B	NA	NA	1,700 U	95 J	250 B
Explosives (UG/KG)																							
No Detections																							
Total Metals (MG/KG)																							
Aluminum	7,820 J	6,160	6,195	3,990	6,520	9,670	11,100	4,910	4,410	13,700 J	NA	8,270	8,840	8,290	8,460	10,400	11,700	6,750	4,130	5,090	5,780	11,200	6,300
Antimony	1.1 L	1.5 U	1.52 U	1.5 U	1.4 U	2.7 U	2.9 U	0.76 UL	1.00 L	0.73 UL	NA	1.9 U	1.8 U	2.2 U	2.1 U	1.6 J	1.2 U	1.8 U	0.76 UL	0.77 UL	4.8 U	1.8 U	1.9 U
Arsenic	9.4	9.9	9.67	6.1	10.2	16.1	17.5	7.30	9.10	24.1	NA	15.4	15.1	16.4	12.7	16.3	18.8	14.4	6.60	8.20	9.7 J	16.2	9
Barium	128 J	57.3 B	57.5 B	70.4	152	182	195	62.8	54.1 J	149 J	NA	121	118	117	111	144	146	139	46.4 J	70.9	111 J	208	66.6 J
Beryllium	2.2	2	2.03	1.3 J	1.7 J	2.5 J	2.7 J	1.10 J	1.20 J	2.9	NA	2.6	2.7	2.3 J	2.2	2.4	2.6	1.8	1.10 J	1.10 J	1.8 J	2.6	2
Calcium	4,210 J	1,610	1,615	3,470	4,760	7,520	7,580	2,250	1,190 J	4,780 J	NA	79,500	71,500	64,000	94,100	3,640	3,590	25,300	1,060 J	2,420	5,890	4,520	2,700
Chromium	15.6	13.7	13.6	7.1	14.7	17.2	16.9	8.90	12.2	31	NA	49.9	50.3	54.3	80.9	23.5	24.7	17.9	12.3	11.5	4.5 J	17.6	14
Cobalt	44.2	26.8 E	26.8	31.7	44.3	66.3	73.4	25.4	27.6	28	NA	39.9 E	40.6 E	46.2	47.9	39.2	36.3	36.1	25.9	31.5	51.9	72.6	42.1
Copper	38.9	45.8	46.0	22.3	30.7	50.2	51	14.0	18.4	67.5	NA	64.7	65.7	60.6	62.8	46.5	50.7	35.7	15.9	16.2	28.9	40.3	35.7
Cyanide	NA	NA	NA	1.7	0.93 U	1.4 U	1.5 U	NA	NA	NA	NA	NA	NA	1.1 U	1.1 U	0.86 U	0.83 U	0.9 U	NA	NA	2.5 U	1.23 U	1 U
Iron	34,800 J	26,800	26,879	18,600	27,200	34,900	33,700	23,600 J	29,900 J	47,100 J	NA	26,400	26,400	22,900	20,700	30,700	33,600	26,700	28,000 J	28,100 J	20,500	33,900	18,300
Lead	36	35 E	35.0	24.3	37.9	35.9	39.8	15.0 K	22.8 K	43.6	NA	29.5 E	22.2 E	32.3	26.3	32.5	33.8	24.3	26.6 K	14.0 K	27.3	37.2	24
Magnesium	1,240 J	727 B	728 B	797 J	1,130 J	1,870 J	2,150 J	836 J	559 J	1,040 J	NA	2,600	2,450	2,600	3,620	1,050 J	1,050 J	1,220 J	557 J	1,070 J	1,140 J	1,810 J	714 J
Manganese	941 J	342 E	343	1,190	1,130	1,240	1,160	1,050 K	482 K	603 J	NA	746 E	734 E	1,050	1,020	1,110	892	1,330	598 K	1,040 K	1,420	1,700	131
Mercury	0.07 U	0.2	0.2	0.21 B	0.17 U	0.38 L	0.46 L	0.039 U	0.046 U	0.24 B	NA	1.7	1.6	4.8	1.7	0.17 U	0.17 U	0.18 UL	0.048 K	0.042 U	1.4	0.23 U	0.28 L
Nickel	63.7	53.8 E	54.1	50	70.6	117	132	45.9	49.9	48.8	NA	72.3 E	72.6 E	76.4	85.2	64.9	62.9	61.7	49.7	50.5	78	110	68
Potassium	948 J	677 B	680 B	532 J	849 J	854 J	1,090 J	775 J	726 J	843 J	NA	686 B	771 B	650 J	801 J	953 J	984 J	651 J	732 J	731 J	657 J	1,320 J	441 J
Selenium	1 U	3.6 N	3.07	0.68 U	2.1	2.4 J	2.3 U	0.71 U	0.77 U	1.1 U	NA	1.9 UN	1.8 N	1 U	1.1 B	1.7 U	1.6 U	1.4 U	0.59 U	0.58 U	2.2 U	2.4 U	1.5 U
Silver	2.4 B	0.54 B	0.46 B	0.18 UL	1.8 U	0.33 U	0.52 J	0.22 UL	0.27 UL	3.1 B	NA	0.82 B	0.84 B	0.27 UL	0.25 UL	1.7 U	1.6 U	0.21 U	0.22 UL	0.23 UL	0.59 UL	2.4 U	0.23 U
Sodium	59.1 B	213 B	214 B	299 B	181 U	298 J	476 J	171 J	179 J	114 B	NA	1,850 B	1,660 B	1,190 J	1,890 J	168 U	161 J	414 J	113 J	252 J	899 B	236 U	249 J
Thallium	0.48 U	2.1 U	2.12 U	3.4 B	2.1 U	2.7 U	2.9 U	1.30 J	1.50 J	1.1 J	NA	2.7 U	2.5 U	1 U	0.97 U	2 U	1.9 U	1.8 U	1.10 J	1.90 J	2.3 U	2.7 U	1.9 U
Vanadium	23.8	15.5	15.5	11.3 J	16.7 J	26.3 J	29.4	14.7	15.4 J	28	NA	14 B	14.7 B	16.4 J	14.4 J	19.3	20.9	16.4 J	15.5	15.5	19.4 J	25.1	14.9 J
Zinc	221 J	178 E	178	141	203	337	388	120 J	153 J	209 J	NA	263 E	281 E	299	343	227	236	184	147 J	143 J	255	334	201
Wet Chemistry (MG/KG)																							
% Solids	NA	NA	NA	NA	NA	35.7	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	55.2	NA	NA	NA	NA	47.3
Total organic carbon (TOC)	NA	NA	NA	NA	NA	78,000	NA	16,000	20,000	NA	NA	NA	NA	NA	NA	NA	NA	100,000	6,400	8,600	NA	NA	67,000
pH	NA	NA	NA	NA	NA	6.9	NA	7.30	7.20	NA	NA	NA	NA	NA	NA	NA	NA	7.5	7.50	7.30	NA	NA	6.5
Acid Volatile Sulfide/Simultaneously Extractable Metals (UMOLE/G)																							
Acid Volatile Sulfide	NA	NA	NA	NA	NA	32	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	16	NA	NA	NA	NA	12
Cadmium	NA	NA	NA	NA	NA	0.0089	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.004 B	NA	NA	NA	NA	0.0049 B
Copper	NA	NA	NA	NA	NA	0.16	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.3	NA	NA	NA	NA	0.23
Lead	NA	NA	NA	NA	NA	0.19	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.077	NA	NA	NA	NA	0.1
Nickel	NA	NA	NA	NA	NA	0.57	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.4	NA	NA	NA	NA	0.34
SEM/AVS Ratio	NA	NA	NA	NA	NA	0.14	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.15	NA	NA	NA	NA	0.22
Simul-ExtractMetal	NA	NA	NA	NA	NA	4.6	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	2.5	NA	NA	NA	NA	2.6
Zinc	NA	NA	NA	NA	NA	3.7	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1.7	NA	NA	NA	NA	1.9

NA - Not analyzed
B - Analyte not detected above associated blank
E - Estimated
J - Reported value is estimated
L - Reported value may be biased low

N - Tentative ID, consider present
R - Unreliable result
U - Analyte not detected

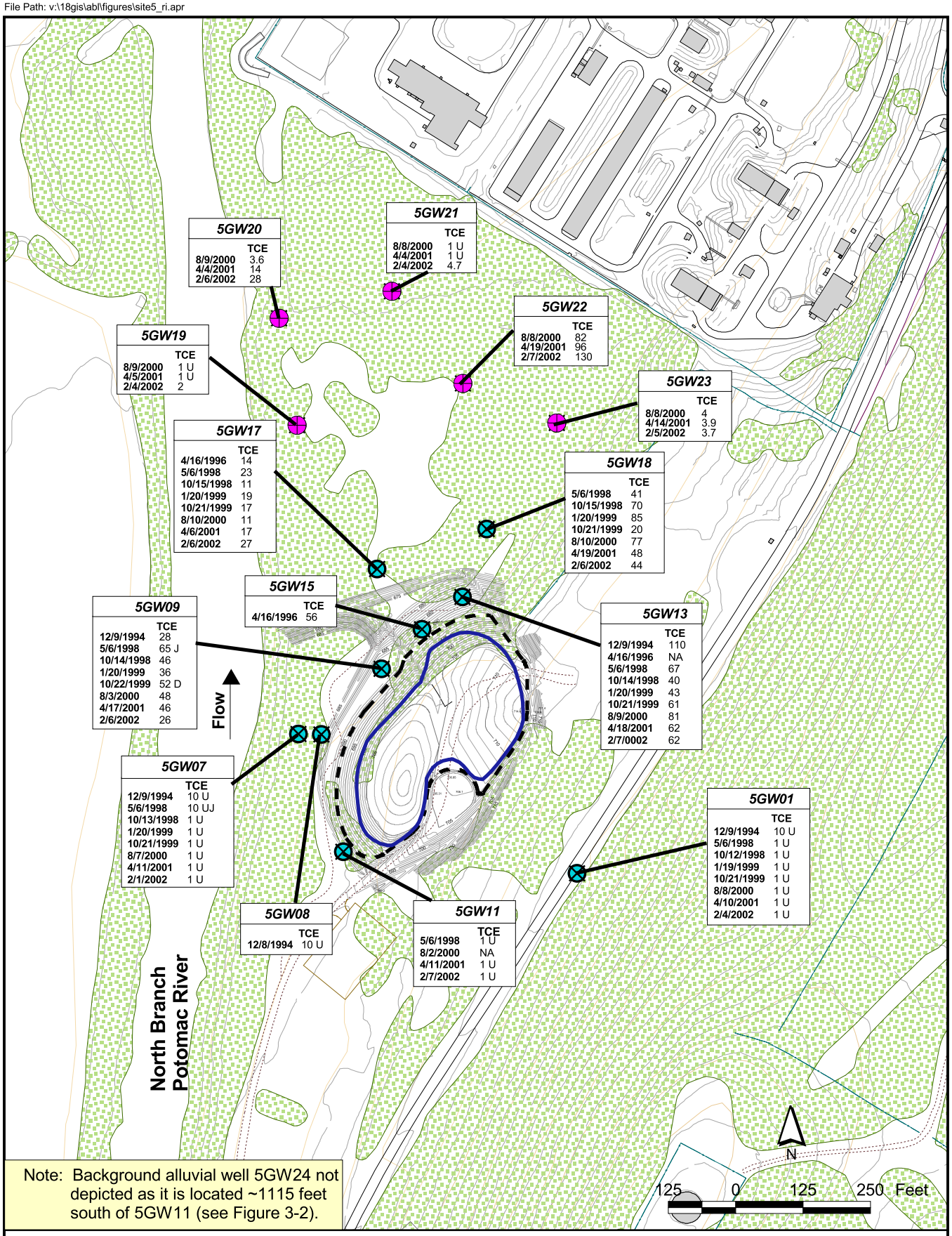
Table 5-6
Chemicals Detected in Sediment
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Station ID	5SD-3A	5SD-3B	5SD-4/5SW-4			5SD-5		5SD-5A	5SD-6	5SD-6A	5SD-7	5SD-7A
Sample ID	AS05-5SD03A	AS05-5SD03B	AS05-5SD04-R05	AS05-5SD04-R06	AS05-5SD04-R07	AS05-5SD05	AS05-5SD05P	AS05-5SD05A	AS05-5SD06	AS05-5SD06A	AS05-5SD07	AS05-5SD07A
Sample Date	02/27/02	02/27/02	08/03/00	06/20/01	02/25/02	02/25/02	02/25/02	02/27/02	02/25/02	02/27/02	02/25/02	02/27/02
Chemical Name												
Volatile Organic Compounds (UG/KG)												
Acetone	NA	NA	13 UJ	15 U	33 U	NA	NA	NA	NA	NA	NA	NA
Methylene chloride	NA	NA	5 B	4.6 B	7.2 B	NA	NA	NA	NA	NA	NA	NA
Semivolatile Organic Compounds (UG/KG)												
1-Methylnaphthalene	2.20 J	4.40	NA	NA	28 L	17.0	12.0	6.30	11.0	7.30 L	2.70	1.50 J
2-Methylnaphthalene	5.50	11.0	420 U	510 U	44 L	26.0	17.0	13.0	20.0	17.0 L	4.10	3.30
3- and 4-Methylphenol	NA	NA	420 U	63 J	NA	NA	NA	NA	NA	NA	NA	NA
4-Methylphenol	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Acenaphthene	2.30 U	0.98 J	420 U	510 U	13 L	4.00 J	2.10 J	3.80 J	3.10	2.10 L	0.57 J	2.10 U
Acenaphthylene	2.30 U	3.00	420 U	510 U	19 L	5.60	4.50	4.30 J	5.30	1.20 L	0.84 J	2.10 U
Anthracene	0.49 J	2.60	420 U	510 U	36 L	12.0	7.30	16.0	8.00	2.50 L	1.00 J	2.10 U
Benzaldehyde	NA	NA	NA	510 U	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(a)anthracene	2.50	15.0	420 U	510 U	230 L	64.0	50.0	74.0	45.0	7.10 L	5.70	2.30
Benzo(a)pyrene	2.50	16.0	420 U	510 U	260 L	72.0	52.0	64.0	51.0	8.70 L	5.40	2.00 J
Benzo(b)fluoranthene	3.30	18.0	420 U	510 U	240 L	95.0	57.0	64.0	56.0	12.0 L	6.70	2.50
Benzo(g,h,i)perylene	1.70 J	13.0	420 U	510 U	170 L	65.0	45.0	45.0	47.0	9.20 L	3.80	1.10 J
Benzo(k)fluoranthene	1.60 J	14.0	420 U	510 U	250 L	69.0	54.0	58.0	52.0	8.50 L	4.80	1.00 J
Caprolactam	NA	NA	NA	510 R	NA	NA	NA	NA	NA	NA	NA	NA
Chrysene	3.40	17.0	420 U	510 U	260 L	83.0	57.0	66.0	54.0	15.0 L	6.30	2.00 J
Di-n-butylphthalate	NA	NA	110 J	510 U	NA	NA	NA	NA	NA	NA	NA	NA
Dibenz(a,h)anthracene	1.80 J	5.30	420 U	510 U	56 L	21.0	15.0	18.0	16.0	3.00 L	2.50	1.50 J
Diethylphthalate	NA	NA	420 U	510 U	NA	NA	NA	NA	NA	NA	NA	NA
Fluoranthene	3.40	17.0	420 U	510 U	330 L	88.0	67.0	140	64.0	14.0 L	8.10	2.80
Fluorene	1.60 J	3.40	420 U	510 U	35 L	11.0	6.70	12.0	11.0	6.60 L	1.40 J	1.00 J
Indeno(1,2,3-cd)pyrene	2.40	12.0	420 U	510 U	160 L	53.0	39.0	43.0	39.0	7.20 L	4.30	1.90 J
Naphthalene	2.60	5.10	420 U	510 U	27 L	16.0	11.0	8.90	9.40	9.00 L	2.30	1.90 B
Phenanthrene	6.50	18.0	420 U	510 U	210 L	80.0	49.0	110	50.0	28.0 L	8.10	3.80
Phenol	NA	NA	420 U	510 U	NA	NA	NA	NA	NA	NA	NA	NA
Pyrene	3.50	21.0	420 U	510 U	340 L	110	88.0	140	74.0	15.0 L	8.50	2.60
bis(2-Ethylhexyl)phthalate	NA	NA	420 U	510 U	NA	NA	NA	NA	NA	NA	NA	NA
Explosives (UG/KG)												
No Detections												
Total Metals (MG/KG)												
Aluminum	5,370	4,470	3,520	5,870	7,280	5,470	5,150	3,950	2,950	6,580	3,200	5,580
Antimony	0.67 UL	0.69 UL	1.2 U	1.1 U	3.3 U	1.40 UL	0.96 UL	0.68 UL	0.81 UL	0.85 UL	0.69 UL	0.67 UL
Arsenic	6.90	9.10	7.3	10.5	11.6	8.40	7.50	6.40	4.40	11.2	5.30	6.10
Barium	63.3	47.9	35.5 J	119	147	60.9 J	60.9 J	41.7 J	31.5 J	65.1	41.0 J	70.2
Beryllium	1.30	1.40	1.3	1.5	2 J	1.40 J	1.30 J	1.10 J	0.82 J	1.40 J	0.86 J	1.20
Calcium	1,480	1,440	908 J	2,720	5,790	2,370	1,890	953 J	1,440	2,320	674 J	4,820
Chromium	13.3	15.7	7.6	13	12.7	13.1	15.2	12.5	6.60	12.4	9.80	18.7
Cobalt	29.1	29.6	29.5	39.3	60.1	25.6	23.8	26.8	18.2	31.3	17.5	24.2
Copper	15.9	19.5	16.1	25.4	34.3	26.3	31.4	17.6	11.2	19.5	10.2	13.7
Cyanide	NA	NA	0.63 U	0.76 U	1.7 U	NA	NA	NA	NA	NA	NA	NA
Iron	35,700 J	40,800 J	22,200	28,100	31,300	21,200 J	21,200 J	30,600 J	10,700 J	32,200 J	19,400 J	38,900 J
Lead	13.7 K	21.2 K	18.5	27.7	31.6	18.4 K	22.5 K	18.9 K	10.1 K	21.0 K	11.9 K	14.7 K
Magnesium	661 J	554 J	494 J	896 J	1,330 J	707 J	583 J	469 J	357 J	756 J	599 J	1,590
Manganese	1,250 K	686 K	237	916	893	332 K	349 K	458 K	334 K	929 K	239 K	1,340 K
Mercury	0.037 U	0.037 U	0.13 B	0.15 U	0.31 UL	0.073 U	0.14 K	0.067 K	0.19 K	0.042 U	0.036 U	0.035 U
Nickel	45.9	52.9	48.4	60.9	98.3	45.2	43.2	48.9	26.6	57.9	31.6	40.8
Potassium	615 J	668 J	400 J	806 J	766 J	777 J	711 J	639 J	388 J	1,030 J	416 J	554 J
Selenium	0.51 U	0.55 U	0.54 U	1.5 U	2.6 U	1.00 U	0.99 U	0.52 U	0.61 U	2.10	0.53 U	0.51 U
Silver	0.20 UL	0.21 UL	0.15 UL	1.5 U	0.4 U	0.40 UL	0.28 UL	0.20 UL	0.24 UL	0.25 UL	0.21 UL	0.20 UL
Sodium	360 J	168 J	249 B	145 U	458 J	237 J	149 J	102 J	135 J	184 J	92.7 J	198 J
Thallium	1.30 J	1.80 J	1.9 B	1.7 U	3.3 U	1.90 U	1.40 U	1.30 J	1.10 U	1.90 J	1.20 J	1.40 J
Vanadium	14.9	17.9	11.1 J	15.5	22.4 J	14.1 J	13.1 J	14.9	7.90 J	17.6	9.10 J	33.2
Zinc	135 J	166 J	149	188	277	149 J	143 J	148 J	76.4 J	157 J	114 J	129 J
Wet Chemistry (MG/KG)												
% Solids	NA	NA	NA	NA	37.2	NA	NA	NA	NA	NA	NA	NA
Total organic carbon (TOC)	4,900	7,800	NA	NA	91,000	130,000	120,000	7,000	62,000	19,000	9,000	3,700
pH	7.40	7.40	NA	NA	7	7.30	7.30	7.10	7.10	7.40	7.20	7.60
Acid Volatile Sulfide/Simultaneously Extractable												
Acid Volatile Sulfide	NA	NA	NA	NA	43	NA	NA	NA	NA	NA	NA	NA
Cadmium	NA	NA	NA	NA	0.0059	NA	NA	NA	NA	NA	NA	NA
Copper	NA	NA	NA	NA	0.26	NA	NA	NA	NA	NA	NA	NA
Lead	NA	NA	NA	NA	0.099	NA	NA	NA	NA	NA	NA	NA
Nickel	NA	NA	NA	NA	0.72	NA	NA	NA	NA	NA	NA	NA
SEM/AVS Ratio	NA	NA	NA	NA	0.088	NA	NA	NA	NA	NA	NA	NA
Simul-ExtractMetal	NA	NA	NA	NA	3.8	NA	NA	NA	NA	NA	NA	NA
Zinc	NA	NA	NA	NA	2.7	NA	NA	NA	NA	NA	NA	NA

NA - Not analyzed
B - Analyte not detected above associated blank
E - Estimated
J - Reported value is estimated
L - Reported value may be biased low

N - Tentative ID, consider present
R - Unreliable result
U - Analyte not detected

File Path: v:\18gis\abl\figures\site5_ri.apr



Note: Background alluvial well 5GW24 not depicted as it is located ~1115 feet south of 5GW11 (see Figure 3-2).

LEGEND

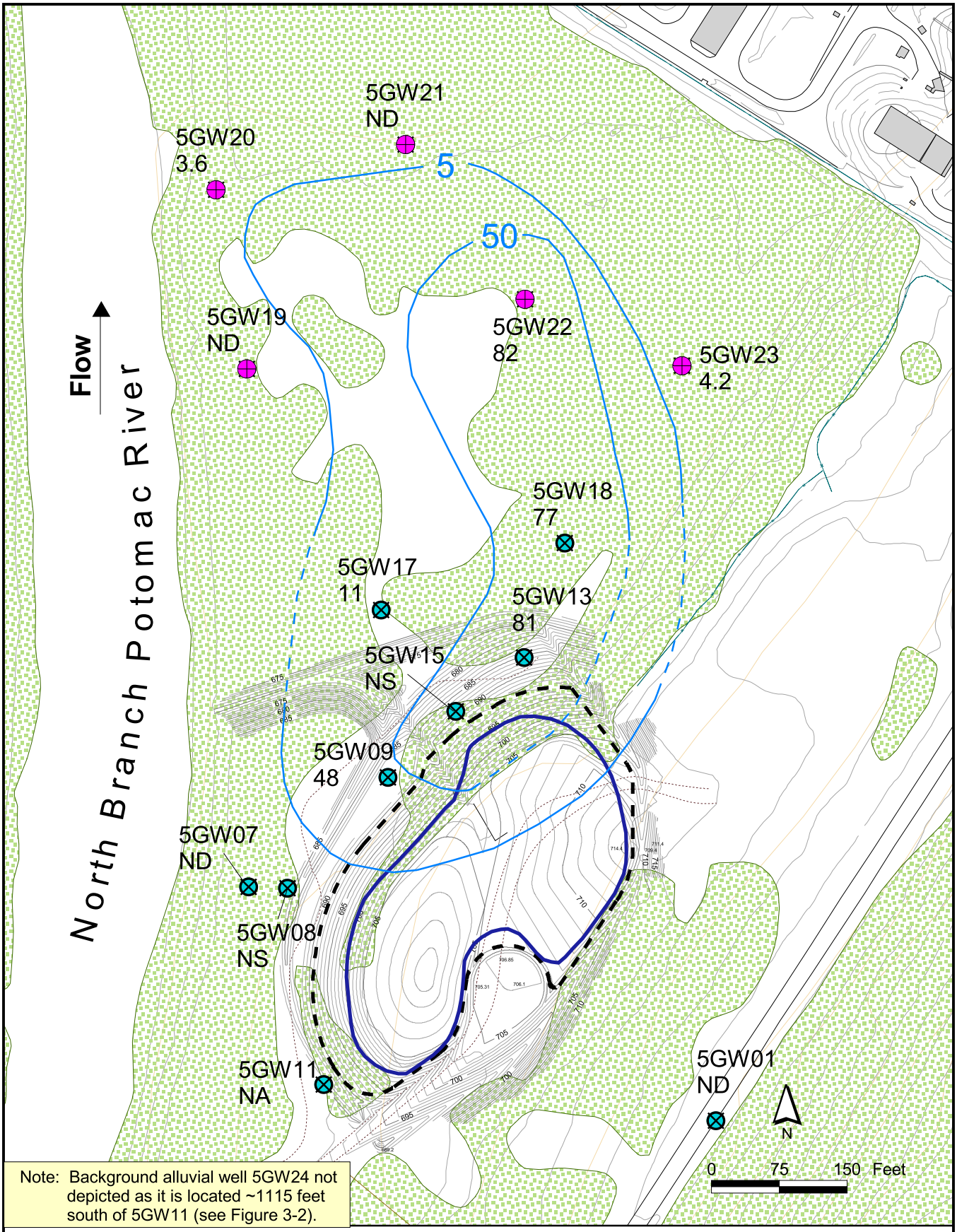
- Alluvial Monitoring Well Installed During Focused RI
- Existing Alluvial Monitoring Well
- Edge of Waste
- Vegetation
- Edge of Landfill Cap

U = Undetected
UJ = Undetected, estimated reporting limit
D = Diluted result
J = Estimated result
Note: Concentrations in µg/L

Figure 5-1
Historical Concentrations of TCE in Alluvial Aquifer in µg/L
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

CH2MHILL

File Path: v:\18gis\abl\figures\site5_ri.apr



Note: Background alluvial well 5GW24 not depicted as it is located ~1115 feet south of 5GW11 (see Figure 3-2).

LEGEND

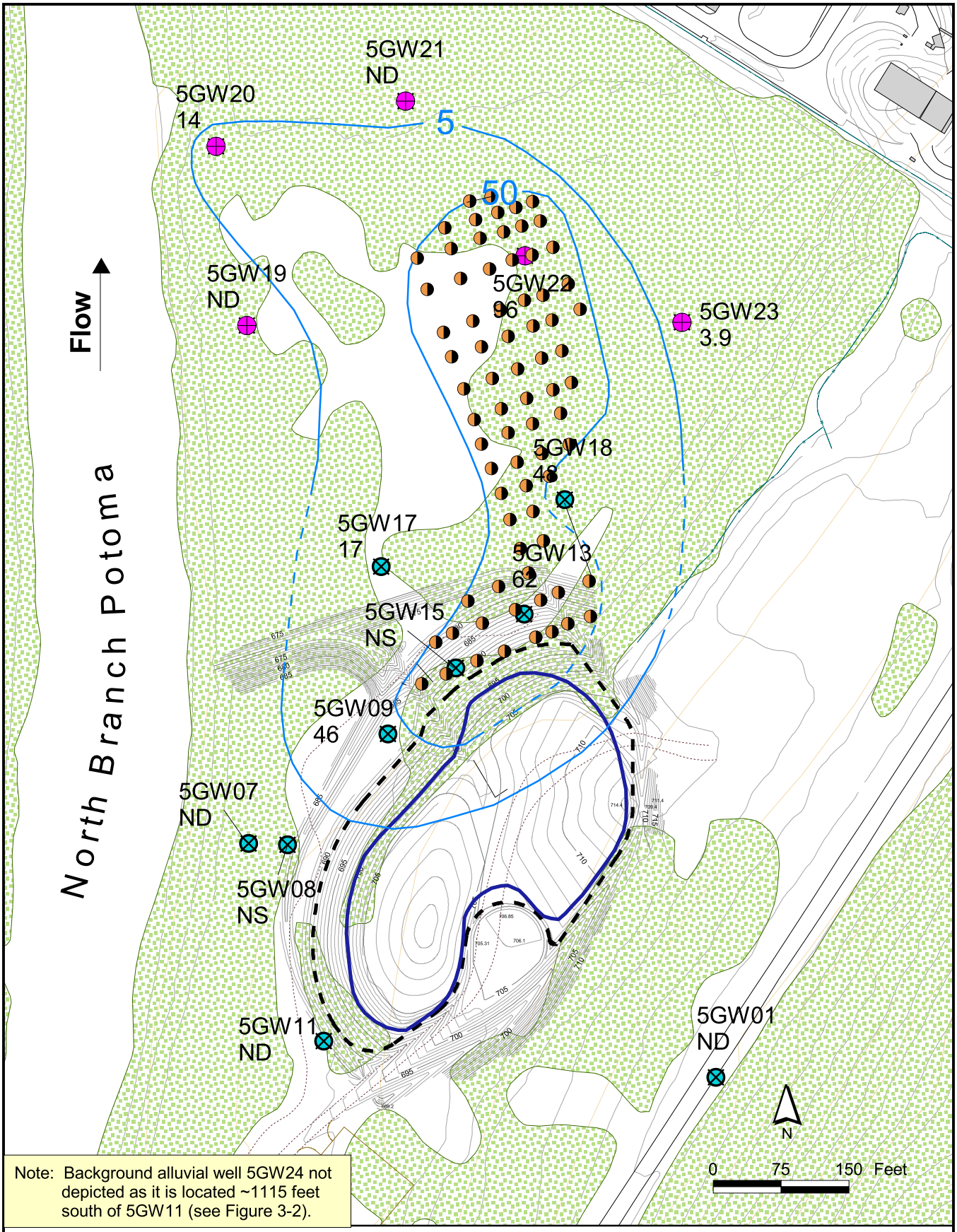
- Existing Alluvial Monitoring Well
- Alluvial Monitoring Well Installed During Focused RI
- Edge of Waste
- Edge of Landfill Cap
- Vegetation

4.2 = TCE in ug/L
NA = Not Analyzed for TCE
NS = Not Sampled
ND = Not Detected
50 ug/L Isoconcentration line for TCE; dashed where inferred

Figure 5-2
Isoconcentration Map for TCE in Alluvial Aquifer (August 2000)
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

CH2MHILL

File Path: v:\18gis\abl\figures\site5_ri.apr



Note: Background alluvial well 5GW24 not depicted as it is located ~1115 feet south of 5GW11 (see Figure 3-2).

LEGEND

- Existing Alluvial Monitoring Well
- Alluvial Monitoring Well Installed During Focused RI
- Edge of Waste
- Edge of Landfill Cap
- Vegetation

3.9 = TCE in ug/L
NS = Not Sampled
ND = Not Detected
50 ug/L Isoconcentration line for TCE; dashed where inferred

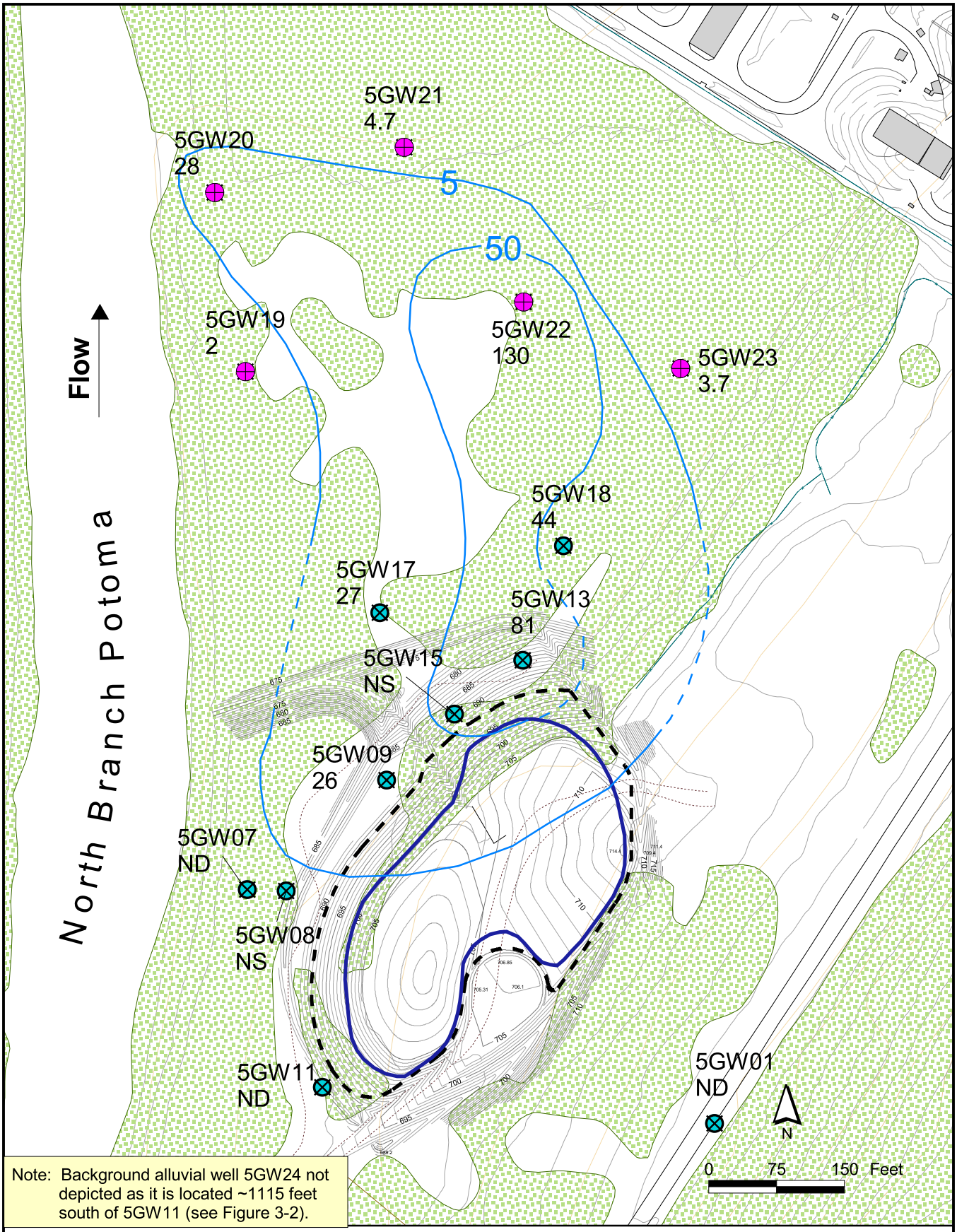
Figure 5-3

Isoconcentration Map for TCE in Alluvial Aquifer (April 2001)

Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

CH2MHILL

File Path: v:\18gis\abl\figures\site5_ri.apr



Note: Background alluvial well 5GW24 not depicted as it is located ~1115 feet south of 5GW11 (see Figure 3-2).

LEGEND

- Existing Alluvial Monitoring Well
- Alluvial Monitoring Well Installed During Focused RI
- Edge of Waste
- Edge of Landfill Cap
- Vegetation

4.7 = TCE in ug/L
NS = Not Sampled
ND = Not Detected
50 ug/L Isoconcentration line for TCE; dashed where inferred

Figure 5-4
Isoconcentration Map for TCE in Alluvial Aquifer (February 2002)
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

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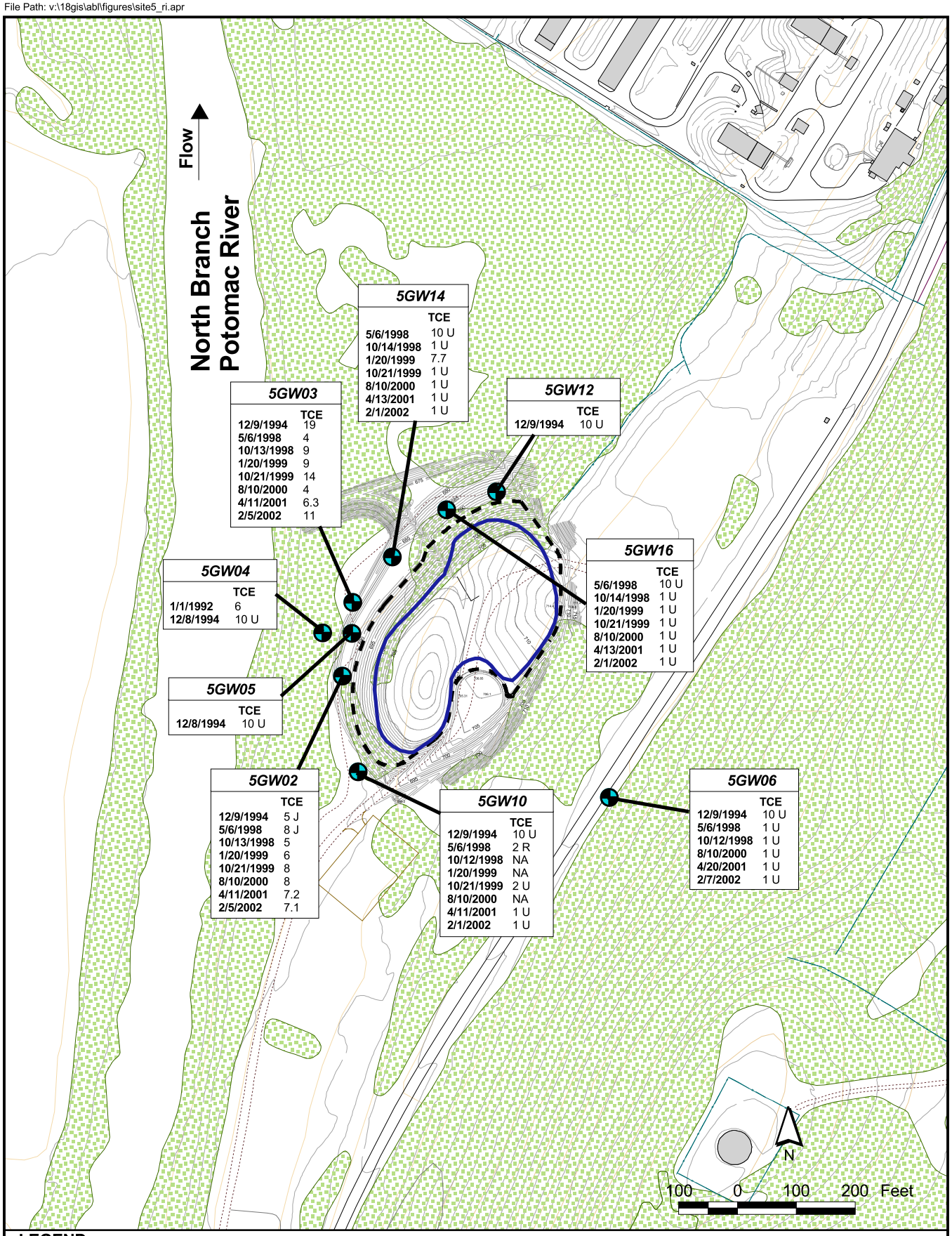
File Path: v:\18gis\abl\figures\site5_ri.apr



LEGEND

- Bedrock Monitoring Well
- Edge of Waste
- Edge of Landfill Cap
- Vegetation
- NA = Not Analyzed

U = Undetected
R = Unreliable result
NA = Not analyzed
J = Estimated result
Note: Concentrations in µg/L

Figure 5-5
Historical Concentrations of TCE in Bedrock Aquifer in µg/L
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

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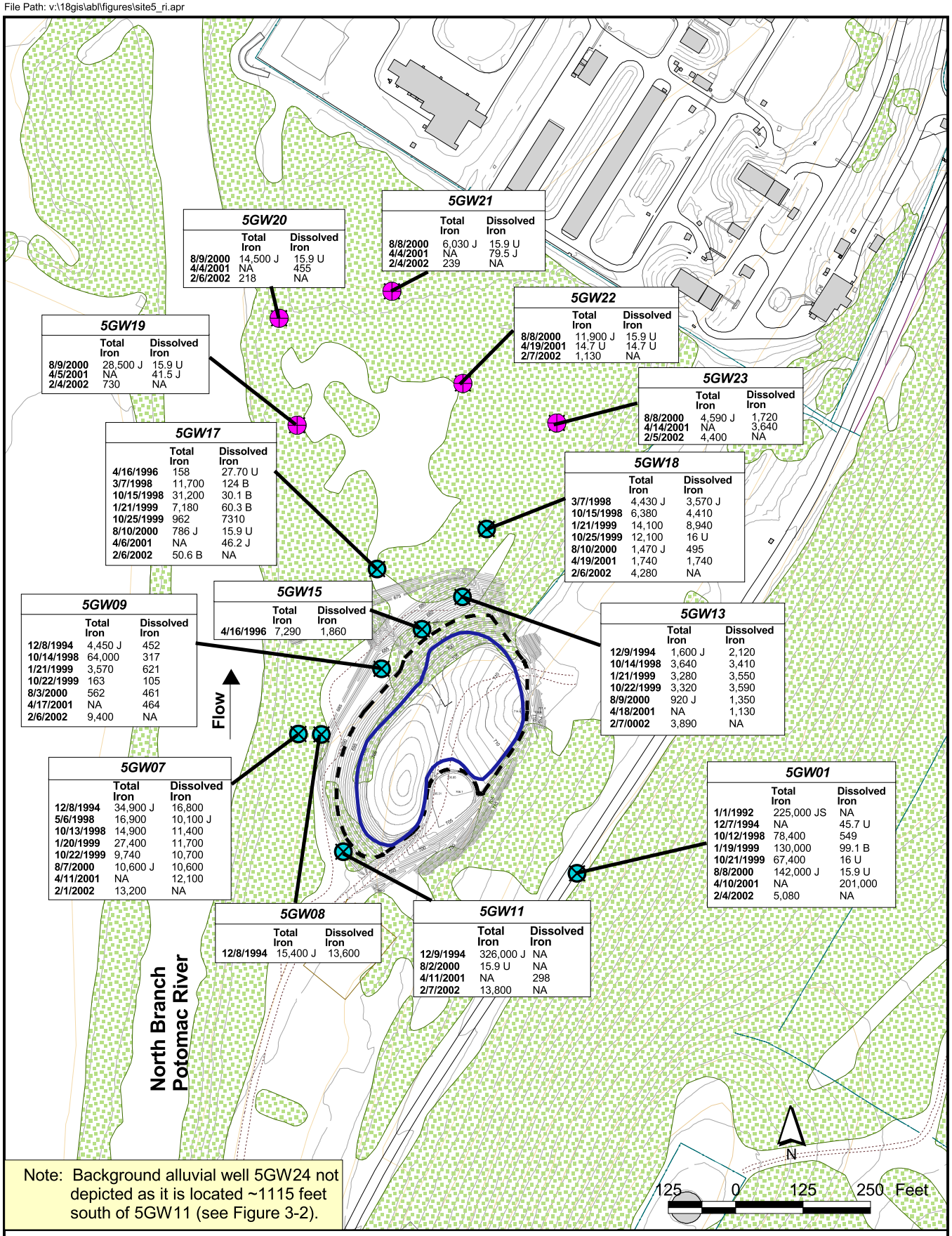
File Path: v:\18gis\abl\figures\site5_ri.apr



Note: Background alluvial well 5GW24 not depicted as it is located ~1115 feet south of 5GW11 (see Figure 3-2).

LEGEND

- Alluvial Monitoring Well Installed During Focused RI
- Existing Alluvial Monitoring Well
- Edge of Waste
- Vegetation
- Edge of Landfill Cap

U = Undetected
B = Similar concentration found in associated blank
NA = Not analyzed
J = Estimated result
JS = Estimated value calculated by Method of Standard Additions

Figure 5-6
Historical Concentrations of Iron in Alluvial Aquifer in µg/L
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

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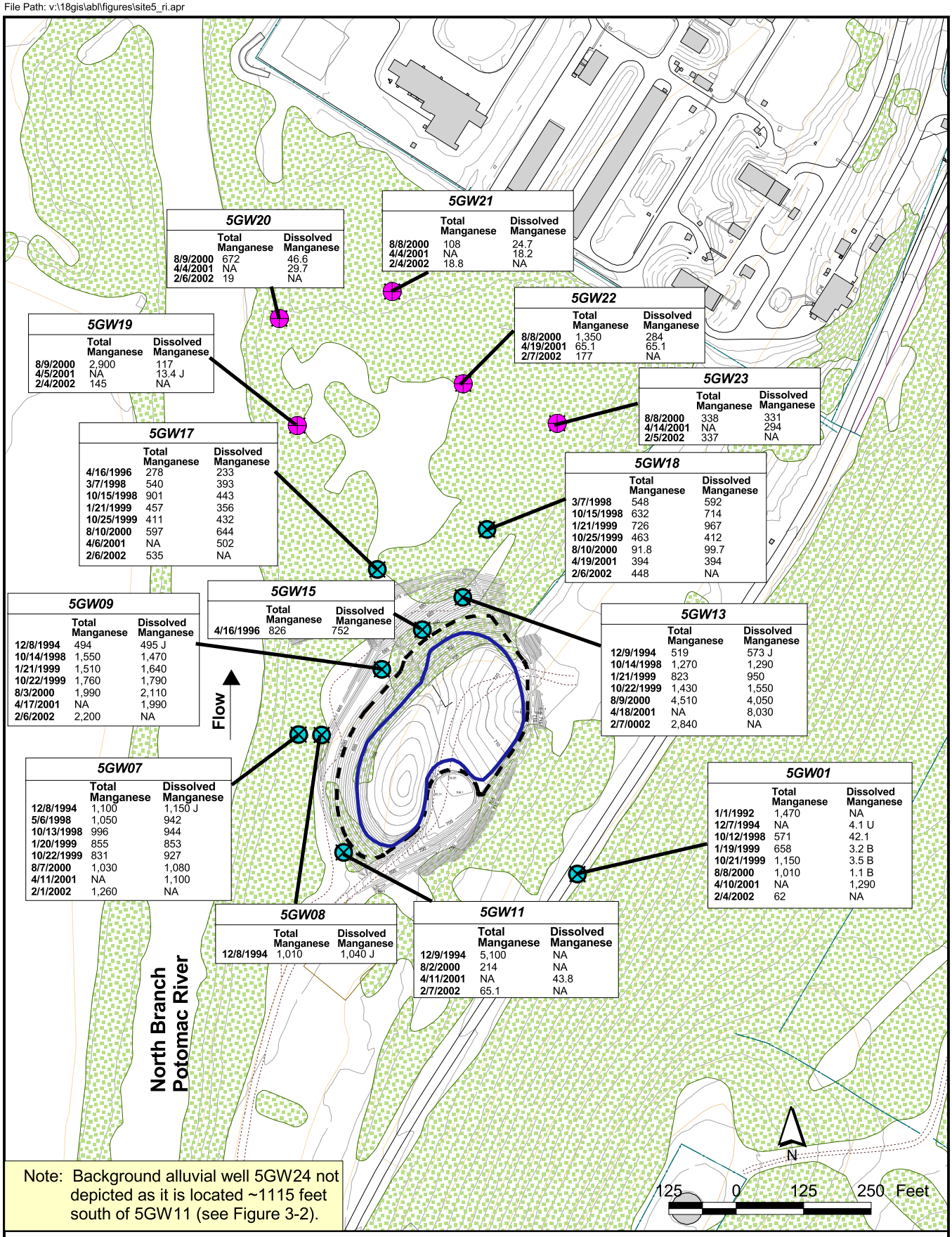
File Path: v:\18gis\abl\figures\site5_ri.apr



5GW20

	Total Manganese	Dissolved Manganese
8/9/2000	672	46.6
4/4/2001	NA	29.7
2/6/2002	19	NA

5GW21

	Total Manganese	Dissolved Manganese
8/8/2000	108	24.7
4/4/2001	NA	18.2
2/4/2002	18.8	NA

5GW22

	Total Manganese	Dissolved Manganese
8/8/2000	1,350	284
4/19/2001	65.1	65.1
2/7/2002	177	NA

5GW19

	Total Manganese	Dissolved Manganese
8/9/2000	2,900	117
4/5/2001	NA	13.4 J
2/4/2002	145	NA

5GW23

	Total Manganese	Dissolved Manganese
8/8/2000	338	331
4/14/2001	NA	294
2/5/2002	337	NA

5GW17

	Total Manganese	Dissolved Manganese
4/16/1996	278	233
3/7/1998	540	393
10/15/1998	901	443
1/21/1999	457	356
10/25/1999	411	432
8/10/2000	597	644
4/6/2001	NA	502
2/6/2002	535	NA

5GW18

	Total Manganese	Dissolved Manganese
3/7/1998	548	592
10/15/1998	632	714
1/21/1999	726	967
10/25/1999	463	412
8/10/2000	91.8	99.7
4/19/2001	394	394
2/6/2002	448	NA

5GW15

	Total Manganese	Dissolved Manganese
4/16/1996	826	752

5GW09

	Total Manganese	Dissolved Manganese
12/8/1994	494	495 J
10/14/1998	1,550	1,470
1/21/1999	1,510	1,640
10/22/1999	1,760	1,790
8/3/2000	1,990	2,110
4/17/2001	NA	1,990
2/6/2002	2,200	NA

5GW13

	Total Manganese	Dissolved Manganese
12/9/1994	519	573 J
10/14/1998	1,270	1,290
1/21/1999	823	950
10/22/1999	1,430	1,550
8/9/2000	4,510	4,050
4/18/2001	NA	8,030
2/7/0002	2,840	NA

5GW07

	Total Manganese	Dissolved Manganese
12/8/1994	1,100	1,150 J
5/6/1998	1,050	942
10/13/1998	996	944
1/20/1999	855	853
10/22/1999	831	927
8/7/2000	1,030	1,080
4/11/2001	NA	1,100
2/1/2002	1,260	NA

5GW01

	Total Manganese	Dissolved Manganese
1/1/1992	1,470	NA
12/7/1994	NA	4.1 U
10/12/1998	571	42.1
1/19/1999	658	3.2 B
10/21/1999	1,150	3.5 B
8/8/2000	1,010	1.1 B
4/10/2001	NA	1,290
2/4/2002	62	NA

5GW08

	Total Manganese	Dissolved Manganese
12/8/1994	1,010	1,040 J

5GW11

	Total Manganese	Dissolved Manganese
12/9/1994	5,100	NA
8/2/2000	214	NA
4/11/2001	NA	43.8
2/7/2002	65.1	NA

Note: Background alluvial well 5GW24 not depicted as it is located ~1115 feet south of 5GW11 (see Figure 3-2).

LEGEND

- Alluvial Monitoring Well Installed During Focused RI
- Existing Alluvial Monitoring Well
- Edge of Waste
- Vegetation
- Edge of Landfill Cap

U = Undetected
B = Similar concentration found in associated blank
NA = Not analyzed
J = Estimated result

Figure 5-7
Historical Concentrations of Manganese in Alluvial Aquifer in ug/L
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

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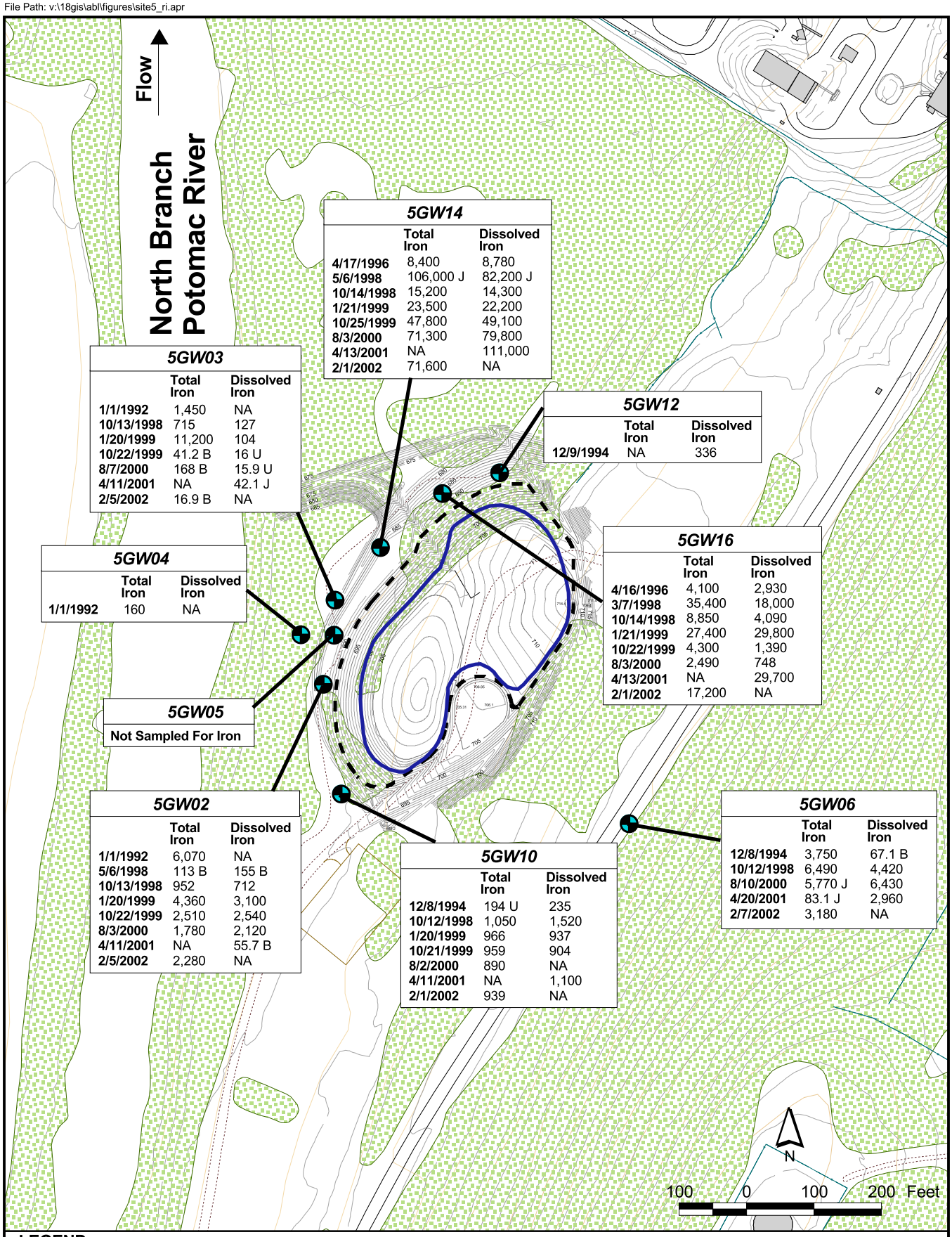
File Path: v:\18gis\abl\figures\site5_ri.apr



5GW14

	Total Iron	Dissolved Iron
4/17/1996	8,400	8,780
5/6/1998	106,000 J	82,200 J
10/14/1998	15,200	14,300
1/21/1999	23,500	22,200
10/25/1999	47,800	49,100
8/3/2000	71,300	79,800
4/13/2001	NA	111,000
2/1/2002	71,600	NA

5GW03

	Total Iron	Dissolved Iron
1/1/1992	1,450	NA
10/13/1998	715	127
1/20/1999	11,200	104
10/22/1999	41.2 B	16 U
8/7/2000	168 B	15.9 U
4/11/2001	NA	42.1 J
2/5/2002	16.9 B	NA

5GW12

	Total Iron	Dissolved Iron
12/9/1994	NA	336

5GW04

	Total Iron	Dissolved Iron
1/1/1992	160	NA

5GW16

	Total Iron	Dissolved Iron
4/16/1996	4,100	2,930
3/7/1998	35,400	18,000
10/14/1998	8,850	4,090
1/21/1999	27,400	29,800
10/22/1999	4,300	1,390
8/3/2000	2,490	748
4/13/2001	NA	29,700
2/1/2002	17,200	NA

5GW05

Not Sampled For Iron

5GW02

	Total Iron	Dissolved Iron
1/1/1992	6,070	NA
5/6/1998	113 B	155 B
10/13/1998	952	712
1/20/1999	4,360	3,100
10/22/1999	2,510	2,540
8/3/2000	1,780	2,120
4/11/2001	NA	55.7 B
2/5/2002	2,280	NA

5GW10

	Total Iron	Dissolved Iron
12/8/1994	194 U	235
10/12/1998	1,050	1,520
1/20/1999	966	937
10/21/1999	959	904
8/2/2000	890	NA
4/11/2001	NA	1,100
2/1/2002	939	NA

5GW06

	Total Iron	Dissolved Iron
12/8/1994	3,750	67.1 B
10/12/1998	6,490	4,420
8/10/2000	5,770 J	6,430
4/20/2001	83.1 J	2,960
2/7/2002	3,180	NA

LEGEND

- Bedrock Monitoring Well
- Edge of Waste
- Edge of Landfill Cap
- Vegetation
- NA = Not Analyzed

U = Undetected
B = Similar concentration found in associated blank
NA = Not analyzed
J = Estimated result

Figure 5-8
Historical Concentrations of Iron in Bedrock Aquifer in ug/L
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

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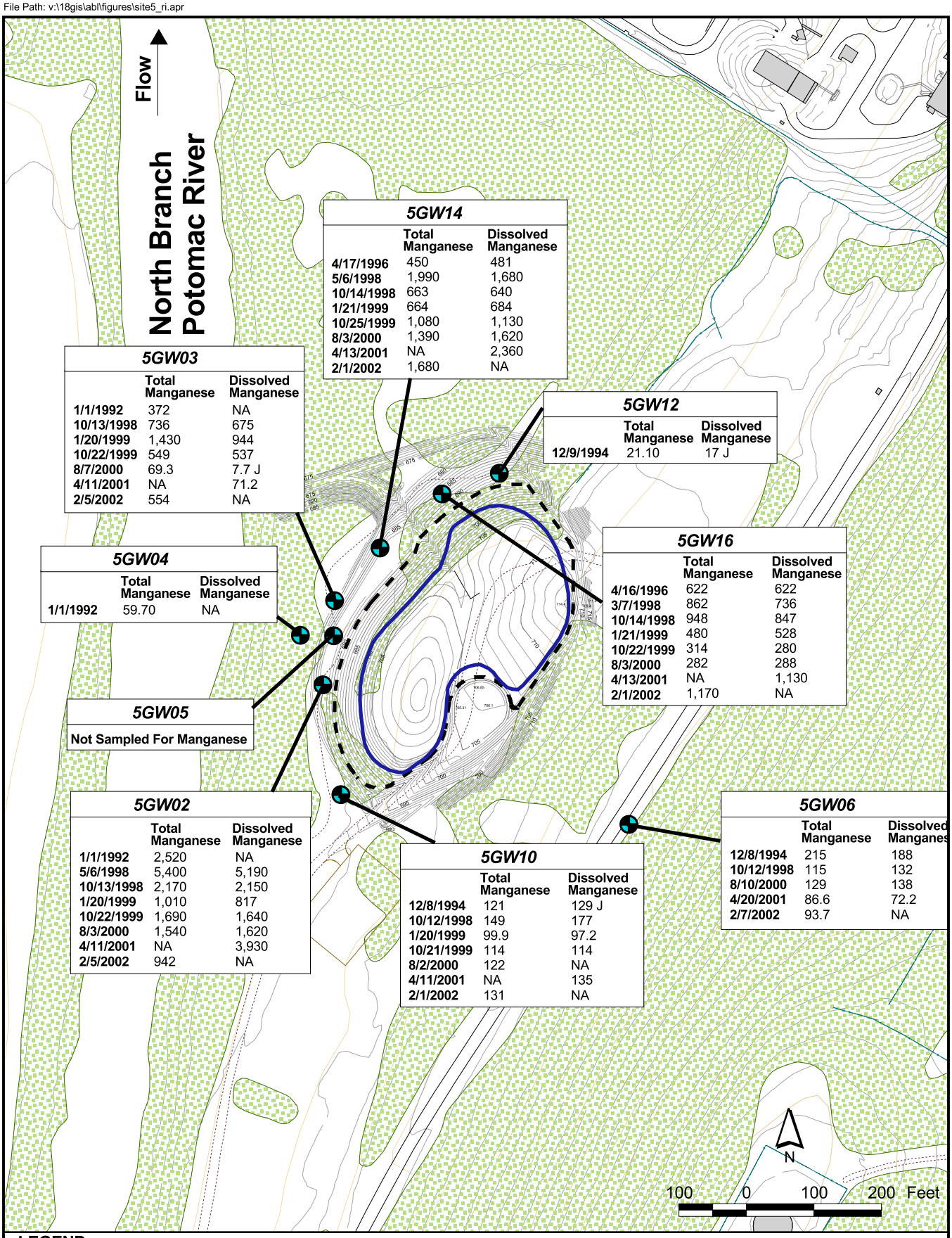
File Path: v:\18gis\abl\figures\site5_ri.apr



5GW14

	Total Manganese	Dissolved Manganese
4/17/1996	450	481
5/6/1998	1,990	1,680
10/14/1998	663	640
1/21/1999	664	684
10/25/1999	1,080	1,130
8/3/2000	1,390	1,620
4/13/2001	NA	2,360
2/1/2002	1,680	NA

5GW03

	Total Manganese	Dissolved Manganese
1/1/1992	372	NA
10/13/1998	736	675
1/20/1999	1,430	944
10/22/1999	549	537
8/7/2000	69.3	7.7 J
4/11/2001	NA	71.2
2/5/2002	554	NA

5GW12

	Total Manganese	Dissolved Manganese
12/9/1994	21.10	17 J

5GW04

	Total Manganese	Dissolved Manganese
1/1/1992	59.70	NA

5GW16

	Total Manganese	Dissolved Manganese
4/16/1996	622	622
3/7/1998	862	736
10/14/1998	948	847
1/21/1999	480	528
10/22/1999	314	280
8/3/2000	282	288
4/13/2001	NA	1,130
2/1/2002	1,170	NA

5GW05

Not Sampled For Manganese

5GW02

	Total Manganese	Dissolved Manganese
1/1/1992	2,520	NA
5/6/1998	5,400	5,190
10/13/1998	2,170	2,150
1/20/1999	1,010	817
10/22/1999	1,690	1,640
8/3/2000	1,540	1,620
4/11/2001	NA	3,930
2/5/2002	942	NA

5GW10

	Total Manganese	Dissolved Manganese
12/8/1994	121	129 J
10/12/1998	149	177
1/20/1999	99.9	97.2
10/21/1999	114	114
8/2/2000	122	NA
4/11/2001	NA	135
2/1/2002	131	NA

5GW06

	Total Manganese	Dissolved Manganese
12/8/1994	215	188
10/12/1998	115	132
8/10/2000	129	138
4/20/2001	86.6	72.2
2/7/2002	93.7	NA

LEGEND

- Bedrock Monitoring Well
- Edge of Waste
- Edge of Landfill Cap
- Vegetation
- NA = Not Analyzed

NA = Not analyzed
J = Estimated result

Figure 5-9
Historical Concentrations of Manganese in Bedrock Aquifer in ug/L
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

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SECTION 6

Contaminant Fate and Transport

This section provides a qualitative discussion and a semi-quantitative analysis of the fate and transport of contaminants identified in Site 5 groundwater.

6.1 Chemical and Physical Properties

Mobility and persistence are two key terms used to describe the movement and partitioning of chemicals in the environment (air, water, and soil). Mobility is the potential for a chemical to migrate through a medium and persistence is a measure of how long a constituent will remain in the environment.

Several physicochemical properties are typically used to predict the mobility and persistence of contaminants in media. Principal properties that influence the mobility and persistence include water solubility, vapor pressure, Henry's Law Constant, and carbon/water partition coefficient. Table 6-1 summarizes the physical and chemical properties for representative constituents detected in the site groundwater, as well as their persistence properties in soil, groundwater, and surface water.

6.1.1 Water Solubility

Water solubility is the maximum concentration of a chemical that can dissolve in pure water at a given temperature and pH. Water solubility is a critical property affecting the environmental transport of a chemical; highly soluble chemicals can be rapidly leached from contaminated soil and are generally mobile in groundwater. The solubility of chemicals that are not readily soluble in water, such as inorganics, can be enhanced in the presence of organic solvents. In general, VOCs have relatively high water solubilities and inorganics have relatively low water solubilities.

6.1.2 Vapor Pressure/Henry's Law Constant

A chemical's volatilization rate from water depends on its vapor pressure and water solubility. Highly water-soluble chemicals generally volatilize from water at lower rates than chemicals with low water solubility. While vapor pressure is a measure of the volatility of chemicals in their pure state, the Henry's Law Constant is the ratio of a chemical's vapor pressure (in atmosphere) to its solubility (in moles/m^3). The Henry's Law Constant is more accurate than vapor pressure in estimating releases from water to air. Chemicals with Henry's Law Constant greater than approximately 10^{-3} atmosphere-cubic meters per mole (atm-m^3/mol) (e.g., VOCs) can be expected to volatilize readily from water, while chemicals with values less than 10^{-3} atm-m^3/mol (e.g., SVOCs) will volatilize only to a limited extent.

6.1.3 Carbon/Water Partition Coefficient (K_{oc})

The carbon/water partition coefficient is often used to estimate the extent to which a chemical will partition between organic matter and water. Chemicals with low K_{oc} values

(less than 10 milliliters/gram) are found mainly in the water phase, and chemicals with high K_{oc} values tend to adsorb to the soil matrix. The distribution coefficient (K_d) is defined as the product of the K_{oc} and the fraction of organic carbon.

6.1.4 Persistence

Persistence is a measure of how long a chemical will exist in air, water, or soil. Phase transfer and chemical and biological degradation are major forms of removal and transformation processes. Persistence is expressed as a half-life ($t_{1/2}$), generally in days. In general, inorganics are persistent in water and soil media.

Degradation can occur by both chemical and biological processes. Chemical degradation can occur through such processes as hydrolysis and photolysis. Biological degradation occurs most readily among organic compounds, with VOCs typically being more biodegradable than SVOCs. Many organic compounds degrade to compounds that may be more toxic than the parent compound (e.g., TCE degrades to DCE and vinyl chloride). Rates of degradation are available in literature but vary greatly according to the nature and conditions of the experiments used to obtain the data.

Other environmental factors that may affect the mobility and persistence of contaminants include pH, concentrations of other constituents in the media, soil moisture, oxidation-reduction potential, water chemistry, organic-matter content, and the presence and types of microorganisms in the subsurface.

6.2 Contaminant Source Areas

TCE was the only VOC in the alluvial and bedrock aquifers that was identified as a COC in the HHRA and was present at levels exceeding the MCL. Iron and manganese were the only inorganics in the alluvial and bedrock aquifers that were identified as COCs in the HHRA.

6.2.1 Alluvial Aquifer

As displayed on the isoconcentration maps generated from the August 2000, April 2001, and February 2002 LTM data (Figures 5-2, 5-3, and 5-4, respectively), the source of the alluvial dissolved-phase TCE plume is in the landfill and is believed to be drums disposed in the landfill.

The inorganic analytical results indicate that: (1) metallic debris buried within the landfill may be contributing to the iron and manganese concentrations present in the alluvial aquifer downgradient of the landfill, and/or (2) the groundwater chemistry beneath the landfill may have been altered (e.g., change in pH or presence of TCE), causing the naturally occurring iron and manganese in the Site 5 alluvium to become more soluble.

6.2.2 Bedrock Aquifer

The source of TCE in the bedrock aquifer is presumed to be vertical migration from the overlying, unconfined alluvial aquifer.

The inorganic analytical results indicate that: (1) metallic debris buried within the landfill may be contributing to the iron and manganese concentrations present in the bedrock

aquifer downgradient of the landfill, and/or (2) the groundwater chemistry beneath the landfill may have been altered (e.g., change in pH or presence of TCE), causing the naturally occurring iron and manganese in the Site 5 bedrock to become more soluble.

6.3 Mechanisms of Migration

There are a limited number of mechanisms by which constituents can migrate from the Site 5 inert landfill to potential receptors. Installation of the landfill cap (1997) limits precipitation from infiltrating and leaching residual contaminants from the landfilled material to groundwater and minimizes the migration of potential organic vapors to air.

Once in the groundwater, constituents migrate in the predominant direction of groundwater flow. The North Branch Potomac River is likely the ultimate discharge area for groundwater from Site 5, as discussed below.

6.3.1 Migration into Surface Water and Sediment

Groundwater discharge is a potential transport mechanism for groundwater contaminants to impact the surface water and sediment of the North Branch Potomac River. Groundwater discharge to surface water is a function of the difference between hydraulic head in the aquifer and that of the river.

A study of the spatial correlation between constituents detected in groundwater and surface water/sediment was conducted as part of the Focused RI to assess whether groundwater discharge was a significant transport mechanism to these media. The spatial correlation findings are presented as follows.

6.3.1.1 VOCs

No spatial correlation was found between VOCs in groundwater and VOCs in surface water or sediment. Results of the HHRA and ERA indicate that no VOCs were identified as COCs in surface water or sediment.

It is believed that TCE in groundwater either: (1) attenuates before the groundwater discharges to the river; (2) is diluted to non-detectable concentrations in the surface water upon groundwater discharge to the river; or (3) has yet to be transported to the river.

Alluvial Aquifer. The potentiometric surface map for the alluvial aquifer (Figure 4-5) indicates that groundwater flows to the north-northwest from the landfill. This is reflected in the analytical data. VOCs are primarily migrating north of the landfill, with a secondary westerly component, toward the North Branch Potomac River near well 5GW20. The average linear groundwater velocity in the alluvial aquifer is estimated at 294 ft/yr (Table 4-1). It is estimated that the lateral distance from the northern edge of the landfill to the North Branch Potomac River between wells 5GW19 and 5GW20 is roughly 800 feet. Based on this groundwater flow velocity and direction and an estimated distance of 800 feet from the northern edge of the landfill to the river, it would require between 2 and 3 years for alluvial groundwater beneath the landfill to reach the river, in the absence of any attenuation processes.

It is more likely that migration of VOCs in groundwater is retarded by the chemical properties of the VOCs and the biological, chemical, and physical nature of the subsurface media.

Table 6-2 summarizes the retardation factors calculated for representative VOCs detected in Site 5 groundwater. It should be noted that the TOC used for the retardation-factor calculations was determined from surface soil samples collected near the Site 5 landfill. In general, TOC concentrations decrease with increased depth below ground surface, especially below the water table. Therefore, the retardation factors presented in Table 6-2 are likely to be higher than the actual values in the Site 5 alluvial aquifer.

By dividing the range of linear groundwater velocity values (Table 4-1) by the retardation factors in Table 6-2, the travel time for each representative VOC in the alluvial aquifer was estimated (Table 6-3). Because the actual retardation values are likely to be lower than those in Table 6-2, the actual velocity of each VOC may be higher than that shown in Table 6-3.

As shown in Table 6-3, TCE travels at an estimated range of 2 to 38 ft/yr (average velocity of 13 ft/yr), which is the lowest travel time of the VOCs detected in Site 5 groundwater. Assuming a distance of 800 feet from the landfill to the North Branch Potomac River and north-northwest groundwater flow, 21 to 400 years (average of 62 years) would be required for TCE to be transported in the alluvial aquifer from the northern edge of the landfill to the North Branch Potomac River.

Bedrock Aquifer. The potentiometric surface map for the bedrock aquifer (Figure 4-6) indicates that the principal groundwater flow direction is to the west from the landfill. This is reflected in the analytical data, because VOCs have been detected in the bedrock aquifer west of the landfill but have not been detected in the bedrock aquifer north of the landfill.

As discussed in Section 4, the calculated vertical component of hydraulic gradient between the alluvium and bedrock is downward at most Site 5 well locations. This suggests that some VOC-contaminated groundwater may migrate from the overlying alluvium to the bedrock. However, the low concentrations of TCE in bedrock groundwater indicate that this is not the principal avenue for VOC migration at the site.

Generally, organic matter is less prevalent in bedrock than in shallower unconsolidated deposits. Therefore, retardation of the VOCs in the bedrock should be less than the retardation in the alluvium. The lower retardation of VOCs coupled with the higher groundwater velocity estimated for the bedrock aquifer should result in increased VOC travel times in the bedrock aquifer. Travel times for the bedrock aquifer have not been estimated because the relatively low TCE concentrations in the bedrock aquifer are not believed to significantly impact the surface water or sediment of the North Branch Potomac River.

6.3.1.2 SVOCs

No spatial correlation was found between SVOCs in groundwater and SVOCs in surface water or sediment. No SVOCs were identified as HHRA or ERA COCs in groundwater, surface water, or sediment.

6.3.1.3 Inorganics

Analytical results indicate that groundwater and surface water iron and manganese concentrations are spatially related. Iron and manganese concentrations in the downgradient surface water samples were generally slightly higher but similar to those in the upgradient sample. However, the surface water concentrations are well below the tap water RBCs for

iron and manganese. Analytical results indicate that groundwater and sediment manganese concentrations are spatially related but groundwater and sediment iron concentrations are not. The residential soil RBC for manganese in sediment was exceeded for each sample during each LTM event, except in 5SD-3 during the February 2002 LTM event. However, manganese concentrations in the downgradient sediment samples were generally slightly higher but similar to those in the upgradient sample.

No inorganics were identified as HHRA or ERA COCs in surface water or sediment. Mercury was the only inorganic that was identified as a potential ERA COC in sediment for benthic communities. Fish tissue samples were subsequently analyzed and the data indicate that the mercury in sediment has limited bioavailability and that Site 5 is not a likely source of this chemical (Section 8).

TABLE 6-1
Physical, Chemical, and Half-Life Data of Representative Chemicals
Focused RI/FS Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Chemical	Molecular Weight	Specific Gravity	Water Solubility	Vapor Pressure	Henry's Law Constant	Log K_{oc}	Half-Life Range (days)					
							Soil		Groundwater		Surface Water	
	(g/mole)	(unitless)	(g/100mL)	(mm Hg)	(atm-m^3/mole)	(mL/g)	Low	High	Low	High	Low	High
VOCs												
Acetone	58.08	0.7857	miscible	181.7	4.26E-05	0.73	1	7	2	14	1	7
cis-1,2-Dichloroethene	96.94	1.284	3.50E-02	180	4.08E-03	1.69	28	182	56	2850	28	182
trans-1,2-Dichloroethene	96.94	1.257	6.30E-03	265	9.38E-03	2.10	28	182	56	2850	28	182
Methylene chloride	84.92	1.326	1.67E-02	424	2.03E-03	1.4						
1,1,1-Trichloroethane	133.4	1.33	1.50E-01	100	6.30E-03	2.03						
Trichloroethene	131.39	1.462	1.10E-01	57.8	9.10E-03	2.11	182	365	321	1643	182	365
Inorganics												
Iron	55.85	7.86	NU	NU	NU	NA	NR	NR	NR	NR	NR	NR
Manganese	54.94	7.20	NU	NU	NU	NA	NR	NR	NR	NR	NR	NR

Notes:
K_{oc} = Organic carbon partition coefficient
ρ = 1.85 g/cm^3 (bulk density of soil)
n_e = 0.25 (bulk porosity of soil)
NA = Not available
NR = Not relevant for the indicated inorganic
NU = Not Known; form of inorganic is not identified
g/mole = gram per mole
mm Hg = milimeter of mercury
atm-m^3/mole = atmosphere cubic meter per mole
mL/g = mililiter per gram
Specific gravity, solubility, and vapor pressure are at 20 ^oC, if available, or nearest temperature

Data sources:
Montgomery and Welkom, 1989, *Groundwater Chemicals Desk Reference,* Volume 1
U.S. Department of Health and Human Services (ATSDR), 1993, *Toxicological Profile for RDX (Draft)*
U.S. EPA Office of Drinking Water, 1989, *Trinitrotoluene Health Advisory*
Half-lives from Howard, Ph. H. et al, 1991, *Handbook of Environmental Degradation Rates* and from *ATSDR, 1993*
Dragun, James. *The Soil Chemistry of Hazardous Materials*
Weast, R.C. 1988 Handbook of Chemistry and Physics. CRC Press.
U.S. EPA. 1990. Superfund Subsurface Contamination Reference Guide. Table 3. EPA/540/2-90/001
Superfund Public Health Evaluation Manual. USEPA/540/1-86/060 OERR 10/86
Online, ChemFinder Search Engine. Accessed March 10, 2003

TABLE 6-2
Retardation Factors for Representative VOCs Detected in the Alluvial Aquifer
Final Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

VOC	Dry Bulk Density[a] (P_b) (g/cm^3)	Volumetric Moisture Content[b] (n)	Total Organic Carbon[c] (T_{oc}) (mg/kg)	Fractional Organic Carbon[d] (F_{oc})	Organic Carbon Partition Coefficient[e] (K_d) (mL/g)	Retardation Factor[f] (r)
Acetone	1.88	0.2	15,180	0.015	1	1.14
1,2-DCE (total)	1.88	0.2	15,180	0.015	39	6.56
Methylene Chloride	1.88	0.2	15,180	0.015	25	4.57
1,1,1-TCA	1.88	0.2	15,180	0.015	155	23.12
TCE	1.88	0.2	15,180	0.015	152	22.69

Notes:

[a] Average dry bulk density for silty sand and gravel (Lambe and Whitman, 1969)
[b] Equal to the assumed porosity (in the saturated zone)
[c] Average of T_{OC} values determined from soil samples collected at Site 5 during Phase II RI (CH2M HILL, 1996b)
[d] $T_{OC}/10^6$
[e] Tabulated values from Fetter (1988)
[f] $= [1+(P_b/n)(K_d)]$

TABLE 6-3
Estimated VOC Travel Times in the Alluvial Aquifer
Final Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

VOC	Maximum Velocity of VOC[a] (ft/yr)	Minimum Velocity of VOC[b] (ft/yr)	Average Velocity of VOC[c] (ft/yr)	Minimum Time for VOC to Move from Landfill to River[d] (yr)	Maximum Time for VOC to Move from Landfill to River[d] (yr)	Average Time for VOC to Move from Landfill to River[d] (yr)
Acetone	751	45	257	1	18	3
1,2-DCE (total)	131	8	45	6	100	18
Methylene Chloride	188	11	64	4	73	12
1,1,1-TCA	37	2	13	22	400	62
TCE	38	2	13	21	400	62

Notes:

[a] Equal to the maximum average linear velocity from Table 4-1 divided by the retardation factor from Table 6-2
[b] Equal to the minimum average linear velocity from Table 4-1 divided by the retardation factor from Table 6-2
[c] Equal to the mean average linear velocity from Table 4-1 divided by the retardation factor from Table 6-2
[d] Calculation uses an average distance of 800 feet from the northern edge of the landfill to the North Branch Potomac River between wells 5GW19 and 5GW20

SECTION 7

Human Health Risk Assessment

7.1 Introduction

This chapter presents the results of an assessment of potential human health risks associated with the presence of site-related surface water, sediment, and groundwater contaminants at Site 5. This baseline risk assessment was conducted to assess the potential human health impacts from the site under current conditions, as well as to determine if any further actions may be needed at the site to be sufficiently protective of human health. This risk assessment has been prepared utilizing conservative assumptions, and all feasible exposure pathways have been considered based on current site conditions and potential future site use. The risk assessment incorporates the general methodology described in *Risk Assessment Guidance for Superfund (RAGS), Volume 1, Human Health Evaluation Manual, Part A* (USEPA, 1989), *Risk Assessment Guidance for Superfund, Volume 1, Human Health Evaluation Manual, Part D* (USEPA, 1997a), and USEPA Region III Technical Guidance Manuals for Risk Assessment.

The results of the Site 5 baseline HHRA will be used to document the potential for endangerment to human health, to provide a basis to select action levels, and to assist in identifying media that may need to be addressed through remedial action.

7.1.1 Scope of Risk Assessment

The HHRA for Site 5 comprises the following components:

- **Identification of Chemicals of Potential Concern (COPCs) -** identifies and characterizes the distribution of COPCs found on the site. Chemicals identified in this screening are the focus of the subsequent evaluation in the risk assessment.
- **Exposure Assessment -** identifies potential exposure pathways; characterizes the potentially exposed populations (e.g., industrial workers, construction workers, residents); and estimates the magnitude, frequency, and duration of exposures.
- **Toxicity Assessment -** identifies the types of adverse health effects associated with exposure to COPCs, lists available toxicity factors (e.g., cancer slope factors and reference dose values), and summarizes the relationship between magnitude of exposure and occurrence of adverse health effects. It also identifies related uncertainties (such as the weight-of-evidence for carcinogenicity of a particular chemical in humans) associated with these values.
- **Risk Characterization -** integrates the results of the exposure assessment and toxicity assessment to estimate the potential risks to human health. Both cancer and noncancer human health effects are evaluated. Pathways that pose an unacceptable risk based on quantitative risk characterization are identified.
- **Uncertainty Assessment -** identifies sources of uncertainty associated with the data, methodology, and the values used in the risk assessment estimation.

These components are described briefly in the following sections. Spreadsheets prepared in accordance with USEPA RAGS Part D were used to screen for COPCs, and to calculate estimated exposures and health risks associated with the COPCs. These spreadsheets are presented in Appendix F, Tables 1 through 10.8.CT.

7.2 Identification of Chemicals of Potential Concern

The identification of COPCs includes data collection, data evaluation, and data screening steps. The data collection and evaluation steps involve gathering and reviewing the available site data and identifying a set of data that is of acceptable quality for the risk assessment. This data set is then further screened against concentrations that are protective of human health to reduce the data set to those chemicals and media of potential concern. The data used for the quantitative risk analysis were all validated and met Data Quality Objectives (DQOs) prior to use in the risk assessment.

Section 7.2.1 discusses the selection of data used for the quantitative risk assessment. Section 7.2.2 discusses the methodology used to further reduce the risk assessment data set to the constituents and media which are of primary concern to human health and Section 7.2.3 identifies the COPCs that were quantitatively assessed in the risk assessment.

7.2.1 Data Evaluation and Selection

Several remedial investigation and remedial action activities within the CERCLA and IRP processes have been conducted at ABL. A discussion of the remedial investigation and remedial actions conducted at Site 5 is included in Section 2.

Data are available for constituents in the surface water and sediment of the North Branch Potomac River, and groundwater from alluvial and bedrock aquifers at Site 5. Table 7-1 summarizes the samples that were used to estimate potential exposures and risks in each of these media.

Data selected for evaluation in the HHRA were reviewed to determine their reliability for the quantitative risk assessment. A review of the data and discussions with USEPA and the Navy identified the following criteria for data usability:

- Estimated values flagged with a J qualifier were treated as unqualified detected concentrations and were included in the calculation of summary statistics without modification.
- Data qualified with an R (rejected) were not used in the risk assessment.
- Data qualified with a B (blank contamination) were used in the risk assessment as if they were non-detects, with the B-flagged reported concentration used as the sample quantitation limit. One-half of the B-flagged reported concentrations were used to calculate exposure point concentrations.
- One-half of the sample quantitation limit (SQL) or sample detection limit (DL) was used in the risk assessment for cases where no detectable contaminant quantities were found in that sample, but the contaminant was detected in other samples from a medium.

- For duplicate samples, the maximum concentration of the primary and duplicate samples was used as the sample concentration. In calculating the frequency of detection and the 95 percent upper confidence limit of the mean (UCL), the sample and corresponding duplicate were counted as a single sample.

7.2.2 Data Summary

All of the data used in the risk assessment have been validated and are assumed to represent current conditions. For each medium (surface water, sediment, and groundwater), chemical-specific summary statistics are presented in Appendix F for the data sets used for the risk calculations. These summary statistics include frequency of detection, minimum and maximum detected values, normal and lognormal arithmetic mean, normal and lognormal standard deviation, results of W-test, and 95 percent UCL for normal and lognormal distribution. Methods for calculating exposure point concentrations, including the 95 percent UCL values, are discussed in Section 7.3.3.

7.2.2.1 Surface Water and Sediment

Surface water and sediment samples from the North Branch Potomac River were collected adjacent to Site 5 in 1994 (sediment only), 1998 (sediment only), 2000, 2001, and 2002. Sediment samples were analyzed for low concentration VOCs, TCL SVOCs, cyanide, explosives, and TAL metals. The surface water samples were analyzed for low concentration VOCs, cyanide, and TAL metals (total and dissolved). Table 7-1 summarizes each sample and the corresponding analysis. A statistical summary of constituents detected in the surface water and sediment are presented in Appendix F, Tables F-5 and F-6.

7.2.2.2 Groundwater

Groundwater samples have been collected during 13 sampling events at Site 5. Sample results from the alluvial aquifer downgradient from the site between the landfill and the river and the bedrock aquifers were used in the HHRA. The risk assessment used only the most recent round of sampling results - alluvial aquifer and bedrock aquifer groundwater data from February 2002.

7.2.3 Selection of Chemicals of Potential Concern (COPCs)

All of the detected constituents were screened in accordance with USEPA Region III guidelines (USEPA, 1993a), using the steps described below. The COPC selection process was conservative to ensure selection of the constituents comprising the majority of the potential risk associated with the site. The maximum detected concentration of each constituent in each medium was compared to a screening value (typically a risk-based concentration) to select the COPCs for the medium. If the maximum concentration of a constituent exceeded the screening value, the constituent was selected as a COPC and retained for the risk evaluation.

- **Comparison with Health-based Criteria for Surface Water:** The maximum detected chemical concentrations in surface water were compared to ten times USEPA Region III tap water RBCs (USEPA, 2002). Tap water RBCs based on noncarcinogenic effects were divided by ten to account for exposure to multiple constituents, but were then multiplied by ten to account for surface water comparison, as noted above. RBCs based

on carcinogenic effects were used as presented in the RBC table, but were then multiplied by ten to account for surface water comparison, as noted above. Constituents with maximum detected concentrations below the adjusted RBCs were not retained as COPCs. Lead concentrations in surface water were compared to the action level of 15 µg/L. If the lead concentration exceeded that screening value, it was discussed qualitatively in the toxicity assessment section for recreational users.

- **Comparison with Health-based Criteria for Sediment:** The maximum detected chemical concentrations in sediment were compared to ten times the USEPA Region III residential soil RBCs (USEPA, 2002). RBCs based on noncarcinogenic effects were divided by ten to account for exposure to multiple constituents, but were then multiplied by ten to account for sediment comparison, as noted above. RBCs based on carcinogenic effects were used as presented in the RBC table, but were then multiplied by ten to account for sediment comparison, as noted above. Constituents with maximum detected concentrations below the adjusted RBCs were not retained as COPCs. Lead concentrations in sediment were compared to the USEPA residential child soil screening value of 400 mg/kg, as determined by the Integrated Exposure Uptake Biokinetic Model (IEUBK). If the lead concentration exceeded the screening value, it was discussed qualitatively in the toxicity assessment section for recreational users.

- **Comparison with Health-based Criteria for Groundwater:** The maximum detected chemical concentrations in the alluvial and bedrock aquifers were compared to the USEPA Region III tap water RBCs (USEPA, 2002). The screening-level RBCs for noncarcinogens were adjusted (i.e., divided by ten) to reflect a target hazard quotient of 0.1. The screening-level RBCs for carcinogens are based on a target cancer risk of $1x10^{-6}$ and were not adjusted from the values presented in the RBC table.

  USEPA has presented guidance on evaluating lead concentrations in drinking water. Lead concentrations less than 15 µg/L in groundwater (the Safe Drinking Water Act action level for lead in potable water) are considered adequately protective of human health under residential land-use conditions. exceedence of this value prompts further evaluation to assess the potential for human health impacts. Therefore, the lead groundwater action level of 15 µg/l was used to screen the groundwater lead data.

- **Comparison with Recommended Dietary Allowances (RDAs):** Chemicals that are human nutrients, present at low concentrations (i.e., only slightly elevated above naturally occurring levels), and toxic only at very high doses were eliminated from the quantitative risk analysis. These constituents are calcium, magnesium, potassium, and sodium.

Constituents may be considered for inclusion in the risk assessment even if they have been eliminated through one of the methods above based on historical information, exceptional toxicity, mobility, persistence, or bioaccumulation, special treatability problems, or non-compliance with ARARs.

7.2.4 Chemicals of Potential Concern

Table 7-2 identifies the chemicals that were selected as COPCs based on the above screening methodology for surface water, sediment, and groundwater. A summary of the COPC screening for each media is shown in Appendix F, Tables F.2.1 through F.2.8.

7.3 Exposure Assessment

Exposure refers to the potential contact of an individual with a chemical. The exposure assessment identifies pathways and routes by which an individual may be exposed to the COPCs and estimates the magnitude, frequency, and duration of potential exposure. The magnitude of exposure is determined by estimating the amount of a constituent available at the exchange boundaries (i.e., the lungs, gastrointestinal tract, and skin). Chemical intakes and associated health risks are only quantified for complete exposure pathways.

Contaminant fate and transport are evaluated in Section 6, which discusses the potential release mechanisms at the site. A conceptual exposure model showing potential exposure scenarios identified under current and potential future conditions is presented in Figure 7-1. The following sections discuss the three components of exposure assessment:

- Characterization of exposure setting
- Identification of exposure pathways
- Quantification of exposure

7.3.1 Characterization of Exposure Setting

Characterizing an exposure setting consists of two parts: (1) presenting the physical characteristics of the site as they relate to exposure, and (2) characterizing human populations on or near the site.

7.3.1.1 Physical Characteristics

Basic site characteristics such as physical setting, climate, groundwater hydrology, and the presence and location of surface water were summarized in Section 2 and Section 4.

7.3.1.2 Potentially Exposed Populations

Potentially exposed populations are identified based on their locations relative to the site, their activity patterns, and the presence of potential sensitive subpopulations. Table 7-3 summarizes the potentially exposed populations evaluated in this risk assessment.

Current Land Use. As noted in Section 2, Site 5 is a capped, former landfill adjacent to the North Branch Potomac River. Other than monthly site inspections and periodic sampling events, there are no regular human activities at the site.

Land access to the site is currently restricted to onsite workers by fences and security guards. It is possible to access the site via the North Branch Potomac River, but the presence of perimeter fencing and “No Trespassing” signs is meant to discourage this activity.

Access to the North Branch Potomac River, which borders the site on the west, is unrestricted, and the river is used for recreational purposes. For this reason, adult and adolescent recreational users could wade in the river and be exposed to contaminants in surface water and sediment, if present.

Groundwater is not currently used as a potable water supply at Site 5. The closest potable groundwater supply is located approximately 2,000 feet upgradient of Site 5. These water supply wells do not appear to be influencing groundwater flow directions at Site 5. The

current understanding of groundwater flow directions and contaminant distribution at Site 5 supports this assertion. Therefore, pathways associated with current groundwater use at the facility are incomplete and were not included in the quantitative risk analysis.

Potential Future Uses. Site 5 is anticipated to remain an industrial area in the future. However, the most conservative future use of the site is residential development. As such, the use of alluvial and bedrock groundwater at Site 5 as domestic potable water supplies was included in the risk analysis. Future adult and child residents could be chronically exposed through both direct and indirect contact with impacted alluvial and/or bedrock groundwater. Exposure routes comprise ingestion, dermal contact, and inhalation of vapors generated during showering. The Foster and Chrostowski Shower Model was used to estimate potential exposure by a residential adult to groundwater while showering.

In addition to the residential scenario, groundwater exposures were also quantitatively evaluated under a construction worker scenario. It was assumed that adult construction workers would be exposed through direct or indirect contact to alluvial groundwater that may seep into trenches or pits during future development activities at the site. This scenario is considered conservative and unlikely to occur in practice because, under normal excavation procedures, the water table would not be encountered or, if it was, the groundwater would be pumped to minimize or eliminate infiltration into the excavation. Because of the relative shallowness and small amount of water likely to be present in any construction excavation, exposure routes were assumed to be limited to dermal contact and inhalation of vapors.

It is assumed that the future use of the surface water and sediment is the same as the current scenario (i.e., recreational use).

7.3.2 Identification of Exposure Pathways

An exposure pathway can be described as a mechanism that moves a COPC from its source to an exposed population or individual, referred to as a receptor. An exposure pathway must be complete or exposure cannot occur. A complete exposure pathway has five elements:

- A source (e.g., chemical residues in soil)
- A mechanism for release and migration of chemicals (e.g., leaching)
- An environmental transport medium (e.g., soil, groundwater)
- A point or site of potential human contact (i.e., exposure point, e.g., contact with soil, drinking water)
- A route of intake (e.g., incidental ingestion of soil, ingestion of groundwater used as a drinking water source)

All five elements must be present for a pathway to be considered complete. If one or more elements are not present, then the pathway is incomplete and there is no possibility of exposure. The following subsections discuss the elements as they pertain to the site.

7.3.2.1 Contaminant Sources

Contaminant sources at Site 5 comprise inert wastes generated by ABL. Inert wastes were defined as wastes not contaminated with explosives or generated at an area on the facility where explosives were managed.

7.3.2.2 Release and Transport Mechanisms

The fate and transport of chemicals in surface water, sediment, and groundwater are determined by physical characteristics of the site as well as by the chemical and physical properties of the constituents. A detailed description of the fate and transport analysis of the site conditions is included in Section 6 of this report.

7.3.2.3 Potential Exposure Points and Exposure Routes

Exposure points are locations where humans could come in contact with contamination. On-site exposure points include surface water, sediment, and groundwater.

Potential exposure routes are evaluated for current and potential future site use. Existing and potential exposure pathways are illustrated in the conceptual exposure model (Figure 7-1). Exposure scenarios and potentially complete pathways of exposure evaluated in this risk assessment are presented in Table 7-3.

Current Exposure Routes. As identified in Section 7.3.1.2, the current land use exposure routes are:

- Recreational person (adult and adolescent): incidental ingestion of and dermal contact with surface water and sediment;

Future Exposure Routes. As identified in Section 7.3.1.2, the future land use exposure routes are:

- Residents: inhalation of VOCs from groundwater while showering (adults), ingestion of groundwater (adults and children), and dermal contact with groundwater (children), all of which include both the alluvial and bedrock groundwater;
- Recreational person (adult and adolescent): incidental ingestion of and dermal contact with surface water and sediment;
- Construction Worker: incidental ingestion of and dermal contact with alluvial groundwater.

The exposure pathways listed above were selected in consultation with USEPA Region III and the Navy, and were documented in Interim Deliverable Table 1. All of these pathways were quantified for potential exposure. The exposure concentrations used to calculate potential risks to each of the receptors are presented in Appendix F, Tables 3.1 through 3.8. The exposure parameters and equations used to calculate the risks are presented in Appendix F, Tables 4.1 through 4.14.

7.3.3 Quantification of Exposure

Exposure is quantified by estimating the exposure point concentrations (EPCs) and chemical intake by the receptor for both the reasonable maximum exposure (RME) and central tendency (CT) scenarios.

7.3.3.1 Exposure Point Concentrations

EPCs are estimated chemical concentrations that a receptor may contact and are specific to each exposure medium. EPCs may be directly monitored or estimated using environmental fate and transport models. For this assessment, fate and transport modeling was used to estimate constituent concentrations in vapors from groundwater while showering, and in vapors volatilized from groundwater from an open excavation. Per discussions with USEPA, volatilization while showering was estimated using the Foster and Chrostowski model (Foster and Chrostowski, 1987, as shown in Appendix F, Table 7.8.RME Supplement). Volatilization from groundwater in an open excavation was estimated using a two-film volatilization model (as shown in Appendix F, Table 7.9.RME Supplement).

The EPC for the RME scenario and the CT scenario is based on the 95 percent UCL for a medium in which five or more samples were collected. The maximum detected concentration was used in place of the 95 percent UCL when the calculated 95 percent UCL was greater than the maximum detected value, or there were fewer than five samples in the data set. The Shapiro-Wilks W-test using an alpha value of one percent was used to determine if the data fit a lognormal or normal distribution. If the W-test was inconclusive, the 95 percent UCL that best fit the data as indicated by the higher W-test value was used.

The 95 percent UCL for a lognormal distribution was calculated as follows:

$$95 \text{ percent UCL} = \exp(TM + 0.5 \times s^2 + (s \times H/(n-1)^{0.5}))$$

Where:

exp	=	natural log
TM	=	transformed mean
s	=	standard deviation of the transformed data
H	=	H-statistic
n	=	sample size

The 95 percent UCL for a normal distribution was calculated as follows:

$$95 \text{ percent UCL} = NM+(t \times s/(n)^{0.5})$$

Where:

NM	=	normal arithmetic mean
t	=	t-statistic
s	=	standard deviation
n	=	sample size

In estimating the 95 percent UCL, data were evaluated for usability based on the factors identified by USEPA (Section 7.2.1). The 95 percent UCL concentrations are included in Appendix F, Table 3.1 through 3.8.

7.3.3.2 Estimation of Chemical Intakes for Individual Pathways

Chemical intake is the amount of the chemical contaminant entering the receptor's body. Chemical intakes are generally expressed as follows:

$$I = \frac{C \ x \ CR \ x \ EF \ x \ ED}{BW \ x \ AT} = (mg/kg/day)$$

Where:

I	=	intake (mg/kg-day)
C	=	chemical concentration at exposure point (mg/L, mg/kg, mg/m^3)
CR	=	contact rate, or amount of contaminated medium contacted per unit time or event (L/day, mg/event, m^3/day)
EF	=	exposure frequency (days/year)
ED	=	exposure duration (years)
BW	=	body weight of exposed individual (kg)
AT	=	averaging time, or period over which exposure is averaged (days)

The intake equation requires specific exposure parameters for each exposure pathway. Exposure parameters are often assumed values, and their magnitude influences the estimates of potential exposure (and risk). The reliability of the values chosen can also contribute substantially to the uncertainty of the resulting risk estimates. Many of the exposure parameters have default values, which were used for this assessment. These assumptions, based on estimates of body weights, media intake levels, and exposure frequencies and duration, are provided by USEPA guidance. Other assumptions (e.g., exposure duration for the construction worker) required consideration of location-specific information and were determined using professional judgment. Appendix F, Tables 4.1 through 4.14 present the exposure factors used for different scenarios at the site. Both RME and CT intakes were included in this evaluation. CT intakes were calculated for exposure scenarios with RME cumulative cancer risks greater than $1x10^{-4}$ or cumulative noncancer hazards greater than 1.

For residential exposure to groundwater, lifetime age-adjusted intakes were calculated for carcinogenic constituents. This involved determining age-adjusted factors for ingestion.

For dermal exposure to groundwater during construction and bathing, the non-steady state model or pseudo steady-state model was used to estimate the absorbed dose for organic constituents (USEPA, 1992a). If the exposure time was shorter than the lag time (time to reach pseudo steady state), the non-steady state model was used. These models are shown for groundwater exposure pathways in the Table 4s in Appendix F. The only COPC for the surface water was an inorganic constituent; therefore, it was not necessary to use the non-steady-state or pseudo state-state model for estimating dermal exposure to surface water.

7.4 Toxicity Assessment

Toxicity assessment defines the relationship between the magnitude of exposure and possible severity of adverse effects, and weighs the quality of available toxicological evidence. Toxicity assessment generally consists of two steps: hazard identification and dose-response assessment. Hazard identification is the process of determining the potential adverse effects from exposure to the chemical along with the type of health effect involved. Dose-response assessment is the process of quantitatively evaluating the toxicity information and characterizing the relationship between the dose of the contaminant administered or received and the incidence of adverse health effects in the exposed population. Toxicity criteria (e.g., reference doses and slope factors) are derived from the dose-response relationship. USEPA has performed the toxicity assessment step for many chemicals and has published the results in the Integrated Risk Information System (IRIS; USEPA, 2000a) and Health Effects Assessment Summary Tables (HEAST) databases.

Health effects are divided into two broad groups: noncarcinogenic and carcinogenic effects. This division is based on the different mechanisms of action currently associated with each category. Chemicals causing noncarcinogenic health effects are evaluated independently from those having carcinogenic effects. Some chemicals may produce both noncarcinogenic and carcinogenic effects, and are therefore evaluated in both groups. This section discusses noncarcinogenic and carcinogenic effects separately, and concludes with a brief discussion of the toxicological properties of selected COPCs.

The primary source of toxicity values is the USEPA's IRIS database, which contains up-to-date health risk and USEPA regulatory information. IRIS includes only reference doses (RfDs) and slope factors (SFs) that have been verified by USEPA work-groups. The IRIS database is the USEPA's preferred source of toxicity information. The HEAST, which are issued by USEPA's Office of Solid Waste and Emergency Response, were consulted when data were not available in IRIS. If data were not available from either of these sources, toxicity values provided in USEPA's *Risk-Based Concentration Table* (USEPA, 2002) were used.

7.4.1 Toxicity Information for Noncarcinogenic Effects

Noncarcinogenic health effects include a variety of toxic effects on body systems, such as renal toxicity (toxicity to the kidneys) to central nervous system disorders. Noncarcinogenic health effects can be grouped into two basic categories: acute toxicity and chronic toxicity. Acute toxicity can occur after a single exposure (usually at high doses), and the effect is most often seen immediately. Chronic toxicity generally occurs after repeated exposure (usually at low doses) and is seen months or years after the initial exposure. The toxicity of a chemical is assessed through a review of toxic effects noted in short-term (acute) animal studies, long-term (chronic) animal studies, and epidemiological investigations of exposed human populations, typically in the workplace.

USEPA (USEPA, 1989) defines the chronic RfD as a dose that is likely to be without appreciable risk of deleterious effects during a lifetime of exposure. Chronic RfDs are specifically developed to be protective for long-term exposure to a compound (for example, 7 years to a lifetime), and consider uncertainty in the toxicological database and sensitive

receptors. Chronic RfDs may be overly protective if used to evaluate the potential for adverse health effects resulting from short-term exposure. USEPA's NCEA develops subchronic RfDs for short-term exposure (2 weeks to 7 years). Chronic and subchronic RfDs are developed for both the inhalation and oral exposures. Subchronic RfDs were used for the construction worker scenario because the exposure duration is 1 year.

In the development of RfDs, all available studies examining the toxicity of a chemical following exposure are considered based on their scientific merit. The lowest dose level at which an observed toxic effect is occurring is identified as the "lowest-observed-adverse-effect-level" (LOAEL) and the dose at which no effect is observed is identified as the "no-observed-adverse-effect-level" (NOAEL). Several uncertainty factors (UFs) may be applied to account for uncertainty. UFs account for uncertain data quality, extrapolation of data from animal studies to human exposures, or the use of subchronic studies to develop chronic criteria. These UFs range between 10 to 10,000, and reflect the varying degrees of uncertainty in the toxicity criteria.

USEPA-derived oral and inhalation chronic RfDs, and associated UF and modifying factor (MF) values, available for the COPCs at Site 5 are listed in Tables 5.1 and 5.2, in Appendix F.

Per USEPA guidance, oral RfD values were adjusted from administered dose to absorbed dose for evaluating dermal toxicity. The RfD was adjusted using oral absorption factors from USEPA (USEPA, 1999a) and comments provided by USEPA. The adjusted dermal RfDs are summarized in Table 5.1 in Appendix F.

7.4.2 Toxicity Information for Carcinogenic Effects

Potential carcinogenic effects from human exposure to chemicals are estimated quantitatively using oral and inhalation cancer slope factors (CSFs). CSFs may be derived from the results of chronic animal bioassays, human epidemiological studies, or both. Animal bioassays are usually conducted at dose levels that are much higher than levels likely to be produced by human exposure to environmental media. This design detects possible adverse effects in the relatively small test populations used in the studies. These high dose levels must be extrapolated to lower doses. A number of mathematical models and procedures have been developed to extrapolate from the high doses used in the studies to the low doses typically associated with environmental exposures.

The USEPA-preferred linearized multistage (LMS) model is usually used to estimate the largest linear slope (within the upper 95 percent UCL) at low extrapolated doses that is consistent with the data. The 95 percent UCL slope of the dose-response curve is subjected to various adjustments, and an inter-species scaling factor is usually applied to derive a CSF or inhalation unit risk factor for humans. It is assumed that if a cancer response occurs at the dose level in the study, there is some probability that a response will occur at all lower exposure levels (i.e., a dose-response relationship with no threshold is assumed). Dose-response data derived from human epidemiological studies are fitted to dose-time-response curves on an ad hoc basis. In both types of analyses, conservative (e.g., health protective) assumptions are applied and the models are believed to provide rough estimates of the upper limits on potential lifetime risk.

USEPA-derived oral and inhalation cancer slope factors are listed in Tables 6.1 and 6.2 in Appendix F, respectively. Per USEPA guidance, oral CSF values were adjusted from administered dose to absorbed dose for evaluating dermal toxicity. The CSF was adjusted using oral absorption factors from USEPA (USEPA, 1999a) and comments provided by USEPA. The adjusted dermal RfDs are summarized in Table 6.1 in Appendix F.

In addition to deriving a quantitative estimate of cancer potency, USEPA also assigns weight-of-evidence classifications to potential carcinogens. Chemicals are classified as Group A, Group B1, Group B2, Group C, Group D, or Group E carcinogens.

- Group A chemicals (known human carcinogens) are agents for which there is sufficient evidence to support the causal association between exposure to the agents in humans and cancer.
- Group B1 chemicals (probable human carcinogens) are agents for which there is limited evidence of possible carcinogenicity in humans with sufficient evidence of carcinogenicity in laboratory animals.
- Group B2 chemicals (probable human carcinogens) are agents for which there is sufficient evidence of carcinogenicity in animals but inadequate evidence in humans.
- Group C chemicals (possible human carcinogens) are agents for which there is limited evidence of carcinogenicity in animals and inadequate or a lack of human data.
- Group D chemicals (not classifiable as to human carcinogenicity) are agents with inadequate human and animal evidence of carcinogenicity or for which no data are available.
- Group E chemicals (evidence of noncarcinogenicity in humans) are agents for which there is no evidence of carcinogenicity from human or animal studies, or both.

7.4.3 Chemicals for Which no USEPA Toxicity Values Are Available

Most of the chemicals detected at the site have toxicity factors. Lead does not have available published toxicity factors. Lead is regulated by USEPA based on blood-lead uptake using a physiologically-based pharmacokinetic model referred to as the IEUBK model. As a screening tool, lead is screened at 400 mg/kg in sediment, and 15 µg/L in surface water and groundwater. Additionally, acenaphthylene, 1-methylnaphthalene, 3- and 4-methylphenol, phenanthrene, and benzo(g,h,i)perylene do not have available published toxicity factors. The RBC for naphthalene was used as a surrogate for screening acenaphthylene and 1-methylnapyrene. The RBC for 4-methylphenol was used as a surrogate for 3- and 4-methylphenol, and the RBC for pyrene was used as a surrogate for phenanthrene and benzo(g,h,i)perylene, based on previous recommendations for USEPA Region III.

7.4.4 Toxicity Profiles of Selected Chemicals

Detailed toxicity information for the COPCs can be found in USEPA's IRIS database, Agency for Toxic Substances and Disease Registry (ATSDR) toxicological profiles, and other published literature.

7.5 Risk Characterization

Risk characterization is the process of integrating the previous elements of the risk assessment into quantitative and semi-quantitative expressions of risk. The quantification of risk is then used as an integral component in remedial decision-making and selection of potential remedies or actions.

7.5.1 Noncarcinogenic and Carcinogenic Risk Estimation Methods

Potential human health risks are discussed independently for carcinogenic and noncarcinogenic contaminants because of the different toxicological endpoints, relevant exposure duration, and methods used to characterize risk. The noncarcinogenic health impacts from carcinogens are also assessed.

7.5.1.1 Noncarcinogenic Risk Estimation

Noncarcinogenic health risks are estimated by comparing actual or expected exposure levels to threshold concentrations (or RfDs). The expected intake divided by the RfD is equal to the hazard quotient (HQ):

Hazard Quotient (HQ) = Intake / RfD

The intake and RfD are expressed in the same units and represent the same exposure period (i.e., chronic or subchronic). The intake and RfD also represent the same exposure route, (i.e., inhalation intakes are divided by the inhalation RfD, oral intakes are divided by the oral RfD, and dermal intakes are divided by an adjusted oral RfD). When HQ exceeds unity (i.e., exposure exceeds the RfD), a certain degree of health risk is indicated. To assess the potential for noncarcinogenic health effects posed by exposure to multiple chemicals, a "hazard index" approach is used (USEPA, 1989). This approach assumes that noncarcinogenic hazards associated with exposure to more than one chemical are additive. Synergistic or antagonistic interactions between chemicals are not accounted for. The HI may exceed unity even if all of the individual HQs are less than one. The chemicals may then be segregated by similar mechanisms of toxicity and toxicological effects, and separate HIs derived based on mechanism and target organs affected.

7.5.1.2 Carcinogenic Risk Estimation

The potential for carcinogenic effects due to exposure to site-related contamination is evaluated by estimating excess lifetime cancer risk. Excess lifetime carcinogenic risk is the incremental increase in the probability of developing cancer during one's lifetime in addition to the background probability of developing cancer. The background probability of developing cancer from all known causes is about one in two for men and one in three for women. Therefore, a $2x10^{-6}$ excess lifetime carcinogenic risk means that an individual's probability of developing cancer in his or her lifetime changes from approximately 0.500000 to 0.500002. Or, expressed another way, for every 1 million people exposed to the carcinogen throughout their lifetime, the incidence of cancer *may* increase by two cases.

Potential carcinogenic risks associated with exposure to individual carcinogens were calculated using the CSFs from IRIS and HEAST presented in the Toxicity Assessment

section and the intakes calculated in the Exposure Assessment section. Risk is calculated by multiplying the intake by the CSF.

$$\text{Risk} = \text{Intake} \times \text{CSF}$$

The combined risk from exposure to multiple chemicals at a site was evaluated by adding the risks from individual chemicals. Risks were also added across the pathways if an individual would be exposed through multiple pathways. For example, a person contacting the surface water could be exposed by both the oral and dermal pathways.

When a cumulative carcinogenic risk to an individual receptor under the assumed RME exposure conditions at the site exceeds 100 in a million (10^{-4} excess cancer risk), CERCLA generally requires remedial action to reduce risks at the site (USEPA, 1991). If the cumulative risk is less than 10^{-4}, action generally is not required, but may be warranted if a risk-based chemical-specific standard (e.g., the MCL) is exceeded. A risk-based remedial decision could be superseded by the presence of noncarcinogenic impact or environmental impact requiring action at the site.

7.5.2 Risk Assessment Results

The results of the risk characterization are presented below. Total risks are summarized by receptor following the media specific discussions. A summary of the results by media is shown in Table 7-4 for the RME risk estimates and Table 7-5 for the CT risk estimates. The CT values were calculated only when the cumulative RME hazards exceeded 1 or the cumulative cancer risks exceeded 10^{-4}.

7.5.2.1 Surface Water Exposure

Surface water samples collected from the North Branch Potomac River adjacent to Site 5 in 2000, 2001, and 2002 were evaluated in the risk assessment. The surface water samples were analyzed for TCL VOCs, cyanide, and TAL metals (total and dissolved).

The RME risk estimates for exposure to surface water were calculated for an adult and adolescent recreational person under current/future site use (Appendix F, Tables 7.1.RME, 7.2.RME, 8.1.RME, and 8.2.RME). The calculated surface water RME risks are summarized in Table 7-4. It was assumed these receptors would be exposed to surface water through incidental ingestion and dermal contact.

Adult Recreational Person. The noncarcinogenic hazard associated with exposure to surface water by an adult recreational person (0.035) is below USEPA's target hazard index of 1.0 (Appendix F, Table 7.1.RME). The carcinogenic risk associated with exposure to the surface water by an adult recreational person ($6x10^{-6}$) is within the USEPA's target risk range of $1x10^{-6}$ to $1x10^{-4}$ (Appendix F, Table 8.1.RME).

None of the RME hazards or risks for an adult recreational person are above the USEPA target risk; therefore, CT HIs and CT carcinogenic risks were not calculated.

Adolescent Recreational Person. The noncarcinogenic hazard associated with exposure to an adolescent recreational person (0.036) is below USEPA's target hazard index of 1.0 (Appendix F, Table 7.2.RME). The carcinogenic risk associated with exposure to the surface

water by an adolescent recreational person ($2x10^{-6}$) is within the USEPA's target risk range of $1x10^{-6}$ to $1x10^{-4}$ (Appendix F, Section Table 8.2.RME).

None of the RME hazards or risks for an adolescent recreational person are above the USEPA target risk; therefore, CT HIs and CT carcinogenic risks were not calculated.

7.5.2.2 Sediment Exposure

Sediment samples were collected along the reach of the North Branch Potomac River adjacent to Site 5. RME risk estimates for exposure to sediment were calculated for an adult and adolescent other recreational person under current/future site use (Appendix F, Tables 7.3.RME, 7.4.RME, 8.3.RME and 8.4.RME). The calculated sediment RME risks are summarized in Table 7-4. It was assumed these receptors would be exposed to sediment through incidental ingestion and dermal contact.

Adult Other Recreational Person. The noncarcinogenic hazard associated with exposure to an adult recreational person (0.03) is below USEPA's target hazard index of 1.0 (Appendix F, Table 7.3.RME). The carcinogenic risk associated with exposure to the surface water by an adult recreational person ($8x10^{-7}$) is below the USEPA's target risk range of $1x10^{-6}$ to $1x10^{-4}$ (Appendix F, Table 8.3.RME).

None of the RME hazards or risks for an adult recreational person are above the USEPA target risk; therefore, CT HIs and CT carcinogenic risks were not calculated.

Adolescent Other Recreational Person. The noncarcinogenic hazard associated with exposure to an adolescent recreational person (0.03) is below USEPA's target hazard index of 1.0 (Appendix F, Table 7.4.RME). The carcinogenic risk associated with exposure to the surface water by an adolescent recreational person ($3x10^{-7}$) is below the USEPA's target risk range of $1x10^{-6}$ to $1x10^{-4}$ (Appendix F, Table 8.4.RME).

None of the RME hazards or risks for an adolescent recreational user are above the USEPA target risk; therefore, CT HIs and CT carcinogenic risks were not calculated.

7.5.2.3 Groundwater Exposure

Alluvial and bedrock groundwater beneath the site are not currently used as a potable water supply and will not likely be used as a potable water supply in the future. However, alluvial and bedrock groundwater beneath the site were evaluated as worst-case risk estimates for potable groundwater use.

Alluvial Groundwater. Risk estimates for exposure to alluvial groundwater were calculated for child and adult residents under potential future residential use of the site (Appendix F, Tables 7.5.RME, 7.6.RME, and 7.8.RME, and Tables 8.5.RME, 8.6.RME, and 8.8.RME, and summarized in Tables 7-4 and 7-5). It was assumed that a resident would drink the water and bathe with the water, the latter resulting in inhalation of volatiles (adult only) and dermal absorption (child only).

As noted earlier, lead is evaluated in a different manner than other constituents. Lead was detected in the alluvial groundwater at a maximum concentration of 17.4 µg/L, which exceeds the screening value. However, the lead models use the arithmetic mean concentrations to determine potential effects. Because the arithmetic mean lead

concentration (3.2 µg/L) is notably less than the screening level, it is not expected to have an adverse effect on the residential child or industrial worker.

Resident. The RME noncarcinogenic hazards associated with use of the alluvial groundwater as a potable residential water supply are above USEPA's benchmark noncarcinogenic HI of 1.0 for both the potential future child and adult resident. The noncarcinogenic hazards to a child and adult resident are 59 and 20, respectively. The hazard is primarily associated with ingestion of TCE, iron, and manganese, all of which have individual hazard indices above 1.

As discussed in Section 7.3.3.2, the carcinogenic risk for groundwater for the resident is presented as a lifetime age-adjusted risk. The RME carcinogenic risk associated with use of the groundwater as a potable residential water supply exceeds USEPA's benchmark range of $1x10^{-4}$ to $1x10^{-6}$. The residential lifetime carcinogenic risk calculated for Site 5 alluvial groundwater is $2.2x10^{-3}$. This risk is primarily associated with inhalation and ingestion of TCE.

Because both the RME noncarcinogenic hazard and carcinogenic risk for exposure to groundwater by a future adult and child resident exceed USEPA's benchmark values, CT exposure was evaluated for these scenarios. The CT risk estimates are summarized in Table 7-5 (and Appendix F, Tables 7.13.CT, 7.14.CT, 8.13.CT, 8.14.CT, and 8.15.CT). The calculated CT noncarcinogenic hazard (1.2) for an adult resident exceeds USEPA's target HI. The hazard is primarily associated with ingestion of TCE; however, none of the HIs for the individual COPCs present is above 1, and the hazards for exposure to the alluvial groundwater summed by target organ are also below 1. The CT noncarcinogenic hazard (23) for a child resident is also greater than USEPA's target HI. The hazard is primarily associated with ingestion of TCE, iron, and manganese, and dermal absorption of TCE in the groundwater. The CT carcinogenic risk ($4x10^{-4}$) for lifetime resident exceeds USEPA's benchmark range of $1x10^{-4}$ to $1x10^{-6}$. The risk is associated with inhalation and ingestion of TCE.

Construction Worker. Exposure to alluvial groundwater by a construction worker during excavation was evaluated as a potential future exposure scenario (Appendix F, Tables 7.7.RME, 7.9.RME, 8.7.RME, and 8.9.RME). The RME noncarcinogenic risk (5.6) is above USEPA's benchmark noncarcinogenic HI of 1.0. The hazard is primarily associated with dermal contact with TCE. The carcinogenic risk for exposure to groundwater by a construction worker ($9x10^{-6}$) is within USEPA's target risk range.

A CT hazard analysis was conducted for exposure to alluvial groundwater by a construction worker during excavation (Appendix F, Table 7.15.CT, and summarized in Tables 7-5). The resulting hazard (4.2) is above USEPA's target HI of 1.0. The risk is associated with dermal exposure to TCE.

Bedrock Groundwater. Risks estimated for exposure to bedrock groundwater were calculated for child and adult residents under potential residential use of the site (Appendix F, Tables 7.10.RME, 7.11.RME, 7.12.RME, 8.10.RME, 8.11.RME. and 8.12.RME). It was assumed that the resident would drink the water and bathe in the water, the latter resulting in inhalation of volatiles (adult only) and dermal absorption (child only).

Resident. The RME noncarcinogenic hazards associated with use of the bedrock aquifer groundwater as a potable residential water supply are above USEPA's benchmark noncarcinogenic HI of 1.0 for both the potential future child and adult resident. The noncarcinogenic hazards to a child and adult resident are 26 and 9.6, respectively. The hazard is primarily associated with ingestion of TCE, iron, and manganese in the groundwater.

The carcinogenic risk for groundwater for the resident is presented as a lifetime age-adjusted risk. The RME carcinogenic risk associated with use of the groundwater as a potable residential water supply equals USEPA's upper benchmark risk level of $1x10^{-4}$. This risk is primarily associated with TCE.

Because both the RME noncarcinogenic hazard and carcinogenic risks for exposure to bedrock groundwater by a future adult and child resident exceed USEPA's benchmark values, a CT exposure was evaluated for these scenarios. The CT risks estimated are summarized in Table 7-5 (and Appendix F, Tables 7.16.CT, 7.17.CT, 8.16.CT, and 8.17.CT). The calculated CT noncarcinogenic hazard for an adult resident (4.4) exceeds USEPA's target HI. The hazard is primarily associated with ingestion of iron. The CT noncarcinogenic hazard for a child resident (10) is also greater than USEPA's target HI. The hazard is primarily associated with ingestion of iron and manganese in the groundwater.

7.6 Uncertainty Associated with Human Health Risk Assessment

The risk measures used in risk assessments are not fully probabilistic estimates of risk, but are conditional estimates given that a set of assumptions about exposure and toxicity are realized. Thus it is important to specify the assumptions and uncertainties inherent in the risk assessment to place the risk estimates in proper perspective.

7.6.1 General Uncertainty in COPC Selection

The uncertainty in sampling and possibility of missing a contaminated location is expected to be minimal at this site because of the number of investigations conducted and the amount of sampling data available. The quantitative uncertainty associated with sampling activities is also minimal because the data were fully validated prior to use in the risk assessment. The general assumptions used in the COPCs selection are conservative to ensure estimation of highest possible risk.

7.6.1.1 Uncertainty Associated with Exposure Assessment

Most of the exposure pathways analyzed are assumed, and exposure factors used for quantitation of exposure are conservative and reflect worst-case or upper-bound assumptions. Exposure to the groundwater is assumed to occur at the highest detected concentrations for many of the receptors. However, it is unlikely that a potable well would drawn water solely from this area, and groundwater concentrations would likely decline over time due to dilution.

7.6.1.2 Uncertainty Associated with Toxicity Assessment

Uncertainties associated with the noncarcinogenic toxicity factors are included in Appendix F, Tables 5.1 and 5.2. The uncertainty associated with CSFs is mostly associated

with the low dose extrapolation where carcinogenicity at low doses is assumed to be straight-line responses. This is a conservative assumption, which introduces a high uncertainty into slope factors that are from this extrapolated area of the dose-response curve. However, most of the experimental studies indicate existence of a threshold for carcinogenicity.

Carcinogenic slope factors developed by the USEPA represent upper bound estimates. Any carcinogenic risks generated in this assessment should be regarded as an upper bound estimate on the potential carcinogenic risks rather than an accurate representation of carcinogenic risk. The true carcinogenic risk is likely to be less than the predicted value.

Additional uncertainty is in the prediction of relative sensitivities of different species of animals and the applicability of animal data to humans.

7.6.1.3 Uncertainty in Risk Characterization

The uncertainties identified in each component of risk assessment ultimately contribute to uncertainty in risk characterization. The addition of risks and HIs across pathways and chemicals contributes to uncertainty based on the interaction of chemicals such as additivity, synergism, potentiation, and susceptibility of exposed receptors.

In general, assessment of uncertainty is very important for sites with contaminant concentrations presenting a risk at the acceptable limit level with questionable exceedence (for example, slightly above the upper-bound risk ranges of 1 in 10,000 for carcinogenic risk or noncancer HI of 1.0).

7.7 Summary

This baseline risk assessment was conducted to evaluate the potential human health risks associated with exposure to site-related:

- Surface water and sediment from the North Branch Potomac River, and
- Alluvial and bedrock groundwater.

Potential risks were calculated for a current/future adult recreational person, a current/future adolescent recreational person, a future adult resident, a future child resident, a future lifetime resident, and a future construction worker. The potential risks calculated for the recreational person exposed to surface water and sediment were all within USEPA target levels.

Potable residential use of the alluvial or bedrock groundwater, or contact with the alluvial groundwater during excavation activities could result in carcinogenic risks or noncarcinogenic hazards greater than the USEPA target levels. Tables 7-4 and 7-5 summarize the risks and hazards across media for the RME and CT scenarios, respectively. The following receptors have total calculated RME noncarcinogenic hazards or carcinogenic risks that exceed USEPA's target levels:

- A future adult resident, child resident, age-adjusted resident, and construction worker exposed to alluvial groundwater,

- A future adult resident, child resident, and age-adjusted resident exposed to bedrock groundwater.

The main risk drivers for both the alluvial and bedrock groundwater are:

- TCE
- Iron
- Manganese

Although iron and manganese are identified as risk drivers in groundwater, the concentrations tend to decline to below RBCs as groundwater migrates away from the landfill. The surface water and sediment of the North Branch Potomac River have not been adversely impacted.

TABLE 7-1
Summary of Data Quantitatively Used in Risk Assessment
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Medium	Date of Sampling	Sample Locations	Parameters
Surface Water			
	08/03/2000	AS05-5SW01-R05	LC VOC, TAL Metal, Cyanide
	06/20/2001	AS05-5SW01-R06	LC VOC, TAL Metal (total and dissolved), Cyanide
	02/26/2002	AS05-5SW01-R07	LC VOC, TAL Metal,Cyanide
	02/26/2002	AS05-5SW01P-R07	LC VOC, TAL Metal, Cyanide
	08/03/2000	AS05-5SW02-R05	LC VOC, TAL Metal, Cyanide
	08/03/2000	AS05-5SW02P-R05[a]	LC VOC, TAL Metal, Cyanide
	06/20/2001	AS05-5SW02-R06	LC VOC, TAL Metal (total and dissolved), Cyanide
	06/20/2001	AS05-5SW02P-R06[b]	LC VOC, TAL Metal (total and dissolved), Cyanide
	02/25/2002	AS05-5SW02-R07	LC VOC, TAL Metal, Cyanide
	08/03/2000	AS05-5SW03-R05	LC VOC, TAL Metal, Cyanide
	06/20/2001	AS05-5SW03-R06	LC VOC, TAL Metal (total and dissolved), Cyanide
	02/26/2002	AS05-5SW03-R07	LC VOC, TAL Metal, Cyanide
	08/03/2000	AS05-5SW04-R05	LC VOC, TAL Metal, Cyanide
	06/20/2001	AS05-5SW04-R06	LC VOC, TAL Metal (total and dissolved), Cyanide
	02/25/2002	AS05-5SW04-R07	LC VOC, TAL Metal, Cyanide
Sediment			
	11/16/1994	5SD-1(94)	LC VOC, SVOC, EXPLO, TAL Metal, Cyanide
	11/16/1994	5SD-2(94)	LC VOC, SVOC, EXPLO, TAL Metal, Cyanide
	11/16/1994	5SD-2(94)/DUP [c]	LC VOC, SVOC, EXPLO, TAL Metal, Cyanide
	08/03/2000	AS05-5SD01-R05	LC VOC, SVOC, EXPLO, TAL Metal, Cyanide
	06/20/2001	AS05-5SD01-R06	LC VOC, SVOC, EXPLO, TAL Metal, Cyanide
	02/26/2002	AS05-5SD01-R07	LC VOC, SVOC, EXPLO, TAL Metal, Cyanide
	02/26/2002	AS05-5SD01P-R07 [d]	LC VOC, SVOC, EXPLO, TAL Metal, Cyanide
	02/27/2002	AS05-5SD01A	SVOC, EXPLO, TAL Metal, Cyanide
	02/27/2002	AS05-5SD01B	SVOC, EXPLO, TAL Metal, Cyanide
	05/08/1998	AS05-5SD02-R01	LC VOC, SVOC, EXPLO, TAL Metal, Cyanide
	05/08/1998	AS05-5SD02P-R01 [e]	LC VOC, SVOC, EXPLO, TAL Metal, Cyanide
	08/03/2000	AS05-5SD02-R05	LC VOC, SVOC, EXPLO, TAL Metal, Cyanide
	08/03/2000	AS05-5SD02P-R05 [f]	LC VOC, SVOC, EXPLO, TAL Metal, Cyanide
	06/20/2001	AS05-5SD02-R06	LC VOC, SVOC, EXPLO, TAL Metal, Cyanide
	06/20/2001	AS05-5SD02P-R06 [g]	LC VOC, SVOC, EXPLO, TAL Metal, Cyanide
	02/25/2002	AS05-5SD02-R07	LC VOC, SVOC, EXPLO, TAL Metal, Cyanide
	02/27/2002	AS05-5SD02A	SVOC, EXPLO, TAL Metal, Cyanide
	02/27/2002	AS05-5SD02B	SVOC, EXPLO, TAL Metal, Cyanide
	08/03/2000	AS05-5SD03-R05	LC VOC, SVOC, EXPLO, TAL Metal, Cyanide
	06/20/2001	AS05-5SD03-R06	LC VOC, SVOC, EXPLO, TAL Metal, Cyanide
	02/26/2002	AS05-5SD03-R07	LC VOC, SVOC, EXPLO, TAL Metal, Cyanide
	02/27/2002	AS05-5SD03A	SVOC, EXPLO, TAL Metal, Cyanide
	02/27/2002	AS05-5SD03B	SVOC, EXPLO, TAL Metal, Cyanide
	08/03/2000	AS05-5SD04-R05	LC VOC, SVOC, EXPLO, TAL Metal, Cyanide
	06/20/2001	AS05-5SD04-R06	LC VOC, SVOC, EXPLO, TAL Metal, Cyanide
	02/25/2002	AS05-5SD04-R07	LC VOC, SVOC, EXPLO, TAL Metal, Cyanide
	02/25/2002	AS05-5SD05	SVOC, EXPLO, TAL Metal, Cyanide
	02/25/2002	AS05-5SD05P [h]	SVOC, EXPLO, TAL Metal, Cyanide
	02/27/2002	AS05-5SD05A	SVOC, EXPLO, TAL Metal, Cyanide
	02/25/2002	AS05-5SD06	SVOC, EXPLO, TAL Metal, Cyanide
	02/27/2002	AS05-5SD06A	SVOC, EXPLO, TAL Metal, Cyanide
	02/25/2002	AS05-5SD07	SVOC, EXPLO, TAL Metal, Cyanide
	02/27/2002	AS05-5SD07A	SVOC, EXPLO, TAL Metal, Cyanide

TABLE 7-1
Summary of Data Quantitatively Used in Risk Assessment
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Groundwater - Alluvial Aquifer			
	02/01/2002	AS05-5GW07-R07	LC VOC, Inorg, Fmetals
	02/06/2002	AS05-5GW09-R07	LC VOC, Inorg, Fmetals
	02/07/2002	AS05-5GW11-R07	LC VOC, Inorg, Fmetals
	02/07/2002	AS05-5GW13-R07	LC VOC, Inorg, Fmetals
	02/06/2002	AS05-5GW17-R07	LC VOC, Inorg, Fmetals
	02/06/2002	AS05-5GW18-R07	LC VOC, Inorg, Fmetals
	02/04/2002	AS05-5GW19-R07	LC VOC, Inorg, Fmetals
	02/06/2002	AS05-5GW20-R07	LC VOC, Inorg, Fmetals
	02/04/2002	AS05-5GW21-R07	LC VOC, Inorg, Fmetals
	02/07/2002	AS05-5GW22-R07	LC VOC, Inorg, Fmetals
	02/07/2002	AS05-5GW22P-R07[i]	LC VOC, Inorg, Fmetals
	02/05/2002	AS05-5GW23-R07	LC VOC, Inorg, Fmetals
Groundwater - Bedrock Aquifer			
	02/05/2002	AS05-5GW02-R07	LC VOC, Inorg, Fmetals
	02/05/2002	AS05-5GW02P-R07[j]	LC VOC, Inorg, Fmetals
	02/05/2002	AS05-5GW03-R07	LC VOC, Inorg, Fmetals
	02/01/2002	AS05-5GW10-R07	LC VOC, Inorg, Fmetals
	02/01/2002	AS05-5GW14-R07	LC VOC, Inorg, Fmetals
	02/01/2002	AS05-5GW16-R07	LC VOC, Inorg, Fmetals

Notes:
LC = Low concentration
VOC = volatile organic constituents
SVOC = semivolatile organic constituents
Inorg = inorganic constituents
Fmetals = dissolved inorganic constituents
EXPLO = Explosives
a. duplicate of AS05-5SW02-R05
b. duplicate of AS05-5SW02-R06
c. duplicate of 5SD-2(94)/DUP
d. duplicate of AS05-5SD01-R07
e. duplicate of AS05-5SD02-R01
f. duplicate of AS05-5SD02-R05
g. duplicate of AS05-5SD02-R06
h. duplicate of AS05-5SD05
I. duplicate of AS05-5GW22-R07
j. duplicate of AS05-5GW02-R07

TABLE 7-2
Summary of Chemicals of Potential Concern for the HHRA
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Surface Water	Sediment	Groundwater	
		Alluvial Aquifer	Bedrock Aquifer
Arsenic	Arsenic	Trichloroethene	Trichloroethene
	Iron	cis-1,2-Dichloroethene	Cadmium
	Manganese	Aluminum	Iron
		Antimony	Manganese
		Arsenic	Nickel
		Barium	
		Iron	
		Lead	
		Manganese	
		Nickel	
		Thallium	

TABLE 7-3
Exposure Pathways
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Media	Exposure Route	Current/Future		Future		
		Recreational Person		Construction Worker	Resident	
		Adult	Adolescent		Adult	Child
Surface Water						
	Ingestion	X	X			
	Dermal	X	X			
	Inhalation					
Sediment						
	Ingestion	X	X			
	Dermal	X	X			
	Inhalation					
Groundwater - Columbia Aquifer						
	Ingestion				X	X
	Dermal			X		X
	Inhalation			X	X	
Groundwater - Bedrock Aquifer						
	Ingestion				X	X
	Dermal					X
	Inhalation				X	

Notes:

TABLE 7-4
Summary of RME Cancer Risks and Hazard Indices
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Receptor	Media	Exposure Route	Cancer Risk	Chemicals with Cancer Risks >10^{-4}	Chemicals with Cancer Risks >10^{-5} and <10^{-4}	Chemicals with Cancer Risks >10^{-6} and <10^{-5}	Hazard Index	Chemicals with HI>1
Future Recreational Adult	Surface Water	Ingestion	8.0E-08				0.0005	
		Dermal Contact	5.5E-06			Arsenic	0.034	
		Inhalation	NA				NA	
		Total	5.6E-06				0.035	
	Sediment	Ingestion	6.2E-07				0.02	
		Dermal Contact	1.8E-07				0.007	
		Inhalation	NA				NA	
		Total	8.0E-07				0.03	
	All Media	Total	6.4E-06				0.06	
Future Recreational Adolescent	Surface Water	Ingestion	4.1E-08				0.0007	
		Dermal Contact	2.1E-06			Arsenic	0.035	
		Inhalation	NA				NA	
		Total	2.2E-06				0.036	
	Sediment	Ingestion	3.2E-07				0.03	
		Dermal Contact	2.7E-08				0.003	
		Inhalation	NA				NA	
		Total	3.5E-07				0.03	
	All Media	Total	2.5E-06				0.07	
Future Resident Adult	Groundwater Alluvial	Ingestion	NA				20	Trichloroethene, iron, manganese
		Dermal Contact	NA				NA	
		Inhalation	1.1E-03	Trichloroethene			0.78	
		Total	1.1E-03				21	
	Groundwater Bedrock	Ingestion	NA				9.5	Iron, manganese
		Dermal Contact	NA				NA	
		Inhalation	6.1E-05		Trichloroethene		0.04	
		Total	6.1E-05				9.6	
	All Media	Total	1.1E-03				30	
Future Resident Child	Groundwater Alluvial	Ingestion	NA				54	Trichloroethene, iron, manganese
		Dermal Contact	5.1E-05		Trichloroethene		5.0	Trichloroethene
		Inhalation	NA				NA	
		Total	5.1E-05				59	
	Groundwater Bedrock	Ingestion	NA				26	Trichloroethene, iron, manganese
		Dermal Contact	2.9E-06			Trichloroethene	0.49	
		Inhalation	NA				NA	
		Total	2.9E-06				26	
	All Media	Total	5.3E-05				85	

TABLE 7-4
Summary of RME Cancer Risks and Hazard Indices
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Receptor	Media	Exposure Route	Cancer Risk	Chemicals with Cancer Risks >10^{-4}	Chemicals with Cancer Risks >10^{-5} and <10^{-4}	Chemicals with Cancer Risks >10^{-6} and <10^{-5}	Hazard Index	Chemicals with HI>1
Future Resident Child/Adult	Groundwater Alluvial	Ingestion	1.0E-03	Trichloroethene	Arsenic			
		Dermal Contact	5.1E-05		Trichloroethene			
		Inhalation	1.1E-03	Trichloroethene				
		Total	2.2E-03					
	Groundwater Bedrock	Ingestion	5.4E-05		Trichloroethene			
		Dermal Contact	2.9E-06			Trichloroethene		
		Inhalation	6.1E-05		Trichloroethene			
		Total	1.2E-04					
	All Media	Total	2.3E-03					
Future Construction Worker	Groundwater Alluvial	Ingestion	NA				NA	
		Dermal Contact	9.0E-06			Trichloroethene	5.6	Trichloroethene
		Inhalation	3.8E-07				0.035	
		Total	9.4E-06				5.6	
	All Media	Total	9.4E-06				5.6	

TABLE 7-5
Summary of CT Cancer Risks and Hazard Indices
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Receptor	Media	Exposure Route	Cancer Risk	Chemicals with Cancer Risks >10^{-4}	Chemicals with Cancer Risks >10^{-5} and <10^{-4}	Chemicals with Cancer Risks >10^{-6} and <10^{-5}	Hazard Index	Chemicals with HI>1
Future Resident Adult	Groundwater Alluvial	Ingestion	NA				1.2	
		Dermal Contact	NA				NA	
		Inhalation	2.7E-04	Trichloroethene			NA	
		Total	2.7E-04				1.2	
	Groundwater Bedrock	Ingestion	NA				4.4	Iron
		Dermal Contact	NA				NA	
		Inhalation	NA				NA	
		Total					4.4	
	All Media	Total	2.7E-04				5.6	
Future Resident Child	Groundwater Alluvial	Ingestion	NA				21	Trichloroethene, iron, manganese
		Dermal Contact	8.1E-06			Trichloroethene	2.4	Trichloroethene
		Inhalation	NA				NA	
		Total	8.1E-06				23	
	Groundwater Bedrock	Ingestion	NA				9.9	Iron, manganese
		Dermal Contact	NA				0.33	
		Inhalation	NA				NA	
		Total					10	
	All Media	Total	8.1E-06				33	
Future Resident Child/Adult	Groundwater Alluvial	Ingestion	1.6E-04	Trichloroethene	Arsenic			
		Dermal Contact	8.1E-06			Trichloroethene		
		Inhalation	2.7E-04	Trichloroethene				
		Total	4.4E-04					
	Groundwater Bedrock	Ingestion	NA					
		Dermal Contact	NA					
		Inhalation	NA					
		Total						
	All Media	Total	4.4E-04					
Future Construction Worker	Groundwater Alluvial	Ingestion	NA				NA	
		Dermal Contact	NA				4.2	Trichloroethene
		Inhalation	NA				NA	
		Total					4.2	
	All Media	Total					4.2	

Notes:
NA - Not Applicable, not evaluated

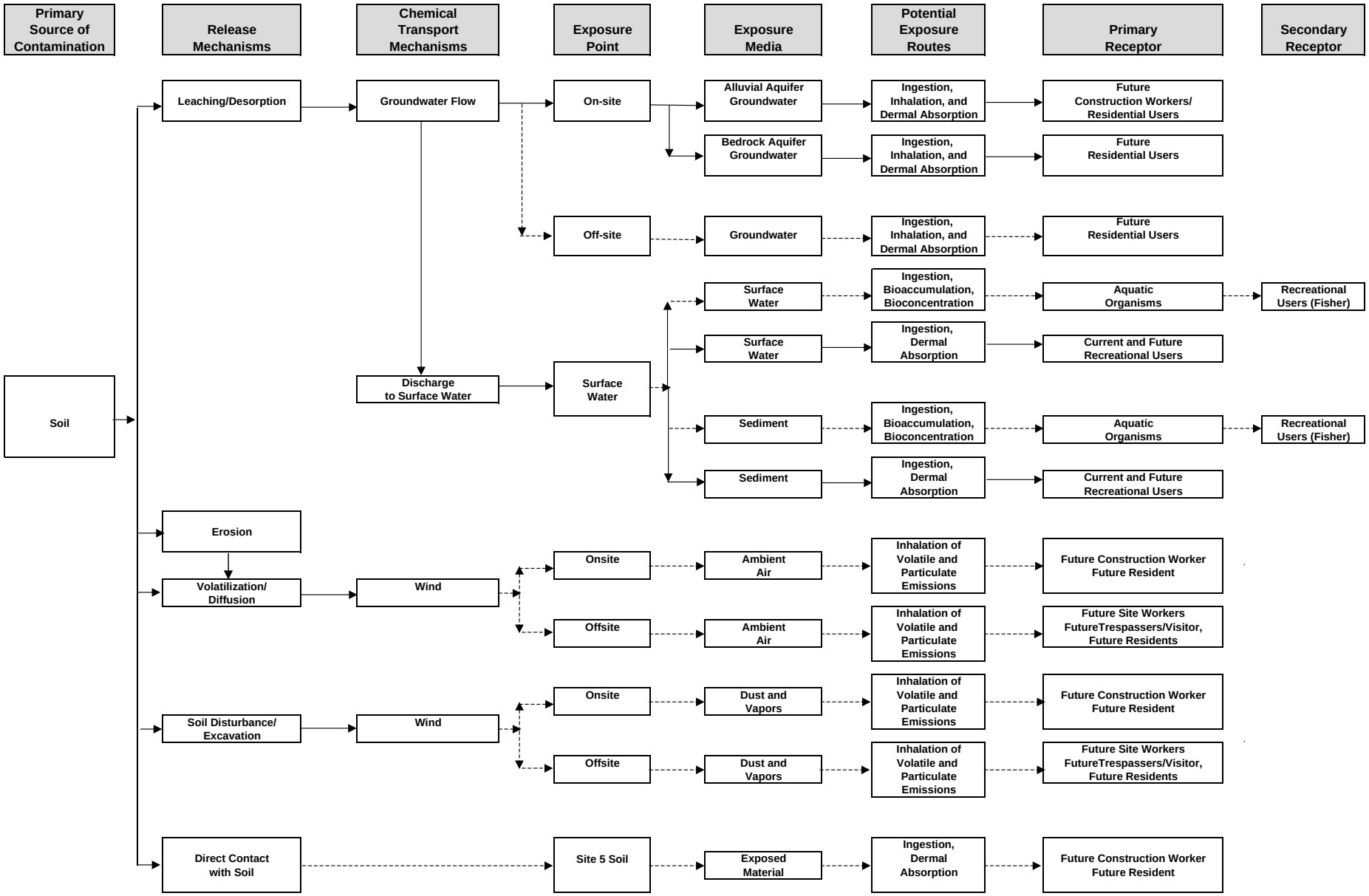

Figure 7-1

Conceptual Site Model for Potential Human Exposures

Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

SECTION 8

Ecological Risk Assessment

This chapter presents a screening ecological risk assessment (SERA), constituting Steps 1 and 2 of the ERA process, and the first step (Step 3) of a baseline ecological risk assessment (BERA) for Site 5.

8.1 Introduction

This section defines the scope and objectives of the ERA and describes the ERA process.

8.1.1 Scope of the ERA

Because the Site 5 landfill was capped in 1997, there are currently no complete exposure pathways to soils on the site. Thus, surface soils are not evaluated in this ERA. Also due to the presence of the landfill cap, chemical transport from the site to adjacent portions of the North Branch Potomac River via surface runoff is no longer a complete pathway, although surface runoff to the river is likely to have occurred in the past. In addition, the landfill cap will decrease the amount of chemical transport from the site to the river via groundwater by reducing the infiltration of precipitation. However, transport of chemicals via groundwater likely still occurs as a result of historical groundwater contamination. Thus, this ERA focuses on evaluating site-related chemicals in the sediment and surface water of adjacent portions of the river (which may be co-mingled with chemical contributions from upstream sources). Groundwater is evaluated in this ERA only as a potential transport medium.

As part of the Phase II Remedial Investigation (CH2M HILL, 1996b), a qualitative ERA was conducted at Site 5. The 1996 ERA involved a comparison of surface water, sediment, and surface soil data collected in 1994 with medium-specific screening values. The results of the 1996 ERA are not quantitatively considered in this ERA. Remedial actions conducted in 1997 (landfill cap) have altered the site conditions.

8.1.2 Ecological Risk Assessment Process

This ERA was conducted in accordance with the *Navy Policy for Conducting Ecological Risk Assessments* (CNO, 1999), the Navy guidance for implementing this ERA policy (NAVFAC, 2001), and the Navy/Tier II ERA approach developed for USEPA Region III. The Navy ERA policy/guidance, which describe a process consisting of eight steps organized into three tiers, are conceptually similar to the eight-step ERA process outlined in USEPA ERA guidance for the Superfund program (USEPA, 1997a). The major differences between the Navy ERA policy/guidance and the USEPA ERA guidance are: (1) the Navy policy/guidance provide clearly defined criteria for exiting the ERA process at specific points, (2) the Navy policy/guidance divide Step 3 (the first step of the BERA) into two distinct sub-steps (Steps 3A and 3B), with a potential exit point after Step 3A, and (3) the Navy policy/guidance incorporate risk management considerations throughout all tiers of the ERA process.

Below are explanations of the terms used to describe the chemical constituents evaluated during the ERA process:

- Chemicals of Potential Concern (COPCs) - identifies those chemicals retained following the SERA (Step 2).
- Potential Chemicals of Concern (PCOCs) - identifies those chemicals retained after Step 3A but before the risk evaluation.
- Chemicals of Concern (COCs) - identifies those chemicals retained following completion of Step 3 (A and B). These are the "risk drivers" and form the basis for any additional Step 4 studies.

Steps 1 and 2 of the ERA process constitute the SERA, which is conducted using intentionally conservative assumptions. If complete exposure pathways exist at a site and the results of the SERA indicate that risks are possible, the site normally continues on to Step 3 (the first step in the BERA) for the pathways, chemicals (termed COPCs at the end of Step 2), receptors, and areas identified in the SERA. As indicated above, Step 3 is divided into two distinct sub-steps in Navy ERA guidance.

Step 3 of the USEPA ERA guidance consists of the following activities (USEPA, 1997a):

1. Refinement of the COPCs from the SERA. In this ERA, the refined COPCs are termed PCOCs following the Step 3A refinement and COCs following the risk evaluation.
2. Further characterizing the potential ecological effects of contaminants.
3. Refining information on contaminant fate and transport, complete exposure pathways, and receptors potentially at risk.
4. Selecting assessment endpoints.
5. Refining the conceptual model and risk hypotheses from the SERA.

Step 3A of the Navy policy/guidance (refinement of conservative exposure assumptions) corresponds to the first activity listed above for the USEPA ERA guidance. In Step 3A, a refined evaluation of exposure estimates is conducted using more realistic assumptions and additional methodologies relative to those used in the SERA, which is intended to be a very conservative assessment. Examples of more realistic exposure assumptions include using central tendency (e.g., mean) estimates (rather than maximums) for media concentrations, bioaccumulation factors, and exposure parameters. Examples of additional methodologies include consideration of upgradient concentrations, detection frequency, and bioavailability (CNO, 1999; NAVFAC, 2001).

If risk estimates (and their associated uncertainty) are acceptable following Step 3A, the site will meet the conditions of the exit criterion specified in the Navy guidance. If the Step 3A evaluation does not support a determination of acceptable risk within acceptable uncertainty, the site continues to Step 3B.

Step 3B of the Navy policy/guidance (problem formulation) corresponds conceptually to the last four activities listed above for the USEPA ERA guidance. In Step 3B, the preliminary conceptual model from the SERA is refined based upon the results of the Step 3A evaluation

to develop a revised list of key receptors, complete and significant exposure pathways, COCs (risk drivers), assessment endpoints, measurement endpoints, and risk hypotheses. Based upon the revised conceptual model, the lines of evidence to be used in characterizing ecological risk are determined. Agreement on the revised conceptual model, COCs, exposure pathways, endpoints, and risk hypotheses constitutes the Scientific Management Decision Point (SMDP) at the end of Step 3 in both Navy and USEPA ERA guidance.

8.1.3 Objectives of the ERA

The objectives of the SERA are to:

- Determine if potential risks to ecological receptors warrant either: (1) additional assessment beyond the conservative screening steps of the ERA process (if unacceptable ecological risks are possible), or (2) the removal of the site from further ecological consideration (if no unacceptable ecological risks are likely).
- Focus subsequent steps of the ERA process on the specific chemicals, pathways, and receptors of potential concern if unacceptable ecological risks are possible.
- Identify any data gaps or areas of unacceptable uncertainty that may require the collection of additional data to support ERA evaluations beyond the screening level.

If the site is not screened out in the SERA, the evaluation continues to Step 3. The general objectives of the Step 3 ERA are to:

- Refine the risk estimates from the SERA to determine if risks to ecological receptors from site-related chemicals are likely to occur based upon realistic exposure scenarios.
- Focus subsequent data collection activities if potential risks are indicated, uncertainties are unacceptably high, and/or data gaps are identified.

At the conclusion of Step 3, there are three possible decision points:

- **No further action is warranted.** This decision is appropriate if the evaluation indicates that sufficient data are available on which to base a conclusion of no unacceptable risk within acceptable uncertainty.
- **Further data are required.** This decision is appropriate if the evaluation indicates that the potential for unacceptable risk exists and additional data to refine these estimates (e.g., additional analytical data, measures of bioavailability) are needed. In this case, the site continues to Step 4 of the ERA process.
- **Take remedial action.** This decision may be appropriate for circumstances in which the potential for unacceptable risks was identified but these potential risks could best be addressed through remedial action (e.g., presumptive remedy) rather than additional study.

8.2 Facility Environmental Setting

This section describes the environmental setting (e.g., habitats and biota) at the ABL facility. The description of the environmental setting at Site 5 is contained in Section 8.3.1.1 as part of

the screening problem formulation. A description of the facility history is contained in Section 2.2.

8.2.1 Physiographic Features

The major physiographic features (location, description, climate, topography, and surface water resources) of the ABL facility and surrounding area were described in Section 2.1. The geology and hydrogeology were described in Section 4. The specific features of Site 5 are described in Section 8.3.1.1.

8.2.2 Habitats

Plant 2 and the northern portion of Plant 1 are almost entirely developed. The remaining portion of Plant 1 (which includes Site 5) is situated on forested, mountainous land that is largely undeveloped. The land surrounding the ABL facility is primarily composed of woodland and cropland (A.T. Kearney, 1993). Across the river from ABL (in Maryland), cropland lies to the northeast and west, and a small residential area and woodlands lie to the north. The areas south and east of the ABL facility are composed largely of mountainous woodlands with some cropland and pastureland. Two limestone quarries occur south and east of the facility (A.T. Kearney, 1993). The quarry located to the east of Plant 1 has been inactive since 1989. The second quarry, which is actively used, is located south of the facility on Route 956 (Baker Environmental, Inc., 1997). A large paper mill, a regional publicly owned treatment works, and sources of acid mine drainage are located upstream of the ABL facility. Discharges from these sources are known to have historically impacted water quality and aquatic life in the North Branch Potomac River (ERM, 1996).

ERM (1996) has described the habitats present on and near the ABL facility. These habitat descriptions are provided below. Upland forest and developed (vegetated) are the main upland habitat types present on Site 5 and immediately surrounding area.

8.2.2.1 Terrestrial Habitats

The following terrestrial habitat types occur on or near the ABL facility (ERM, 1996):

- **Upland Forest**. This is the major terrestrial habitat type that occurs on the ABL facility (southern portion of Plant 1) and in surrounding areas. The dominant plant species in the overstory include white oak, scarlet oak, chestnut oak, black oak, red maple, sugar maple, pignut hickory, sassafras, Virginia pine, and pitch pine. Other species that are present in the overstory include tulip poplar, hackberry, white ash, black cherry, and basswood. The understory (higher elevations) is composed of woody shrubs including mountain laurel, azalea, striped maple, flowering dogwood, redbud, witch-hazel, wild grape, and lowbush blueberry. Woody shrubs and vines present at lower elevations include blackberry, poison ivy, multiflora rose, and Japanese honeysuckle. Ground cover plant species include ferns, mosses, violets, rue amenome, and twinleaf.

- **Successional Thicket/Forest**. This habitat type was observed at two locations: (1) within the ABL facility on hillsides just west of Route 956, and (2) near the town of MacKenzie. These areas were formerly cleared land that is now dominated by woody shrubs and small trees. The dominant tree species include Virginia pine, scarlet oak, red maple, black walnut, black cherry, and black locust. Shrub species include hawthorn, hackberry,

red cedar, flowering dogwood, and Virginia rose. Vines and ground cover species include wild grape, poison ivy, Virginia creeper, trailing pine, springcress, and redtop.

- **Successional Field/Thicket**. This habitat type occurs in two areas on the Maryland side of the North Branch Potomac River. These areas appear to be recently abandoned farmland that consists of a mixture of herbaceous plants and woody shrubs. Dominant herbaceous species include red clover, foxtail, orchard grass, Queen Anne's lace, yellow and white sweet clover, spreading dogbane, milkweed, goldenrod, wild onion, violet, springcress, and poison ivy. Shrub species include hawthorne, multiflora rose, and blackberry.
- **Agricultural Fields.** This habitat type encompasses agricultural fields that are currently farmed or are currently fallow. These fields are scattered throughout the ERM (1996) study area (2-mile [3-km] radius around Site 1) but are more common in the flatter areas on or near the river floodplain. Cropland includes corn, sorghum, barley, oats, wheat, buckwheat, cowpeas, alfalfa, and clover. Pastureland and fallow fields may contain bluegrass, other tall grass species, orchard grass, foxtail, redtop, brome sedge, crown vetch, wild onion, red clover, corn speedwell, henbit, bull thistle, pokeweed, mile-a-minute weed, goldenrod, evening primrose, teasel, daisy fleabane, Queen Anne's lace, yellow sweet clover, spreading dogbane, and milkweed.
- **Rock Outcrop.** Rock outcrops exist along portions of Knobly Mountain and along parts of the North Branch Potomac River. These areas consist of exposed rock that are either unvegetated or are vegetated with lichens, mosses, and other pioneering species. Caves and small caverns are scattered throughout this habitat type.
- **Quarry.** One active limestone quarry operation occurs near the top of Knobly Mountain just off of Route 956. This habitat type has minimal habitat value.
- **Developed (Vegetated).** This habitat type is scattered within the developed areas of Plants 1 and 2 and also occurs in surrounding residential areas. It is composed of a combination of buildings, other structures, roads, and maintained grass lawns. Mowing frequency varies by area, with some areas only infrequently mowed. Infrequent mowing allows other herbaceous species such as orchard grass, least hop clover, redtop, yellow hawkweed, English plantain, goatsbeard, wild onion, fescue, cheatgrass, heal-all, yellow and white sweet clover, yarrow, deer tongue grass, ox-eye daisy, curled dock, and switchgrass to become established.
- **Developed (Unvegetated).** This habitat type includes larger areas occupied by buildings, other structures, and parking lots. Large portions of Plant 1 (northern area) and Plant 2 are composed of this habitat type. The habitat value of these areas is limited due to the lack of vegetation but some urban-adapted species (e.g., rock doves) and species which nest on structures (e.g., barn swallows) may utilize these areas.

8.2.2.2 Wetland and Aquatic Habitats

Other than the North Branch Potomac River and its associated floodplain, wetland areas are relatively uncommon on and in the vicinity of the ABL facility. The distribution of wetlands (based upon 1979 aerial photographs) from National Wetland Inventory mapping of the

area are shown on Figure 8-1. The following wetland and aquatic habitat types occur within the ABL facility and immediate vicinity (ERM, 1996):

- **Riparian Forest.** This is the dominant wetland habitat type on and near the ABL facility (including Site 5) and is associated with the floodplain of the North Branch Potomac River (see category PFO on Figure 8-1). This habitat type is dominated by American sycamore, American elm, black walnut, silver maple, river birch, black willow, slippery elm, eastern cottonwood, and boxelder in the overstory, and wild grape, common spicebush, multiflora rose, Japanese knotweed, jewelweed, springcress, garlic mustard, and smartweed in the shrub and ground layers.

- **Non-forested Vegetated Wetlands.** These habitat types include scrub-shrub (PSS) and emergent (PEM) wetlands. These wetland types are relatively uncommon within the vicinity of ABL (Figure 8-1). Typical plant species in these wetlands include pin oak, red maple, silver maple, and black willow saplings; buttonbush; swamp dewberry; multiflora rose; soft rush; broad-leaved cattail; fox sedge; tussock sedge; shallow sedge; redtop; forget-me-not; smartweed; jewelweed; and horsetail. Water depths are typically 1 foot or less in these wetlands.

- **Open Water.** Open water habitats include the North Branch Potomac River (R2OW), several small intermittent streams, and storm water retention and agricultural ponds (POW) (Figure 8-1). Open water habitats in the adjacent portion of the river and small intermittent streams (drainage channels) are associated with Site 5. The latter two wetland types are relatively uncommon in the vicinity of the ABL facility. The river in the vicinity of the ABL facility has an average annual flow of about 886 cubic feet per second (cfs) and a seven consecutive day low flow (7Q10) of 61.6 cfs based upon USGS data from the Pinto gauging station, located just upriver of Site 1 (USGS, 2001; ERM, 1996). The river typically does not contain any submerged aquatic vegetation, perhaps due to the turbid and discolored nature of the water. The water is relatively hard (average hardness of 158 mg/L in 14 samples collected from the river adjacent to Site 1 in Spring 2001 and 195 mg/L in four samples collected from the river adjacent to Site 5 in June 2001). Table 8-1 summarizes physical parameter measurements for surface water and sediment collected from the portion of the North Branch Potomac River adjacent to Site 5. The locations of these surface water and sediment samples are depicted on Figure 8-2.

CH2M HILL (1995, 1996bb) has described the river habitat at four locations (STN1 through STN4; Figure 8-3) used for biological sampling in July 1994. In general, the river in the vicinity of the ABL facility consists of interspersed shallow riffle areas (composed of large rocks, cobbles, and gravel) and deeper pools (composed of sand and gravel). Submerged logs and other detritus occur throughout the river channel. Many areas of the river are partially shaded by the canopy of trees occurring along the riverbank and the river near the facility is considered warm water habitat. Waters are typically turbid and discolored from off-site upriver discharges.

8.2.2.3 Special Habitats

There are no wilderness areas, wildlife refuges, or wild and scenic rivers in the immediate vicinity of the ABL facility. Dan's Mountain Wildlife Management Area is located about 3 miles southeast of the facility and Dan's Mountain State Park is located about 5.5 miles

southeast of the facility (ERM, 1996). Both of these areas are owned and maintained by the State of Maryland.

8.2.3 Biota

A general description of the biota present on the ABL facility and in surrounding areas was compiled from literature review, existing documents, and site visits. Most of the site visit information is associated with CERCLA sites located within Plant 1 and with Site 5. The biota known or expected to occur in the site vicinity are discussed by major taxonomic group in the following subsections.

8.2.3.1 Birds

Bird species that have been observed on the ABL facility are listed in Table 8-2. The bird species observed during the surveys were generally typical of those expected based upon the geographic area, the time of year, weather conditions, and the habitats present.

The West Virginia and Maryland Breeding Bird Atlas projects were 6-year (1984-1989) and 5-year (1983-1987) projects, respectively, to map the distribution of all bird species nesting in the two states (Buckelew, et. al., 1994; Robbins et. al., 1996). Based upon data from both of these surveys, 103 bird species are known or suspected of breeding in the survey blocks that encompass the facility and immediate vicinity. This includes 53 species listed as confirmed breeders, 39 species listed as probable breeders, and 11 species listed as possible breeders (Table 8-3). One additional species (great blue heron) is listed as "observed," meaning that the species was observed during the atlas project but breeding status could not be ascertained in these survey blocks.

To characterize winter bird usage in the facility vicinity, Christmas Bird Count (CBC) data from 1995 to 2000 were used (BirdSource, 2000). CBCs are one-day counts conducted annually by the National Audubon Society using volunteer observers during the months of December or January within a circle with a diameter of 15 miles. Birds seen or heard are enumerated during these counts. The nearest CBC plot is centered approximately 8 miles east/northeast of ABL near Spring Gap, Maryland.

Table 8-4 lists the number of birds, by species, observed during the five CBC surveys conducted from 1995 to 2000 for the Allegany County census plot; 88 species were observed during this period. Based upon 5-year mean values, the five most commonly observed bird species during the winter period are: (1) European starling; (2) rock dove; (3) American crow; (4) dark-eyed junco; and (5) Canada goose. Because this census plot encompasses a much larger area and more diverse habitats, many of the species listed in Table 8-4 may not actually occur on the ABL facility.

8.2.3.2 Mammals

The nine mammalian species that have been observed on the ABL facility are listed in Table 8-2. The mammalian species observed during the surveys were generally typical of those expected based upon the geographic area, the time of year, weather conditions, and the habitats present.

8.2.3.3 Reptiles and Amphibians

Amphibian and reptile species that have been observed on the ABL facility are listed in Table 8-2; only two reptiles and one amphibian have been observed. This is likely due to the difficulty in observing these species during the brief field surveys conducted. Table 8-5 provides a list of amphibians and reptiles known to occur within Mineral County, West Virginia. Not all of the species listed in Table 8-5 are likely to occur on the facility due to habitat preferences. However, Table 8-5 does provide a better indication of the types of reptiles and amphibians that may occur within suitable habitats in the facility vicinity.

8.2.3.4 Aquatic Organisms

The watershed of the North Branch Potomac River has a history of anthropogenic impacts dating back to the turn of the last century. Forests were clearcut and burned, and acid mine drainage from unregulated coal extraction created biological "dead zones" in the main stem and in many tributaries. Discharges of effluent from the Upper Potomac River Commission Wastewater Treatment Plant (UPRCWTP) at Westernport have created highly discolored and turbid conditions in the North Branch Potomac River, which persist for many miles downstream. A paper mill is responsible for approximately 98 percent of the discharge from the wastewater treatment plant. Although the UPRCWTP discharge is over 21 miles upstream of Pinto, Maryland, it still influences water quality and aquatic communities in the reaches of the river adjacent to the ABL facility (CH2M HILL, 1995).

Fish. Beginning in 1988, the Maryland Department of Natural Resources (MDNR) began characterizing the freshwater fishery in the North Branch Potomac River. Surveys of water quality, benthic macroinvertebrate communities, and fish were conducted in 1989, 1990, 1992, and 1993. These data have been summarized in the *Focused RI of Site 1* (CH2M HILL, 1995). One of the MDNR stations is located at Pinto (Station 6), which is near the southwestern portion of Site 1. Table 8-6 lists the fish species collected, reported as catch per unit effort (individuals per hour from electroshocking surveys), at Station 6, as well as at the next upstream station (Station 5, approximately 20 miles upstream of ABL) and at the next downstream station (Station 7, about 11 miles downstream of ABL).

Macroinvertebrates. A macroinvertebrate survey was conducted in the North Branch Potomac River in July 1994 as part of the Site 1 ERA (CH2M HILL, 1995). Four sampling stations (STN 1 through 4; Figure 8-3) were selected based upon proximity to potential source areas. Two quantitative benthic macroinvertebrate samples (A and B; Table 8-7) were collected at each station using a Surber sampler. Qualitative samples were also collected using a kick net to assist in the characterization of invertebrate community structure. The data are summarized in Table 8-7.

The aquatic biota at Station 1 were quite limited. Some attached plants were present, but little in the way of filamentous algae, macrophytes, and fish. Although no slimes were noted, most of the substrate was covered with a fine layer of silt. Kick net samples for benthic macroinvertebrates within the sampling area produced a restricted community structure. The most abundant components were the aquatic worms from the family Tubificidae. Crayfish (Decapoda) of the genus *Orconectes* were common as well as several midge (Chironomidae) species. Mayflies (Ephemeroptera) of the family Heptageniidae were also common. Specimens from the family Sialidae (alderflies) and Corydalidae (dobsonflies) were also noted.

Mayflies (Ephemeroptera) of the family Heptageniidae were abundant at Station 2, as were crayfish. Amphipods (scuds and sideswimmers) were quite common and associated with leaf litter. Aquatic worms (principally tubificids), riffle beetles, (Elimidae), alderflies (Salidae), and dobsonflies (Corydalidae) also were noted. The benthic macroinvertebrate diversity was generally quite low at this station.

Some diatoms and attached filamentous algae were present at Station 3. No aquatic plants, slimes, or fish were noted. Crayfish (Decapoda) and mayflies (Ephemeroptera) were the main constituents of the benthic macroinvertebrate community. The available substrate material was covered with a fine layer of silt, which limited invertebrate community structure.

Macroinvertebrate community structure, based upon qualitative observations, indicated an abundance of crayfish (Decapoda) at Station 4. Mayflies (Ephemeroptera), principally from the family Heptageniidae, and caddisflies (Trichoptera) of the family Hydropsychidae, were most common. Adult damselflies (Zygoptera) were also noted in the area. Periphytic growth on cobble substrates (probably diatoms) was noted. Some filamentous green algae were also present. Macrophytes were not observed in this reach. A fine layer of silt was present on substrate materials. Several fish, possibly creek chubs, were observed in the area.

Macroinvertebrates are also being sampled in the North Branch Potomac River as part of a long-term monitoring program at Site 1. Macroinvertebrates are collected at six stations (BIOTA 1 through BIOTA 6; Figure 8-3) using Hester-Dendy plate samplers, which are left in place for a 6-week period. The results (number of individual taxa from three sample replicates) of the July 1998, July 2000, and July 2002 sampling events are summarized in Tables 8-8 through 8-10.

The number of organisms and taxa were relatively consistent among stations in July 1998. Organisms from the family Chironomidae were numerically dominant at all stations. The density of organisms at the most downstream station (Station 6) was low relative to the other stations in July 2000, although the number of taxa was relatively consistent among stations. Chironomids and oligochaetes dominated at most stations, although insects from the two orders Ephemeroptera and Trichoptera were relatively common at all stations except Station 5. In July 2002, the number of taxa was highest at Stations 1, 2, and 6 and lowest at Station 4. The density of organisms was highest at Stations 1 and 6, intermediate at Station 2, and lowest at Stations 3, 4, and 5. Chironomids were the dominant taxon at all six stations, although insects from the two orders Ephemeroptera and Trichoptera occurred at all stations.

8.2.3.5 Threatened and Endangered Species

The West Virginia Department of Natural Resources, Natural Heritage Program completed a detailed field study of the ABL facility in 1993 to document the occurrence of rare, threatened, and endangered species (McDonald, 1993). Based upon Natural Heritage Database records, 41 species of rare, threatened, or endangered plants or animals were known to occur in Mineral County, 9 of which could occur on the ABL facility based upon habitat preferences. These 41 species (plus an additional species found during the 1993 survey and 3 federally listed species included in the report) are listed in Table 8-11 along with their June 2000 status. One of the original 41 species (flatleaf rush) is no longer listed.

Of the 3 federally listed species addressed in the 1993 report, the peregrine falcon has since been delisted (25 August 1999), the bald eagle has been downlisted to threatened and is proposed for delisting (6 July 1999), and the loggerhead shrike is no longer on the list of "candidate" species. Consultation with the U.S. Fish and Wildlife Service, conducted as part of the 1995 ERA of Site 1 (CH2M HILL, 1995 and 1996b), revealed no known occurrences of federally listed species (except for occasional transients) in the area.

Five of the species addressed in the 1993 report, 4 plants and 1 mammal, were found to occur on the ABL facility (Table 8-11). Four of these species are currently ranked S3 (somewhat vulnerable to extinction; the lowest of the listing categories) and one is ranked S2 (very rare). All of these species were located in the extreme southern portion of the facility, well away from developed areas and over a mile from Site 5.

As part of the ERA for Site 1 conducted in 1995 (CH2M HILL, 1995 and 1996b), the State of Maryland was also contacted regarding potential occurrences of rare species in the site vicinity. Six species were identified (Table 8-12). The sora inhabits densely vegetated freshwater and salt marshes as well as damp meadows. Maryland represents the southern limits of its breeding range. This species is extremely unlikely to occur at ABL because the ABL property does not provide suitable habitat.

The eastern small-footed bat occurs in the Appalachian Mountains of western Maryland, Virginia, and North Carolina. The bat is found most often near caves. Little is known about the bat's habitat requirements, although roosts usually are found in hemlock forests. It roosts during the fall and winter in inconspicuous places such as under boulders, in crevices in rock falls and quarries, or around the entrances to caves and mines. It may frequent buildings in the summer. No caves have been observed on ABL. Directly across the river in Pinto, Maryland, however, several limestone caves have been reported.

Side-oats grama occurs in plains, prairies, and rocky hills from Maine and Ontario to Montana south to Virginia, Alabama, Texas, and Arizona. It is most abundant in fine-textured soils, seldom grows in coarse-textured soils, and is better adapted to calcareous and moderately alkaline soils than to neutral or acid soils. This species is known to occur in the extreme southern portion of the ABL facility (McDonald, 1993).

Harebell is a member of the bluebell family that occurs along rocky banks and shores and in meadows. Virginia mountain mint prefers dry woods, meadows, fields, and thickets. Cliff stonetop prefers damp calcareous rocks. None of these species is known to occur on the site or in the immediate site vicinity nor are they expected to based upon habitat preferences.

8.3 Screening Ecological Risk Assessment

As discussed in Section 8.1, Steps 1 and 2 of the ERA process constitute the SERA, which is conducted using intentionally conservative assumptions. The principal components of the SERA are problem formulation, exposure estimation, effects evaluation, and risk calculation.

8.3.1 Screening Problem Formulation

Problem formulation establishes the goals, scope, and focus of the ERA. As part of problem formulation, the environmental setting of Site 5 is characterized in terms of the habitats and

biota known or likely to be present. The types and concentrations of chemicals that are present in ecologically relevant media are also described. A preliminary conceptual model is developed for Site 5 that describe potential sources, potential transport pathways, potential exposure pathways and routes, and potential receptors. Assessment endpoints, measurement endpoints, and risk hypotheses are then selected to evaluate those receptors for which complete and potentially significant exposure pathways are likely to exist. The fate, transport, and toxicological properties of the chemicals present at Site 5, particularly the potential for bioaccumulation, are also considered during this process.

8.3.1.1 Environmental Setting

Site 5 is located between State Route 956 (to the east) and the North Branch Potomac River (to the west). This 1.3-acre site is the location of a closed landfill, which was capped in 1997. The landfill consists of one hill covered with herbaceous plants. A gravel access road leads from State Route 956 to the top of the capped landfill (Figure 8-2). A system of drainage ditches surrounds the entire landfill (passing through a culvert under the access road). This ditch system, portions of which are reinforced with large gravel (rip-rap), converges at a point just northwest of the landfill. Surface runoff from the landfill flows into these ditches and then flows in a generally northwestern direction until the convergence point, where it flows as a single ditch west into the North Branch Potomac River, discharging near surface water/sediment sampling location 5SD-2/5SW-2 (Figure 8-2). The ditches are currently unvegetated.

The western boundary of Site 5 consists of a steep bank that slopes towards the North Branch Potomac River. Ground cover at the top of the slope and along the side of the slope consists mainly of red fescue and switch grass. Areas of exposed rock are present along the side slope and along the western edge of Site 5. Unvegetated areas are also present in places along the side slope, probably due to the steepness of the slope and the rocky composition of the substrate. Canopy species in the upland area near the top and toe of the slope include tree-of-heaven, black gum, and black walnut. Canopy species in the river floodplain between the toe of the slope and the river include silver maple and sycamore. Ground cover in these wooded areas primarily consists of dense stands of eulalia and goldenrod in shady areas, and Canada thistle in open, sunny areas.

Wildlife observed at Site 5 during the 1996 ERA field visit included white-tailed deer and a variety of bird species, such as turkey vulture, American crow, American goldfinch, indigo bunting, song sparrow, field sparrow, northern cardinal, and chipping sparrow. The habitat provided by the wooded areas, the river floodplain, and the river itself is likely used by a variety of amphibians, reptiles, birds, and mammals. Aquatic species present in the river were discussed in Section 8.2.3.4; one river sampling location (BIOTA 1) was located just upstream of Site 5 (Figure 8-3).

8.3.1.2 Summary of Analytical Data

Surface water samples from the North Branch Potomac River were collected adjacent to Site 5 in 1994, 2000, 2001, and 2002 (Table 8-13). All of these data were used in the ERA except for the 1994 data. Unvalidated data from 1999 (sampled only for perchlorate) were also not used. Sediment samples from the North Branch Potomac River were collected

adjacent to Site 5 in 1994, 1998, 1999, 2000, 2001, and 2002 (Table 8-13). All of these data were used in the ERA except for the 1999 data, which have not been validated.

Groundwater samples have been collected on 13 occasions at Site 5 (Table 8-13). For this ERA, only alluvial wells between the landfill and the river (i.e., 5GW07, 5GW09, 5GW11, 5GW17, 5GW19, 5GW20) for which data were available from the most recent three rounds of sampling (August 2000, April 2001, and February 2002) were used in the ERA. The evaluation was limited to these data because ecological receptors are not directly exposed to groundwater and the surface water and sediment samples from the river better reflect ecological exposures. These more recent groundwater data from the selected wells (along with data from a background alluvial well, 5GW24) were used to qualitatively evaluate potential chemical transport from the site to the river via groundwater.

Chemical concentrations in whole-body fish tissue were measured at three locations in the North Branch Potomac River near Site 5 in February 2002. These data were used in the ERA.

Table 8-13 provides a summary of the available data and the data selected for use in this ERA. Groundwater, surface water, sediment, and biota (fish) sampling locations are shown on Figure 8-2. The analytical data are summarized in Tables 8-14 (downgradient surface water), 8-15 (downgradient sediment), 8-16 (fish tissue), and 8-17 (downgradient groundwater). Upgradient surface water, sediment, and groundwater data are discussed in Section 8.4.3. The raw analytical data are provided in Appendix D.

8.3.1.3 Preliminary Conceptual Model

Information on the habitat features at the site and on the fate and transport of the chemicals detected at the site was used to build the preliminary conceptual model (Figure 8-4). Key components of the preliminary conceptual model include the identification of potential source areas on the facility, transport pathways, exposure media, exposure routes, and receptors.

Potential Source Areas. The facility-related source area at Site 5 is the landfill. As discussed in Sections 8.2.2.2 and 8.2.3.4, there are other potential non-facility-related sources located upstream of the facility.

Transport Pathways and Exposure Media. A transport pathway describes the mechanisms whereby chemicals may be transported from a source of contamination to ecologically relevant media. These transport pathways are shown on Figure 8-4.

Because of the landfill cap, transport via surface runoff is no longer a complete pathway, although surface runoff to the river is likely to have occurred in the past. In addition, the landfill cap is likely to decrease the amount of chemical transport from the site to the river via groundwater by reducing the infiltration of precipitation. However, transport of chemicals via groundwater likely still occurs as a result of historical groundwater contamination. Site-related chemicals in the sediment and surface water of the river (which may be co-mingled with chemical contributions from upstream sources) may be taken up and accumulated in the tissues of biota, and thus be transported to upper trophic level receptors via food webs.

Exposure Pathways and Routes. An exposure pathway links a source of contamination with one or more receptors through exposure via one or more media and exposure routes. Exposure, and thus potential risk, can only occur if complete exposure pathways exist. Figure 8-4 shows the potentially complete exposure pathways to ecological receptors (solid lines) at Site 5. Due to the presence of the landfill cap, complete exposure pathways to surface soils in terrestrial environments do not currently exist. Potentially complete exposure pathways to aquatic receptors utilizing the river adjacent to Site 5 do exist and are the focus of this ERA.

An exposure route describes the specific mechanism(s) by which a receptor is exposed to a chemical present in an environmental medium. Unrooted, floating aquatic plants, and rooted submerged vascular aquatic plants (although of limited occurrence in the river near Site 5) and algae, may be exposed to chemicals directly from the water or (for rooted plants) from sediments.

Animals may be exposed to chemicals through: (1) direct inhalation of gaseous chemicals or of chemicals adhered to airborne particulate matter; (2) incidental ingestion of contaminated abiotic media (e.g., sediment) during feeding or preening activities; (3) direct ingestion of contaminated water; (4) ingestion of contaminated plant and/or animal tissues for chemicals which have entered food webs; and/or (5) dermal contact with contaminated abiotic media. These routes, where applicable, are depicted on Figure 8-4.

Based upon the general fate properties (e.g., relatively high adsorption to solids) of the chemicals commonly present on Site 5 (primarily inorganics) and the protection offered by hair or feathers, dermal and inhalation exposures for upper trophic level receptor species are not considered significant relative to ingestion exposures and are therefore not evaluated in the ERA. Incidental ingestion of sediment during feeding, preening, or grooming activities is, however, considered in the risk estimates. Direct contact is considered for lower trophic level receptors (e.g., benthic invertebrates).

Direct ingestion of drinking water is only considered where the salinity is below 15 parts per thousand, the approximate toxic threshold for wildlife receptors (Humphreys, 1988). Because the North Branch Potomac River is freshwater habitat, drinking water exposures are included in the ERA. Freshwater is defined as surface water salinity less than or equal to 1.0 part per thousand (USEPA, 1996b).

Receptors. Because of the complexity of natural systems, it is generally not possible to directly assess the potential impacts to all ecological receptors present at a site. Therefore, specific receptor species or species groups (e.g., belted kingfisher) are often selected as surrogates to evaluate potential risks to larger portions of the ecological community (guilds; e.g., piscivorous birds) used to represent the assessment endpoints (e.g., survival and reproduction of piscivorous birds). Selection criteria typically include those species that:

- Are known to occur, or are likely to occur, at the site.
- Have a particular ecological, economic, or aesthetic value.
- Are representative of taxonomic groups, life history traits, and/or trophic levels in the habitats present at the site for which complete exposure pathways are likely to exist.

- Can, because of toxicological sensitivity or potential exposure magnitude, be expected to represent potentially sensitive populations at the site.

The following upper trophic level receptor species were chosen for exposure modeling at Site 5 based upon the criteria listed above:

- Mink (*Mustela vison*) - semi-aquatic mammalian piscivore.
- Raccoon (*Procyon lotor*) - semi-aquatic mammalian omnivore.
- Belted kingfisher (*Ceryle alcyon*) - semi-aquatic avian piscivore/invertivore.
- Great blue heron (*Ardea herodias*) - semi-aquatic avian piscivore.
- Mallard (*Anas platyrhynchos*) - semi-aquatic avian omnivore.

Upper trophic level receptor species quantitatively evaluated in the ERA were limited to birds and mammals, the taxonomic groups with the most available information regarding exposure and toxicological effects. Amphibians are typically selected as a receptor group only when freshwater aquatic or wetland habitats are present on, or in the contaminant transport pathways (as defined in the conceptual model), of a site. Because of the limited amount of toxicological data available for this taxonomic group, exposures via the food web for amphibians were evaluated using bird and mammal receptor species as surrogates. Exposures of immature forms (e.g., tadpoles) were evaluated as part of the aquatic biota evaluation using surface water and/or sediment screening values. Reptiles were evaluated using the same methods as described for amphibians.

Lower trophic level receptor species were evaluated in the ERA based upon those taxonomic groupings for which screening values have been developed; these groupings and screening values are used in most ERAs. As such, specific species of aquatic biota (e.g., fish and macroinvertebrates) were not chosen as receptors; aquatic biota were evaluated on a community level via a comparison to surface water and/or sediment screening values.

Endpoints and Risk Hypotheses. The conclusion of the screening problem formulation includes the selection of ecological endpoints and risk hypotheses, which are based upon the preliminary conceptual model. Two types of endpoints, assessment endpoints and measurement endpoints, are defined as part of the ERA process (USEPA, 1997b). An assessment endpoint is an explicit expression of the environmental component or value that is to be protected. A measurement endpoint is a measurable ecological characteristic that is related to the component or value chosen as the assessment endpoint. The considerations for selecting assessment and measurement endpoints are summarized in USEPA (1997b) and discussed in detail in Suter (1989, 1990, and 1993). Risk hypotheses are testable hypotheses about the relationship among the assessment endpoints and their predicted responses when exposed to contaminants.

Endpoints define ecological attributes that are to be protected (assessment endpoints) and measurable characteristics of those attributes (measurement endpoints) that can be used to gauge the degree of impact that has or may occur. Assessment endpoints most often relate to attributes of biological populations or communities, and are intended to focus the risk assessment on particular components of the ecosystem that could be adversely affected by chemicals attributable to the site (USEPA, 1997b). Assessment endpoints contain an entity (e.g., raccoon population) and an attribute of that entity (e.g., survival rate). Individual assessment endpoints usually encompass a group of species or populations (the receptor)

with some common characteristic, such as specific exposure route or contaminant sensitivity, with the receptor then used to represent the assessment endpoint in the risk evaluation.

Assessment and measurement endpoints may involve ecological components from any level of biological organization, from individual organisms to the ecosystem itself. Effects on individual organisms are important for some receptors, such as rare and endangered species; population- and community-level effects are typically more relevant to ecosystems. Population- and community-level effects are usually difficult to evaluate directly without long-term and extensive study. However, measurement endpoint evaluations at the individual level, such as an evaluation of the effects of chemical exposure on reproduction, can be used to predict effects on an assessment endpoint at the population or community level. In addition, use of criteria values designed to protect the majority (e.g., 95 percent) of the components of a community (e.g., Ambient Water Quality Criteria for the Protection of Aquatic Life) can be useful in evaluating potential community- and/or population-level effects.

Table 8-18 shows the preliminary assessment endpoints, risk hypotheses, and measurement endpoints used in the screening portion of the ERA. Table 8-18 also shows the receptors associated with each endpoint.

8.3.2 Screening Exposure Estimation

Maximum concentrations in surface water, sediment, and fish tissue were used in the screening portion of the ERA to conservatively estimate potential chemical exposures for the ecological receptors selected to represent the assessment endpoints at Site 5. Food web exposures for upper trophic level receptor species were determined by estimating the chemical-specific concentrations in each dietary component using uptake and/or food web models. Incidental ingestion of sediment and ingestion of drinking water were also included when calculating the total level of exposure. Maximum surface water, sediment, and fish tissue concentrations were used in all screening calculations to provide a conservative assessment.

For conservatism, the maximum reporting limit for chemicals analyzed for but not detected was also compared to medium-specific screening values and (where applicable) used for food web exposure modeling. This was done to determine if reporting limits were less than or equal to chemical concentrations at which potential adverse effects to ecological receptors may occur.

8.3.2.1 Selection Criteria for Analytical Data

Available analytical data (described in Section 8.3.1.2 and summarized in Table 8-13) were selected for use in the ERA based upon the following:

- Data must have been validated by a qualified data validator using acceptable data validation methods. Data with rejected (R) qualifiers were not used in the ERA. Unqualified data and data qualified as J, L, or K were treated as detected. Data qualified as U or B were treated as non-detected.

- For samples with duplicate analyses, the higher of the two concentrations was used when both values were detects or when both values were non-detects. In cases where one result was a detection and the other a non-detect, the detected value was used in the ERA.
- Surface soil or sediment data collected prior to any major physical disturbance (such as capping) that would result in the elimination of realistic exposure pathways were not used in the ERA.
- For sediment, samples from depths of 0 to 6 inches were used preferentially because this depth range represents the most realistic exposures for sediment-dwelling species.

8.3.2.2 Exposure Estimation

Upper trophic level receptor exposures to chemicals in surface water and sediment were determined by estimating the concentration of each bioaccumulating chemical in each relevant dietary component. Incidental ingestion of sediment and ingestion of drinking water were included when calculating the total exposure. Because receptors (and their prey) are not exposed directly to groundwater, and because surface water and sediment data were available from the receiving water body, food web exposures were not calculated based upon groundwater concentrations.

Chemicals with the potential to bioaccumulate were evaluated for exposures via food webs. This list of bioaccumulating chemicals is provided in Table 8-19 for relevant constituents and is based upon the list provided in USEPA Table 4-2 (USEPA, 2000b).

Dietary items for which tissue concentrations were modeled consisted of aquatic plants and aquatic invertebrates. Measured tissue data were available for fish. For the screening portion of the ERA, the uptake of chemicals from the abiotic media into these food items was based upon conservative (e.g., maximum or 90th percentile) bioconcentration factors (BCFs) or bioaccumulation factors (BAFs) from the literature. Default factors of one were used only when data were unavailable for a chemical in the literature.

Screening Exposure Point Concentrations. Maximum media concentrations were used as exposure point concentrations for exposure estimation and food web modeling in the screening portion of the ERA. Exposure point concentrations (concentrations in plant, aquatic invertebrate, and fish prey items) for aquatic predators are estimated using bioaccumulation models and maximum measured sediment concentrations or (for fish) maximum measured concentrations. The methodology and models used to derive these estimates are described below.

Aquatic Plants. Tissue concentrations in the aboveground vegetative portion of aquatic and wetland plants were estimated by multiplying the maximum sediment concentration for each chemical by chemical-specific soil-to-plant BCFs (extrapolated to sediments) obtained from the literature. The BCF values used were based upon root uptake from sediment and upon the ratio between dry-weight sediment and dry-weight plant tissue. Literature values based upon the ratio between dry-weight sediment and wet-weight plant tissue were converted to a dry-weight basis by dividing the wet-weight BCF by the estimated solids content for plants (15 percent [0.15]; Sample, et al., 1997).

For inorganic chemicals without literature based BCFs, a sediment-to-plant BCF of 1.0 was assumed. For organic chemicals without literature based BCFs, sediment-to-plant BCFs were estimated using the algorithm provided in Travis, et al. (1988):

$$\log B_v = 1.588 - (0.578)(\log K_{ow})$$

where: B_v = Sediment-to-plant BCF (unitless; dry-weight basis)
K_{ow} = Octanol-water partitioning coefficient (unitless)

The log K_{ow} values used in the calculations were obtained mostly from USEPA (1995a and 1996a) and are listed in Table 8-19. The sediment-to-plant BCFs used in the screening portion of the ERA are shown in Table 8-20.

Benthic Invertebrates. Tissue concentrations in benthic invertebrates were estimated by multiplying the maximum sediment concentration for each chemical by chemical-specific sediment-to-invertebrate BAFs obtained from the literature. The BAF values used were based upon the ratio between dry-weight sediment and dry-weight invertebrate tissue. BAFs based upon depurated analyses (sediment was purged from the gut of the organism prior to analysis) were given preference over undepurated analyses when selecting BAF values because direct ingestion of sediment was accounted for separately in the food web model.

Literature values based upon the ratio between dry-weight sediment and wet-weight invertebrate tissue were converted to a dry-weight basis by dividing the wet-weight BAF by the estimated solids content for aquatic invertebrates (21 percent [0.21]; USEPA, 1993b). For chemicals without literature-based sediment-to-invertebrate BAFs, a BAF of 1.0 was assumed. The sediment-to-invertebrate BAFs used in the screening portion of the ERA are shown in Table 8-20.

Fish. Measured tissue concentrations in whole-body fish (wet-weight basis) were converted to a dry-weight basis using the measured percent solids (25.2 percent).

Dietary Intakes. Dietary intakes for each upper trophic level receptor species were calculated using the following formula (modified from USEPA, 1993b):

$$DI_x = \frac{[[\sum_i (FIR)(FC_{xi})(PDF_i)] + [(FIR)(SC_x)(PDS)] + [(WIR)(WC_x)]]}{BW}$$

where: DI_x = Dietary intake for chemical x (mg chemical/kg body weight/day)
FIR = Food ingestion rate (kg/day, dry-weight)
FC_{xi} = Concentration of chemical x in food item i (mg/kg, dry-weight)
PDF_i = Proportion of diet composed of food item i (dry-weight basis)
SC_x = Concentration of chemical x in soil/sediment (mg/kg, dry-weight)
PDS = Proportion of diet composed of soil/sediment (dry-weight basis)
WIR = Water ingestion rate (L/day)
WC_x = Concentration of chemical x in water (mg/L)
BW = Body weight (kg, wet weight)

Receptor-specific values used as inputs to this equation for the screening portion of the ERA are provided in Table 8-21. Consistent with the conservative approach used for a SERA, the minimum body weight and maximum food and water ingestion rates from the scientific literature were used for each receptor. It was assumed that chemicals were 100 percent bioavailable to the receptor and it was also assumed that each receptor spent 100 percent of its time on the site (i.e., an area use factor [AUF] of 1.0 was assumed).

8.3.3 Screening Effects Evaluation

The purpose of the screening effects evaluation is to establish chemical exposure levels (screening values) that represent conservative thresholds for adverse ecological effects. One set of screening values is typically developed for each selected assessment endpoint.

8.3.3.1 Medium-Specific Screening Values

The screening values used in the ERA were based upon Region III BTAG screening values (USEPA, 1995b) and additional screening values available in the literature. When more than one screening value was available (e.g., fauna and flora) and chemical, the lowest of these values was selected. Screening values were adjusted based upon modifying factors as follows:

- Surface water screening values for several divalent metals were adjusted using a mean measured water hardness value of 195 milligrams/liter (mg/L).
- Equilibrium-partitioning based sediment values (used as a measure of bioavailability) were adjusted using a mean measured TOC value of 4 percent.

The screening values used in the ERA are summarized, by medium, in Table 8-22.

8.3.3.2 Fish Tissue Screening Values

Fish tissue-based screening values (Jarvinen, et al., 1999) were derived for chemicals that were detected in fish tissue samples collected from the North Branch Potomac River adjacent to Site 5. The fish tissue screening values used in this ERA are provided in Section 8.3.4.1.

8.3.3.3 Ingestion Screening Values

Ingestion screening values for dietary exposures were derived for each mammalian and avian receptor species and chemical evaluated in the ERA. Toxicological information from the literature for wildlife species most closely related to the receptor species was used, where available, but was supplemented by laboratory studies of non-wildlife species (e.g., laboratory mice) where necessary. The ingestion screening values are expressed as milligrams of the chemical per kilogram body weight of the receptor per day (mg/kg-BW/day).

Growth and reproduction were emphasized as assessment endpoints because they are the most relevant, ecologically, to maintaining viable populations and because they are generally the most studied chronic toxicological endpoints for ecological receptors. If several chronic toxicity studies were available from the literature, the most appropriate study was selected for each receptor species based upon study design, study methodology, study duration, study endpoint, and test species. NOAELs based upon growth and reproduction were utilized, where available, as the primary screening values. When chronic NOAEL

values were unavailable, estimates were extrapolated from chronic LOAELs using a safety factor of 10. Ingestion screening values for mammals and birds are summarized in Tables 8-23 and 8-24, respectively.

8.3.4 Screening Risk Calculation

The screening risk calculation is the final step in a SERA. In this step, the maximum exposure concentrations (abiotic media) or exposure doses (upper trophic level receptor species) are compared with the corresponding screening values to derive screening risk estimates. The outcome of this step is a list of COPCs for each medium-pathway-receptor combination evaluated or a conclusion of acceptable risk.

8.3.4.1 Selection of COPCs

COPCs are selected using the HQ method. HQs are calculated by dividing the chemical concentration in the medium being evaluated by the corresponding medium-specific screening value or by dividing the exposure dose by the corresponding ingestion screening value. Chemicals with HQs greater than or equal to one are considered COPCs in the SERA.

HQs exceeding one indicate the potential for risk because the chemical concentration or dose (exposure) exceeds the screening value (effect). However, screening values and exposure estimates are derived using intentionally conservative assumptions such that HQs greater than or equal to one do not necessarily indicate that risks are present or impacts are occurring. Rather, it identifies chemical-pathway-receptor combinations requiring further evaluation. HQs that are less than one indicate that risks are very unlikely, enabling a conclusion of no unacceptable risk to be reached with high confidence.

Surface Water. Maximum surface water concentrations for samples located adjacent to, or downgradient of, Site 5 are compared to screening values in Table 8-25. Based upon this comparison for unfiltered samples, five inorganics (aluminum, cyanide, manganese, selenium, and silver) had HQs equaling or exceeding one and were identified as COPCs. The exceedences for cyanide, selenium, and silver were based upon maximum reporting limits. Only silver exceeded screening values (based upon the maximum reporting limit) for filtered samples. No organic chemical exceeded screening values based upon a detected concentration (Table 8-25).

Sediment. Maximum sediment concentrations for samples located adjacent to, or downgradient of, Site 5 are compared to screening values in Table 8-26. Based upon this comparison, 11 inorganics (arsenic, cadmium, cobalt, copper, cyanide, manganese, mercury, nickel, selenium, silver, and zinc) had HQs equaling or exceeding one and were identified as COPCs. The exceedences for cyanide and silver were based upon maximum reporting limits. Beryllium and thallium were identified as COPCs because they were detected and screening values were not available.

Eight organic chemicals (3-and 4-methyphenol, diethylphthalate, phenol, and five PAHs) equaled or exceeded their screening values based upon detected concentrations (Table 8-26) and were identified as COPCs. Total PAHs also slightly exceeded screening values (HQ of 1.01). Nine SVOCs and ten VOCs exceeded screening values based upon maximum reporting limits and were identified as COPCs. One SVOC (benzaldehyde) and two VOCs

(2-butanone and MC) were identified as COPCs because they were detected and screening values were not available.

Fish Tissue. Maximum fish tissue concentrations are compared to screening values in Table 8-27. This comparison was conducted for all detected chemicals (except for the essential nutrients calcium, iron, magnesium, potassium, and sodium). Based upon this comparison, no chemicals exceeded screening values. Four of the metals lacked screening values. Because none of these four chemicals are considered significant bioaccumulators (Table 8-19), they were not identified as COPCs.

Food Web Exposures. Maximum HQs for each upper trophic level receptor are shown in Table 8-28. Based upon a comparison to NOAELs, arsenic, lead, mercury, selenium, zinc, and hexachlorobenzene had HQs that equaled or exceeded one for one or more receptors. These six chemicals were identified as COPCs. The exceedence for hexachlorobenzene was based upon maximum reporting limits. Ingestion screening values were not available for three SVOCs (Table 8-28). These SVOCs were not identified as COPCs because they were not detected in sediment samples.

8.3.5 Screening Risk Conclusions

COPCs were identified in each abiotic medium evaluated (Table 8-29). Therefore, the ERA proceeded to Step 3.

8.4 Baseline Ecological Risk Assessment (Step 3)

The SERA resulted in a set of COPCs for each abiotic medium. This set of COPCs included chemicals with HQs greater than or equal to one (based upon maximum exposures) as well as detected chemicals for which screening values were not available.

8.4.1 Refinement of Conservative Screening Assumptions

According to Superfund guidance (USEPA, 1997b), Step 3 initiates the problem formulation phase of the BERA. Under Navy policy/guidance (CNO, 1999; NAVFAC, 2001), the BERA begins with a preliminary step (Step 3A) in which the conservative assumptions employed in the SERA are refined and risk estimates are recalculated using the same conceptual model for the site. In addition, the refinement may include consideration of other factors such as upgradient and background data, detection frequency, and bioavailability considerations (CNO, 1999; NAVFAC, 2001).

The assumptions, parameter values, and methods that were modified for the Step 3A refinement included:

- Risk estimates based upon maximum chemical concentrations were supplemented by risk estimates based upon average (arithmetic mean) chemical concentrations. In addition, BAFs and BCFs were based upon, or modeled from, central tendency estimates (e.g., median or mean) from the literature as opposed to the maximum or “high-end” (e.g., 90th percentile) estimates used in the SERA for many chemicals. Revised BAF/BCF values used in Step 3A are provided in Table 8-30.

In the BERA, using central tendency estimates (rather than high end or maximums) for exposure parameters such as BAFs provides a more representative estimate of potential exposures and risks to receptor populations (the focus of the assessment endpoints) of upper trophic level receptors. Because these upper trophic level species are highly mobile, they would be expected to effectively average their exposure over time as they forage within the area defining their home range (which will extend to off-site areas), especially given the relatively uniform habitat present within the river floodplain near Site 5. Average prey concentrations at Step 3A are most appropriately estimated using central tendency estimates of media concentrations and accumulation factors. For example, the wildlife dietary exposure models contained in the Wildlife Exposure Factors Handbook (USEPA, 1993b) specify the calculation of an average daily dose. Increasing the representativeness of the exposure estimates relative to population-level effects is consistent with the intent of the Step 3A evaluation. In cases where adequate spatial sampling coverage exists, mean concentrations are also appropriate for evaluating potential risks to populations of lower trophic level receptors because the members of the population are expected to be found throughout an area (where suitable habitat is present), rather than concentrated in one particular location. While effects on individual organisms might be important for some receptors, such as rare and endangered species, population- and community-level effects are typically more relevant to ecosystems. A discussion of the uncertainties associated with the number of available samples and their spatial distribution is contained in Section 8.5.

- Central tendency estimates (e.g., mean, median, midpoint) for body weight and ingestion rate (Table 8-31) were used to develop exposure estimates for upper trophic level receptors, rather than the minimum body weights and maximum ingestion rates used in the SERA. Central tendency estimates for these exposure parameters are more relevant for a BERA because they better represent the characteristics of a greater proportion of the individuals in the population. Populations or communities (rather than individual organisms) were emphasized during the development of the assessment endpoints for the ERA.

- The SERA conservatively identified a chemical as a food web COPC if the estimated dose for at least one upper trophic level receptor exceeded the NOAEL. The actual dose that is protective of a receptor, however, will fall between the NOAEL and the LOAEL. Both the NOAEL and LOAEL were used for comparison in the BERA. However, chemicals were not considered COCs following Step 3A unless the exposure dose exceeded the LOAEL because this dose is expected to be protective of the overall population, which is the assessment endpoint being evaluated.

- Site-specific upgradient concentrations were also considered in Step 3A for surface water and sediment. Surface water (5SW01, 5SW01A, 5SW01B) and sediment (5SD01, 5SD01A, 5SD01B) locations exist in the North Branch Potomac River upgradient of Site 5 (Figure 8-2).

- USEPA guidance (USEPA, 1996b) indicates that the dissolved metal fraction should be preferentially used to the total metal fraction in surface water screening. Total metal concentrations were emphasized in the SERA during the surface water screen for conservatism. Because high levels of suspended solids and sediment-adsorbed metals

could result in overstating bioavailable surface water concentrations (and thus potential exposures and risks), filtered metal concentrations (representing the dissolved fraction) in surface water were also evaluated through a comparison to screening values based upon the dissolved metal fraction.

Only complete and significant pathways identified in the SERA were re-evaluated in Step 3A of the ERA. Similarly, only COPCs and receptors identified in the SERA as requiring further evaluation were addressed in Step 3A. Although many aspects of the estimation of exposure were modified in Step 3A (see above), the screening values (effects) used in Step 3A were the same as the values used in the SERA. Although the same basic conceptual model from the SERA was also used in Step 3A, the endpoints and risk hypotheses from the SERA were modified slightly to better reflect the Step 3A analysis (Table 8-32).

8.4.2 Refined (Step 3A) Risk Characterization

Based upon the results of the SERA, the assessment endpoints, measurement endpoints, and risk hypotheses were modified for the Step 3A evaluation (Table 8-32). Modifications included eliminating from further consideration those assessment endpoints for which no unacceptable risk was found during the SERA and modifying the measurement endpoints to reflect the assumptions and methods used in the Step 3A evaluation. The results of the refined risk characterization are discussed in the following subsections.

8.4.2.1 Surface Water

The comparison of mean chemical concentrations in river surface water with screening values is presented in Table 8-33. Only aluminum (HQ of 2.56) and manganese (HQ of 2.09) exceeded screening values based upon detected unfiltered (total) concentrations. These two metals were identified as PCOCs. There were no exceedences of detected metals based upon filtered (dissolved) concentrations.

A number of chemicals were identified as COPCs in the SERA because maximum reporting limits exceeded screening values. Mean HQs (based upon the mean of one-half of the sample reporting limits) were greater than one only for silver, although HQs were less than three (Table 8-33). None of these undetected chemicals were identified as PCOCs in surface water.

8.4.2.2 Sediment

The comparison of mean chemical concentrations in river sediment with screening values is presented in Table 8-34 (maximum concentrations were used if the mean concentration exceeded the maximum). HQs exceeded one for five detected metals (arsenic, manganese, mercury, nickel, and zinc). Mean HQs were less than three for all of these metals. HQs for 2-methylnaphtalene (1.57), 3- and 4-methylphenol (2.09), acenaphthene (5.63), and fluorene (1.84) also exceeded one and the HQ for diethylphthalate equaled one. These 10 chemicals were identified as PCOCs, although the HQ for total PAHs was less than one. Five detected chemicals (beryllium, thallium, benzaldehyde, 2-butanone, and MC) did not have screening values and were also identified as PCOCs.

Several chemicals were identified as COPCs in the SERA because maximum reporting limits exceeded screening values. Mean HQs (based upon the mean of one-half of the sample reporting limits) were heavily influenced by elevated reporting limits in one sample (AS05-5SD03-R05). Excluding this sample, mean HQs for these undetected chemicals were typically less than five. Thus, none of these undetected chemicals were identified as PCOCs in sediment. This is discussed further in Section 8.5.

8.4.2.3 Food Web Exposures

HQs based upon mean exposure doses for upper trophic level receptor species are shown in Table 8-35. HQs did not exceed one for any receptor or chemical based upon NOAELs.

8.4.3 Risk Evaluation

The potential for adverse effects associated with the PCOCs identified in Section 8.4.2 and Table 8-36 are evaluated in this section.

8.4.3.1 Terrestrial Habitats

Risks in terrestrial habitats are negligible due to the elimination of exposure pathways to site surface soils by the landfill cap.

8.4.3.2 Aquatic Habitats

The North Branch Potomac River is located immediately west of Site 5. Complete transport pathways (current and/or historical) via surface runoff and groundwater link Site 5 to the river based upon topography, proximity, and groundwater flow directions.

Surface Water. The mean surface water concentrations of two detected metals (aluminum and manganese) exceeded screening values based upon unfiltered (total), but not filtered (dissolved), samples from the portions of the river adjacent to and downgradient of Site 5. A comparison of these surface water concentrations to upgradient concentrations (Table 8-37) indicates that concentrations of both chemicals were similar to upgradient concentrations (Table 8-38).

Sediment. In sediment, five metals (arsenic, manganese, mercury, nickel, and zinc) and five organics (2-methylnaphthalene, 3- and 4-methylphenol, acenaphthene, diethylphthalate, and fluorene) equaled or exceeded their screening values based upon detected concentrations. To evaluate these exceedences with respect to Site 5 (given the potential for non-facility-related upstream sources), sediment concentrations from samples collected adjacent to and downgradient of Site 5 were compared to upgradient concentrations (shown in Table 8-39). These comparisons were also conducted for the five detected chemicals (two metals and three organics) lacking screening values. The comparison with upgradient concentrations is contained in Table 8-40.

Among the metals, only mercury notably exceeded upgradient concentrations (Table 8-40). However, mercury was only detected in one AVS/SEM sample (5SD07) located well downstream of Site 5 (Table 8-1). This sample was the only one with a SEM/AVS ratio exceeding one. These data, in combination with the low levels of mercury found in fish tissue samples, suggest that the mercury present in sediments has limited bioavailability. In addition, groundwater data from the site (Table 8-41) suggest that Site 5 is not a source of

mercury to the river. The only detection of mercury in recent groundwater samples was in the background well (5GW24; Figure 8-2).

Five organic PCOCs exceeded upgradient concentrations. However, 2-butanone, MC, and fluorene did not exceed equilibrium partitioning-based sediment values, which provide a measure of bioavailability (Table 8-42), suggesting that they would not pose an unacceptable risk to aquatic organisms. An equilibrium partitioning-based value was not available for 2-methylnaphthalene, although its maximum HQ was only 1.57 in the initial screening and total PAHs did not exceed screening values. Equilibrium partitioning is not applicable to 3- and 4-methylphenol, which are polar organic chemicals. The source of these chemicals is not known although there was only one exceedence (at location 5SD03 in Round 6).

Fish Tissue. Fish tissue screening values were not exceeded for the bioaccumulative metals detected in fish tissue samples.

Food Web Exposures. There were no exceedences of screening values based upon mean food web exposures.

8.4.4 Risk Conclusions

Potential site-related risks to ecological receptors utilizing the portion of the river near Site 5 are low to negligible:

- In surface water, only two detected chemicals (aluminum and manganese) exceeded screening values based upon mean concentrations. However, these two exceedences were based upon total concentrations; there were no exceedences based upon dissolved concentrations which better reflect the bioavailable metal fraction. In addition, the concentrations of both these metals were similar in upgradient samples. This indicates negligible site-related risks to aquatic biota from exposure to surface water.
- In sediment, a comparison to screening values and upgradient concentrations indicated a low potential risk to benthic communities from exposure to mercury, although existing data indicate that the mercury in sediments has limited bioavailability and that Site 5 is not a likely source of this chemical. Sediment screening value exceedences for 3- and 4-methylphenol were limited to one sample, although the source of this chemical is not known.
- Fish tissue screening values were not exceeded for the bioaccumulative metals detected in fish tissue samples, indicating negligible risks to these receptors.
- Potential risks to upper trophic level semi-aquatic receptors are negligible, as there were no exceedences of ingestion screening values based upon mean food web exposures.

The results of this ERA do not warrant continuing the ERA process beyond Step 3A.

8.5 Uncertainties

Uncertainties are present in all risk assessments because of the limitations of the available data and the need to make certain assumptions and extrapolations based upon incomplete information. The uncertainty in this ERA is mainly attributable to the following factors:

- Reporting Limits - Reporting limits for some analytes exceeded applicable screening values in some media; these chemicals were not retained as COCs unless they were detected. In surface water, only the mean reporting limit for silver exceeded screening values but by a factor of less than three. In sediment, mean reporting limits exceeded screening values for a number of chemicals although usually by less than an order of magnitude. This was due mainly to elevated reporting limits in one sample (AS05-5SD03-R05). Excluding this sample, mean HQs for these undetected chemicals were typically less than five.

- Selection of COPCs - Chemicals without available screening values for a medium were not retained as COPCs unless they were detected. This was particularly an issue for the sediment screen (most chemicals had surface water screening values). An evaluation of organic sediment PCOCs without SLC-based screening values (see the following bullet) was conducted by compiling published equilibrium partitioning-based sediment values. Based upon this evaluation, none of the PCOCs exceeded these values.

- Sediment Screening Values - Most of the sediment screening values used in the ERA do not consider site-specific bioavailability to ecological receptors and are typically based upon correlational studies (termed the Screening Level Concentration [SLC] approach). These factors tend to make the resulting screening values very conservative and likely overestimate potential risk.

- Ingestion Screening Values - Data on the toxicity of many chemicals to the specific receptor species used in the ERA were sparse or lacking, requiring the extrapolation of data from other wildlife species or from laboratory studies with non-wildlife species. This is a typical limitation and extrapolation for ERAs because so few wildlife species have been tested directly for most chemicals. The uncertainties associated with toxicity extrapolation were minimized through the selection of the most appropriate test species for which suitable toxicity data were available. The factors considered in selecting a test species to represent a receptor species included taxonomic relatedness, trophic level, foraging method, and similarity of diet.

  A second uncertainty related to the derivation of ingestion screening values applies to metals. Most of the toxicological studies on which the ingestion screening values for metals were based used forms of the metal (such as salts) that have high water solubility and high bioavailability to receptors. Because the media samples on which site-specific exposure estimates were based analyzed for total metals, regardless of form, and these highly bioavailable forms are expected to compose only a fraction of the total metals concentrations, this is likely to result in an overestimation of potential risks for these chemicals.

  A third source of uncertainty associated with the derivation of ingestion screening values concerns the use of uncertainty factors. NOAELs were extrapolated from LOAELs using an uncertainty factor of 10. This approach is likely to be conservative because Dourson, et al. (1983) determined that 96 percent of the chemicals included in a data review had LOAEL/NOAEL ratios of five or less. The use of an uncertainty factor of 10, although potentially conservative, also serves to counter some of the uncertainty associated with interspecies extrapolations, for which a specific uncertainty factor was not used.

- Chemical Mixtures - Information on the ecotoxicological effects of chemical interactions is generally lacking, which required (as is standard for ecological risk assessments) that the chemicals be evaluated on a compound-by-compound basis during the comparison to screening values. This could result in an underestimation of risk (if there are additive or synergistic effects among chemicals) or an overestimation of risks (if there are antagonistic effects among chemicals).

- Receptor Species Selection - Reptiles were selected as receptors in the ERA, but were not evaluated quantitatively even when exposure pathways were likely to be complete. Reptiles were evaluated using other fauna (birds and mammals) as surrogates due to the general lack of reptile-specific toxicological data. This represents an uncertainty in the risk assessment.

  The ERA evaluated amphibians at a critical life stage (tadpole) by screening against surface water and sediment screening values. After a search of toxicological databases, no relevant dietary toxicological information was found for amphibians. Thus, food web exposures for amphibians were not directly, quantitatively evaluated. However, the ERA analyzed ingestion exposures for other upper trophic level receptors that eat one hundred percent aquatic food items (e.g., great blue heron). By analyzing amphibians at a sensitive life stage and evaluating other (non-amphibian) upper trophic level aquatic receptors, the ERA is likely to adequately bound potential risks to amphibian species, even though they were not quantitatively evaluated.

  It was also assumed that any reptiles and amphibians present in the river near Site 5 were not exposed to significantly higher concentrations of chemicals and were not more sensitive to chemicals than other receptor species evaluated in the ERA. This assumption was a source of uncertainty in the ERA. In addition, there is some uncertainty associated with the use of specific receptor species to represent larger groups of organisms (e.g., guilds).

- Food Web Exposure Modeling - Chemical concentrations in some aquatic food items (plants and benthic invertebrates) were modeled from measured media concentrations and were not directly measured. The use of generic, literature-derived exposure models and BAFs introduces some uncertainty into the resulting estimates. The values selected and the methodology employed were intended to provide a conservative (SERA) or reasonable (Step 3A) estimate of potential food web exposure concentrations.

  Another source of uncertainty is the use of default assumptions for exposure parameters such as BCFs and BAFs. Although BCFs or BAFs for many bioaccumulative chemicals were readily available from the literature and were used in the ERA, the use of a default factor of 1.0 to estimate the concentration of some chemicals in receptor prey items is a source of uncertainty.

  Area use factors were assumed to equal one. This is a conservative assumption because a significant percentage of each upper trophic level receptor species time could be spent foraging off-site in unimpacted areas or in areas where chemical concentrations are expected to be significantly lower.

- Total Versus Dissolved Metals - USEPA guidance (USEPA, 1996b) indicates that the dissolved metal fraction should be preferentially used to the total metal fraction in surface water screening. Both total and dissolved concentrations were used in the ERA

for the surface water screen. High levels of suspended solids and sediment-adsorbed metals would result in overstating bioavailable surface water concentrations and thus potential exposures and risks.

- Mean Versus Maximum Media Concentrations - As is typical in an ERA, a finite number of samples of environmental media are used to develop the exposure estimates. The maximum measured concentration provides a conservative estimate for relatively small groups of immobile biota or individual organisms with a limited home range. The most realistic exposure estimates for mobile species with relatively large home ranges and for species populations (even those that are immobile or have limited home ranges) are those based upon the mean chemical concentrations in each medium to which these receptors are exposed. This is reflected in the wildlife dietary exposure models contained in the Wildlife Exposure Factors Handbook (USEPA, 1993b), which specify the use of average media concentrations. Given the mobility of the upper trophic level receptor species used in the ERA, the use of maximum chemical concentrations (rather than mean concentrations) in the SERA to estimate the exposure via food webs is very conservative. This conservatism was reduced to more realistic levels in the values selected for use in the Step 3A evaluation.

- Comparisons to Upgradient Concentrations - Upgradient surface water and sediment concentrations were used to judge the site-relatedness of individual chemicals. If site chemical concentrations were consistent with upgradient concentrations, it was assumed that the chemicals were not site-related. There exists the possibility that concentrations were indeed site-related, rendering the assumption false. However the impact of this possibility is minimal as it related to Site 5 because chemicals at levels consistent with upgradient concentrations should exhibit no different ecological effects than commonly occurring in areas not affected by site-specific releases.

- Spatial Distribution of River Samples - The number of surface water, sediment, and fish tissue samples, and their spatial distribution, were sufficient to evaluate potential ecological risks. Four surface water sampling locations were available, one upstream of the site, one adjacent to the site, and two downstream of the site. There were 16 sediment sampling locations covering the near bank, mid-channel, and far bank areas of the river. Three of these locations were upstream of the site, five were adjacent to the site, and eight were downstream of the site. Fish were sampled in three areas of the river, one upstream of the site and two downstream (Figure 8-2).

TABLE 8-1
Physical Parameters - North Branch Potomac River - Site 5
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Parameter	5SD01-R07	5SD01A	5SD01B	5SD02-R07	5SD02A	5SD02B	5SD03-R07	5SD03A	5SD03B
AVS/SEM (umoles/g)									
Cadmium	0.009	NA	NA	0.004	NA	NA	0.005	NA	NA
Copper	0.160	NA	NA	0.301	NA	NA	0.227	NA	NA
Lead	0.185	NA	NA	0.077	NA	NA	0.101	NA	NA
Mercury	<0.000074	NA	NA	<0.000048	NA	NA	<0.000056	NA	NA
Nickel	0.57	NA	NA	0.40	NA	NA	0.34	NA	NA
Zinc	3.69	NA	NA	1.72	NA	NA	1.92	NA	NA
Total (SEM)	4.61	NA	NA	2.50	NA	NA	2.59	NA	NA
Sulfide (AVS)	32.0	NA	NA	16.2	NA	NA	11.8	NA	NA
SEM/AVS Ratio	0.14	--	--	0.15	--	--	0.22	--	--
Other Parameters									
Total Organic Carbon (mg/kg)	78,000	16,000	20,000	100,000	6,400	8,600	67,000	4,900	7,800
pH	6.90	7.30	7.20	7.50	7.50	7.30	6.50	7.40	7.40
Grain Size (percent)									
Coarse gravel	0.00	0.00	5.40	0.00	3.20	3.30	0.00	0.00	0.00
Fine gravel	0.40	1.40	3.30	3.00	12.8	24.4	0.10	7.40	2.60
Coarse sand	0.30	8.80	0.30	1.80	9.80	12.6	0.20	6.30	8.50
Medium sand	2.20	78.8	8.50	3.80	62.0	47.9	2.10	62.3	72.6
Fine sand	69.6	10.6	81.1	50.4	11.6	11.2	69.8	23.5	16.1
Silt/clay	27.5	0.40	1.40	41.0	0.60	0.60	27.8	0.50	0.20
Water Parameters (Feb 2002)									
Dissolved oxygen (mg/L)	11.9	--	--	12.7	--	--	12.2	--	--
Temperature (C)	8.80	--	--	9.40	--	--	9.50	--	--
Conductivity (ms/cm)	0.435	--	--	0.428	--	--	0.434	--	--
pH	7.16	--	--	--	--	--	7.07	--	--
Eh/ORP (mV)	185	--	--	198	--	--	105	--	--

TABLE 8-1
Physical Parameters - North Branch Potomac River - Site 5
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Parameter	5SD04-R07	5SD05	5SD05P	5SD05A	5SD06	5SD06A	5SD07	5SD07A
AVS/SEM (umoles/g)								
Cadmium	0.006	0.005	0.004	NA	0.002	NA	0.001	NA
Copper	0.262	0.342	0.193	NA	0.147	NA	0.083	NA
Lead	0.099	0.119	0.077	NA	0.049	NA	0.041	NA
Mercury	<0.000071	<0.000349	<0.000051	NA	<0.000043	NA	0.000018	NA
Nickel	0.72	0.46	0.31	NA	0.21	NA	0.18	NA
Zinc	2.73	1.95	1.32	NA	0.87	NA	0.72	NA
Total (SEM)	3.83	2.88	1.90	NA	1.28	NA	1.02	NA
Sulfide (AVS)	43.3	18.1	28.0	NA	5.17	NA	0.53	NA
SEM/AVS Ratio	0.09	0.16	0.07	--	0.25	--	1.93	--
Other Parameters								
Total Organic Carbon (mg/kg)	91,000	130,000	120,000	7,000	62,000	19,000	9,000	3,700
pH	7.00	7.30	7.30	7.10	7.10	7.40	7.20	7.60
Grain Size (percent)								
Coarse gravel	0.00	0.00	0.00	8.20	13.2	0.00	13.6	33.6
Fine gravel	0.00	2.60	1.40	9.30	14.6	13.1	45.6	32.5
Coarse sand	0.90	3.40	2.90	9.30	4.40	16.9	5.90	8.60
Medium sand	2.40	14.1	14.3	60.0	6.70	56.9	8.90	23.2
Fine sand	68.1	66.9	65.0	12.2	44.2	12.3	20.6	1.70
Silt/clay	28.6	13.0	16.4	1.00	16.9	0.80	5.40	0.40
Water Parameters (Feb 2002)								
Dissolved oxygen (mg/L)	11.2	--	--	--	--	--	--	--
Temperature (C)	9.90	--	--	--	--	--	--	--
Conductivity (ms/cm)	0.438	--	--	--	--	--	--	--
pH	--	--	--	--	--	--	--	--
Eh/ORP (mV)	122	--	--	--	--	--	--	--

TABLE 8-2
Wildlife Species Observed at ABL
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Common Name	Scientific Name
Birds	
American crow	*Corvus brachyrhynchos*
American goldfinch	*Carduelis tristis*
American kestrel	*Falco sparverius*
American robin	*Turdus migratorius*
Barn swallow	*Hirundo rustica*
Belted kingfisher	*Ceryle alcyon*
Black-capped chickadee	*Poecile atricapillus*
Black-crowned night-heron	*Nycticorax nycticorax*
Brown-headed cowbird	*Molothrus ater*
Chipping sparrow	*Spizella passerina*
Common grackle	*Quiscalus quiscula*
Eastern kingbird	*Tyrannus tyrannus*
Eastern meadowlark	*Sturnella magna*
Eastern phoebe	*Sayornis phoebe*
Eastern towhee	*Pipilo erythrophthalmus*
European starling	*Sturnus vulgaris*
Field sparrow	*Spizella pusilla*
Great blue heron	*Ardea herodias*
House sparrow	*Passer domesticus*
Indigo bunting	*Passerina cyanea*
Killdeer	*Charadrius vociferus*
Mallard	*Anas platyrhynchos*
Mourning dove	*Zenaida macroura*
Northern cardinal	*Cardinalis cardinalis*
Northern flicker	*Colaptes auratus*
Northern mockingbird	*Mimus polyglottos*
Pileated woodpecker	*Dryocopus pileatus*
Red-bellied woodpecker	*Melanerpes carolinus*
Red-tailed hawk	*Buteo jamaicensis*
Red-winged blackbird	*Agelaius phoeniceus*
Rock dove	*Columba livia*
Song sparrow	*Melospiza melodia*
Tree swallow	*Tachycineta bicolor*
Tufted titmouse	*Parus bicolor*
Turkey vulture	*Cathartes aura*
White-throated sparrow	*Zonotrichia albicollis*
Wild turkey	*Meleagris gallopavo*
Wood duck	*Aix sponsa*
Wood thrush	*Hylocichla mustelina*
Yellow warbler	*Dendroica petechia*
Mammals	
Eastern chipmunk	*Tamias striatus*

TABLE 8-2
Wildlife Species Observed at ABL
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Common Name	**Scientific Name**
Eastern cottontail	*Sylvilagus floridanus*
Eastern fox squirrel	*Sciurus niger*
Eastern harvest mouse	*Reithrodontomys humulis*
Gray squirrel	*Sciurus carolinensis*
Meadow vole	*Microtus pennsylvanicus*
Raccoon	*Procyon lotor*
White-tailed deer	*Odocoileus virginianus*
Woodchuck	*Marmota monax*
Reptiles/Amphibians	
Black rat snake	*Elaphe o. obsoleta*
Bullfrog	*Rana catesbeiana*
Corn snake	*Elaphe g. guttata*

TABLE 8-3
Breeding Bird Atlas Data From the Site Vicinity
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Common Name	Scientific Name	Breeding Status[a]
Great blue heron	*Ardea herodias*	Ob
Green heron	*Butorides virescens*	Pr
Wood duck	*Aix sponsa*	C
American black duck	*Anas rubripes*	C
Mallard	*Anas platyrhynchos*	C
Turkey vulture	*Cathartes aura*	Pr
Cooper's hawk	*Accipiter cooperii*	C
Red-shouldered hawk	*Buteo lineatus*	C
Broad-winged hawk	*Buteo platypterus*	C
Red-tailed hawk	*Buteo jamaicensus*	Pr
American kestrel	*Falco sparverius*	C
Wild turkey	*Meleagris gallopavo*	C
Northern bobwhite	*Colinus virginianus*	Pr
Virginia rail	*Rallus limicola*	C
Sora	*Porzana carolina*	C
Killdeer	*Charadrius vociferus*	C
Spotted sandpiper	*Actitis macularia*	Po
American woodcock	*Scolopax minor*	Po
Rock dove	*Columba livia*	C
Mourning dove	*Zenaida macroura*	C
Yellow-billed cuckoo	*Coccyzus americanus*	Pr
Barn owl	*Tyto alba*	C
Eastern screech-owl	*Otus asio*	C
Great horned owl	*Bubo virginianus*	Po
Barred owl	*Strix varia*	Po
Common nighthawk	*Chordeiles minor*	Po
Whip-poor-will	*Caprimulgus vociferus*	Pr
Chimney swift	*Chaetura pelagica*	Pr
Ruby-throated hummingbird	*Archilochus colubris*	Pr
Belted kingfisher	*Ceryle alcyon*	Pr
Red-bellied woodpecker	*Melanerpes carolinus*	C
Downy woodpecker	*Picoides pubescens*	C
Hairy woodpecker	*Picoides villosus*	Po
Northern flicker	*Colaptes auratus*	C
Pileated woodpecker	*Dryocopus pileatus*	Pr
Eastern wood-pewee	*Contopus virens*	Pr
Acadian flycatcher	*Empidonax virescens*	Pr
Willow flycatcher	*Empidonax traillii*	Pr
Eastern phoebe	*Sayornis phoebe*	C
Great crested flycatcher	*Myiarchus crinitus*	Pr
Eastern kingbird	*Tyrannus tyrannus*	C
Tree swallow	*Tachycineta bicolor*	C
Northern rough-winged swallow	*Stelgidopteryx serripennis*	Pr

TABLE 8-3
Breeding Bird Atlas Data From the Site Vicinity
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Common Name	Scientific Name	Breeding Status[a]
Barn swallow	*Hirundo rustica*	C
Blue jay	*Cyanocitta cristata*	C
American crow	*Corvus brachyrhynchos*	C
Fish crow	*Corvus ossifragus*	Pr
Common raven	*Corvus corax*	C
Black-capped chickadee	*Parus atricapillus*	Pr
Tufted titmouse	*Parus bicolor*	C
White-breasted nuthatch	*Sitta carolinensis*	C
Carolina wren	*Thryothorus ludovicianus*	C
House wren	*Troglodytes aedon*	Pr
Blue-gray gnatcatcher	*Polioptila caerulea*	C
Eastern bluebird	*Sialia sialis*	C
Wood thrush	*Hylocichla mustelina*	Pr
American robin	*Turdus migratorius*	C
Gray catbird	*Dumetella carolinensis*	Pr
Northern mockingbird	*Mimus polyglottos*	Pr
Brown thrasher	*Toxostoma rufum*	C
Cedar waxwing	*Bombycilla cedrorum*	C
European starling	*Sturnus vulgaris*	C
White-eyed vireo	*Vireo griseus*	C
Solitary vireo	*Vireo solitarius*	Po
Yellow-throated vireo	*Vireo flavifrons*	Pr
Warbling vireo	*Vireo gilvus*	Pr
Red-eyed vireo	*Vireo olivaceus*	Pr
Blue-winged warbler	*Vermivora pinus*	Po
Golden-winged warbler	*Vermivora chrysoptera*	Pr
Nashville warbler	*Vermivora ruficapilla*	Po
Northern parula	*Parula americana*	Pr
Yellow warbler	*Dendroica petechia*	Pr
Prairie warbler	*Dendroica discolor*	Pr
Cerulean warbler	*Dendroica cerulea*	Pr
American redstart	*Setophaga ruticilla*	Pr
Worm-eating warbler	*Helmitheros vermivorus*	Pr
Ovenbird	*Seiurus aurocapillus*	Pr
Louisiana waterthrush	*Seiurus motacilla*	C
Kentucky warbler	*Oporornis formosus*	Pr
Common yellowthroat	*Geothlypis trichas*	C
Yellow-breasted chat	*Icteria virens*	C
Scarlet tanager	*Piranga olivacea*	C
Northern cardinal	*Cardinalis cardinalis*	C
Rose-breasted grosbeak	*Pheucticus ludovicianus*	Po
Blue grosbeak	*Guiraca caerulea*	C
Indigo bunting	*Passerina cyanea*	C

TABLE 8-3
Breeding Bird Atlas Data From the Site Vicinity
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Common Name	Scientific Name	Breeding Status[a]
Eastern towhee	*Pipilo erythrophthalmus*	Pr
Chipping sparrow	*Spizella passerina*	C
Field sparrow	*Spizella pusilla*	Pr
Vesper sparrow	*Pooecetes gramineus*	Pr
Savannah sparrow	*Passerculus sandwichensis*	C
Grasshopper sparrow	*Ammodramus savannarum*	Pr
Henslow's sparrow	*Ammodramus henslowii*	Po
Song sparrow	*Melospiza melodia*	C
Swamp sparrow	*Melospiza georgiana*	C
Red-winged blackbird	*Agelaius phoeniceus*	C
Eastern meadowlark	*Sturnella magna*	Pr
Common grackle	*Quiscalus quiscula*	C
Brown-headed cowbird	*Molothrus ater*	C
Orchard oriole	*Icterus spurius*	Pr
Northern oriole	*Icterus galbula*	C
House finch	*Carpodacus mexicanus*	C
American goldfinch	*Carduelis tristis*	C
House sparrow	*Passer domesticus*	C

[a]C - Confirmed breeding; Pr - Probable breeding; Po - Possible breeding; Ob - Observed
Source: Buckelew and Hall (1994); Robbins and Blom (1996)

TABLE 8-4
Christmas Bird Count Data (1995-2000), Allegany County, MD/WV Census Plot
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Common Name	Scientific Name	1995-1996	1996-1997	1997-1998	1998-1999	1999-2000	Average
Red-winged blackbird	*Agelaius phoeniceus*	5	0	18	35	35	18.6
White-crowned sparrow	*Zonoteichia leucophrys*	20	9	19	10	25	16.6
Red-tailed hawk	*Buteo jamaicensis*	23	15	17	4	23	16.4
American robin	*Turdus migratorius*	1	0	2	70	4	15.4
Ruddy duck	*Oxyura jamaicensis*	5	0	10	3	52	14.0
Hairy woodpecker	*Picoides villosus*	7	7	23	22	7	13.2
Winter wren	*Troglodytes troglodytes*	10	6	11	13	18	11.6
Killdeer	*Charadrius vociferus*	10	2	14	9	21	11.2
Hooded merganser	*Lophodytes cucullatus*	0	16	11	5	19	10.2
Brown creeper	*Certhia americana*	7	8	13	13	8	9.8
Brown-headed cowbird	*Molothrus ater*	41	0	0	4	0	9.0
Purple finch	*Carpodacus purpureus*	1	1	6	18	12	7.6
Field sparrow	*Spizella pusilla*	12	8	6	6	4	7.2
American coot	*Fulica americana*	0	0	8	7	20	7.0
Ruby-crowned kinglet	*Regulus calendula*	9	2	10	7	5	6.6
Black vulture	*Coragyps atratus*	3	0	3	0	24	6.0
Hermit thrush	*Catharus guttatus*	3	6	1	16	4	6.0
Pine siskin	*Carduelis pinus*	0	0	0	0	30	6.0
Common raven	*Corvus corax*	2	1	5	12	9	5.8
Great blue heron	*Ardea herodias*	7	2	9	3	7	5.6
American black duck	*Anas rubripes*	10	1	12	1	3	5.4
Belted kingfisher	*Ceryle alcyon*	8	3	2	9	5	5.4
Yellow-bellied sapsucker	*Sphyrapicus varius*	3	3	7	8	5	5.2
Chipping sparrow	*Spizella passerina*	0	5	2	5	5	3.4
Swamp sparrow	*Melospiza georgiana*	4	1	3	5	4	3.4
Red-shouldered hawk	*Buteo lineatus*	3	0	6	2	4	3.0
Pied-billed grebe	*Podilymbus podiceps*	4	1	0	4	5	2.8
Ruffed grouse	*Bonasa umbellus*	2	0	2	1	8	2.6
Common grackle	*Quiscalus quiscula*	10	0	2	0	0	2.4

TABLE 8-4
Christmas Bird Count Data (1995-2000), Allegany County, MD/WV Census Plot
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Common Name	Scientific Name	1995-1996	1996-1997	1997-1998	1998-1999	1999-2000	Average
Cooper's hawk	*Accipiter cooperii*	3	3	1	2	3	2.4
Eastern phoebe	*Sayornis phoebe*	6	1	1	2	2	2.4
Sharp-shinned hawk	*Accipiter striatus*	2	4	2	2	2	2.4
Common goldeneye	*Bucephala clangula*	1	1	0	0	8	2.0
American green-winged teal	*Anas crecca*	2	0	0	3	4	1.8
Eastern towhee	*Pipilo erythrophthalmus*	3	0	1	3	2	1.8
Bufflehead	*Bucephala albeola*	1	0	0	0	7	1.6
Eastern screech-owl	*Otus asio*	1	1	1	2	2	1.4
Red-breasted nuthatch	*Sitta canadensis*	6	0	1	0	0	1.4
Evening grosbeak	*Hesperiphona vespertina*	6	0	0	0	0	1.2
Ring-billed gull	*Larus delawarensis*	1	1	1	3	0	1.2
Thrush spp.	*Catharus spp*	0	0	1	5	0	1.2
Horned grebe	*Podiceps auritus*	0	0	0	5	0	1.0
Loggerhead shrike	*Lanius ludovicianus*	2	1	1	1	0	1.0
Wood duck	*Aix sponsa*	3	1	0	1	0	1.0
American kestrel	*Falco sparverius*	7	7	8	5	8	7.0
House wren	*Troglodytes aedon*	2	0	0	2	0	0.8
Tundra swan	*Cygnus columbianus*	0	0	1	1	2	0.8
Bonaparte's gull	*Larus philadelphia*	1	0	0	0	2	0.6
Common redpoll	*Carduelis flammea*	2	0	0	0	0	0.4
Great horned owl	*Bubo virginianus*	0	1	0	0	1	0.4
Northern harrier	*Circus cyaneus*	0	2	0	0	0	0.4
Rusty blackbird	*Euphagus carolinus*	0	0	0	2	0	0.4
Turkey vulture	*Cathartes aura*	0	0	0	0	3	0.6
Common merganser	*Mergus merganser*	0	1	0	0	0	0.2
Eastern meadowlark	*Sturnella magna*	0	0	1	0	0	0.2
Gray catbird	*Dumetella carolinensis*	0	0	0	1	0	0.2
Lesser scaup	*Aythya affinis*	0	0	0	1	0	0.2
Merlin	*Falco columbarius*	0	0	1	0	0	0.2

TABLE 8-4
Christmas Bird Count Data (1995-2000), Allegany County, MD/WV Census Plot
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Common Name	Scientific Name	1995-1996	1996-1997	1997-1998	1998-1999	1999-2000	Average
European starling	*Sturnus vulgaris*	1,416	668	1,337	543	907	974
Rock dove	*Columba livia*	1,017	823	1,584	444	975	969
American crow	*Corvus brachyrhynchos*	885	343	405	239	380	450
Dark-eyed junco	*Junco hyemalis*	351	531	505	497	242	425
Canada goose	*Branta canadensis*	475	165	815	410	243	422
Mallard	*Anas platyrhynchos*	532	278	726	197	185	384
Northern cardinal	*Cardinalis cardinalis*	190	165	193	165	205	184
Mourning dove	*Zenaida macroura*	168	92	146	255	172	167
House sparrow	*Passer domesticus*	138	156	211	110	106	144
Black-capped chickadee	*Parus atricapillus*	124	75	170	177	147	139
Tufted titmouse	*Parus bicolor*	118	122	141	148	102	126
American goldfinch	*Carduelis tristis*	103	57	92	163	205	124
Blue jay	*Cyanocitta cristata*	210	110	56	111	80	113
House finch	*Carpodacus mexicanus*	140	40	47	118	198	109
White-throated sparrow	*Zonotrichia albicollis*	106	86	90	103	92	95.4
Song sparrow	*Melospiza melodia*	51	58	67	131	73	76.0
Eastern bluebird	*Sialia sialis*	92	38	48	66	106	70.0
Downy woodpecker	*Picoides pubescens*	66	54	82	60	71	66.6
White-breasted nuthatch	*Sitta carolinensis*	59	36	74	46	75	58.0
Carolina wren	*Thryothorus ludovicianus*	37	32	69	82	68	57.6
American tree sparrow	*Spizella arborea*	27	43	74	68	42	50.8
Northern mockingbird	*Mimus polyglottos*	79	40	34	31	51	47.0
Cedar waxwing	*Bombycilla cedrorum*	35	36	2	122	11	41.2
Red-bellied woodpecker	*Melanerpes carolinus*	27	29	35	41	45	35.4
Northern flicker	*Colaptes auratus*	59	18	23	42	26	33.6
Yellow-rumped warbler	*Dendroica coronata*	97	1	9	43	14	32.8
Wild turkey	*Meleagris gallopavo*	1	80	18	25	36	32.0
Pileated woodpecker	*Dryocopus pileatus*	23	16	22	31	26	23.6
Golden-crowned kinglet	*Regulus satrapa*	17	33	9	33	7	19.8

TABLE 8-4
Christmas Bird Count Data (1995-2000), Allegany County, MD/WV Census Plot
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Common Name	Scientific Name	1995-1996	1996-1997	1997-1998	1998-1999	1999-2000	Average
Palm warbler	*Dendroica palmarum*	1	0	0	0	0	0.2
Rough-legged hawk	*Buteo lagopus*	1	0	0	0	0	0.2
Total Species		73	60	67	71	69	68
Total Individuals		6,904	4,346	7,327	4,834	5,302	5,743
Source: BirdSource (2000)							

TABLE 8-5
Amphibian and Reptile Species Known to Occur in Mineral County, West Virginia
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Common Name	Scientific Name
Amphibians	
Appalachian seal salamander	*Desmognathus m. monticola*
Bullfrog	*Rana catesbeiana*
Eastern American toad	*Bufo a. americanus*
Eastern newt	*Notophthalmus v. viridescens*
Four-toed salamander	*Hemidactylium scutatum*
Fowler's toad	*Bufo woodhousei fowleri*
Gray treefrog	*Hyla chrysoscelis*
Green frog	*Rana clamitans melanota*
Jefferson salamander	*Ambystoma jeffersonianum*
Longtail salamander	*Eurycea l. longicauda*
Mountain dusky salamander	*Desmognathus ochrophaeus*
Northern cricket frog	*Acris c. crepitans*
Northern dusky salamander	*Desmognathus f. fuscus*
Northern red salamander	*Pseudotriton r. ruber*
Northern spring peeper	*Pseudacris c. crucifer*
Northern spring salamander	*Gyrinophilus p. porphyriticus*
N. two-lined salamander	*Eurycea b. bislineata*
Pickerel frog	*Rana palustris*
Redback salamander	*Plethodon cinereus*
Slimy salamander	*Plethodon g. glutinosus*
Spotted salamander	*Ambystoma maculatum*
Upland chorus frog	*Pseudacris triseriata feriarum*
Valley and ridge salamander	*Plethodon hoffmani*
Wood frog	*Rana sylvatica*
Reptiles	
Black rat snake	*Elaphe o. obsoleta*
Common musk turtle	*Sternotherus odoratus*
Common snapping turtle	*Chelydra s. serpentina*
Eastern box turtle	*Terrapene c. carolina*
Eastern earth snake	*Virginia v. valeriae*
Eastern garter snake	*Thamnophis s. sirtalis*
Eastern hognose snake	*Heterodon platirhinos*
Eastern milk snake	*Lampropeltis t. triangulum*
Eastern painted turtle	*Chrysemys p. picta*
Eastern smooth green snake	*Opheodrys v. vernalis*
Eastern worm snake	*Carphophis a. amoenus*
Five-lined skink	*Eumeces fasciatus*
Northern black racer	*Coluber c. constrictor*
Northern brown snake	*Storeria d. dekayi*
Northern copperhead	*Agkistrodon contortrix mokasen*
Northern fence lizard	*Sceloporus undulatus hyacinthinus*
Northern redbelly snake	*Storeria o. occipitomaculata*

TABLE 8-5
Amphibian and Reptile Species Known to Occur in Mineral County, West Virginia
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Common Name	Scientific Name
Northern ringneck snake	*Diadophis punctatus edwardsii*
Northern water snake	*Nerodia s. sipedon*
Timber rattlesnake	*Crotalus horridus*
Wood turtle	*Clemmys insculpta*
Source: Green and Pauley (1987)	

TABLE 8-6

Fish Catch Per Unit Effort (Individuals/Hour) at Station 5 (Upstream), Station 6 (Pinto), and Station 7 (Downstream)

North Branch Potomac River

Focused RI/FS

Site 5, Allegany Ballistics Laboratory

Rocket Center, West Virginia

Common Name	Scientific Name	1988			1989			1990			1992			1993		
		5	6	7	5	6	7	5	6	7	5	6	7	5	6	7
American eel	*Anguilla rostrata*	0	0	0	0	0	0	0	0	1	0	0	2	0	0	0
Chain pickerel	*Esox niger*	0	0	1.5	0	0	0	0	0	1	0	0	0	0	0	0
Carp	*Cyprinus carpio*	0	0	A	0	30	0	0	0	44	0	0	51	0	23.8	0
Cutlips minnow	*Exoglossum maxillingua*	0	0	0	2	0	0	1	0	0	0	1	0	0	0	0
Golden shiner	*Notomigonous crysoleucas*	2.5	45.9	A	0	44	7	0	44	7	0	3	1	0	16.8	1.4
River chub	*Nocomis micropogon*	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Common shiner	*Notropis cornutus*	0	0	A	6	0	0	3	0	1	0	0	2	0	2.2	0
Spotfin shiner	*Notropis spilopterus*	0	0	0	0	0	0	0	0	79	0	0	0	0	0	0
Rosyface shiner	*Notropis rubellus*	0	0	0	0	0	0	0	0	0	0	0	12	0	0	0
Spottail shiner	*Notropis hudsonius*	0	33.5	A	0	0	25	0	0	0	0	0	0	0	0	0
Bluntnose minnow	*Pimephales promelas*	0	0	0	0	30	0	0	10	0	0	48	0	0	35	0
Blacknose dace	*Rhinichthys atratulus*	42	2.5	0	244	0	0	47	1	0	4	41	0	21	22	142
Longnose dace	*Rinichthys cataractae*	14	0	0	10	0	0	1	0	0	20	6	0	6	17	0
Creek chub	*Semotilus atromaculatus*	56	19.9	0	80	40	0	31	15	0	54	43	0	30	44	0
Fallfish	*Semotilus corporalis*	0	0	16.3	0	0	9	0	0	10	0	0	26	0	0	2.8
White sucker	*Catostomus commersoni*	84	176.3	1.5	58	97	106	47	165	110	70	95	3	165	121	4.2
Creek chubsucker	*Erimyzon oblongus*	0	0	0	0	0	0	0	0	1	0	0	1	0	0	1.4
Northern hogsucker	*Hypentilium nigricans*	0	0	3	0	0	2	0	0	1	0	0	0	0	0	0
Golden redhorse	*Moxostoma erythrum*	0	0	A	0	0	107	0	0	101	0	0	23	0	0	8.4
Yellow bullhead	*Ictalurus natilis*	0.7	0	1.5	0	0	1	0	1	3	0	2	2	0	0	2.8
Brown bullhead	*Ictalurus nebulosus*	0	0	3	0	2	2	0	3	6	0	0	1	0	2	2.8
Channel catfish	*Ictalurus punctatus*	0	0	1.5	0	0	3	0	0	0	0	0	2	0	0	4.2
Rock bass	*Amblopites rupestris*	1.3	0	22.3	4	0	26	3	0	21	0	0	8	0	0	32
Redbreast sunfish	*Lepomis auritus*	0	1.2	47.5	0	0	38	0	0	47	0	2	22	0	0.7	8.4
Green sunfish	*Lepomis cyanellus*	0	0	0	8	0	6	0	2	0	0	0	0	0	0	0
Pumpkinseed	*Lepomis gibbosus*	25.5	34.8	8.9	2	23	15	5	20	19	2	3	7	1.5	82	22
Bluegill	*Lepomis macrochirus*	0	0	31.2	0	0	17	0	1	15	0	0	18	0	1.3	20

TABLE 8-6

Fish Catch Per Unit Effort (Individuals/Hour) at Station 5 (Upstream), Station 6 (Pinto), and Station 7 (Downstream)

North Branch Potomac River

Focused RI/FS

Site 5, Allegany Ballistics Laboratory

Rocket Center, West Virginia

Common Name	Scientific Name	1988			1989			1990			1992			1993		
		5	6	7	5	6	7	5	6	7	5	6	7	5	6	7
Smallmouth bass	*Micropterus dolomieui*	0	0	23.7	0	0	19	0	0	5	0	0	10	0	0.7	5.6
Largemouth bass	*Micropterus salmoides*	0	0	19.3	0	0	16	0	0	3	0	0	10	4.5	21	7
Yellow perch	*Perca flavescens*	0	0	1.5	0	0	0	0	0	0	0	0	0	0	0	0
Walleye	*Stizostedion vitreum*	0	0	5.9	0	0	5	0	0	0	0	0	3	0	0	2.8
Greenside darter	*Etheostoma blenniodes*	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0
Tesselated darter	*Etheostoma olmstedi*	0	0	0	0	0	1	0	0	0	0	3	1	0	7.3	0

Note: A = Abundant

Source: CH2M HILL (1995)

TABLE 8-7
Results of Benthic Invertebrate Sampling in the North Branch Potomac River - July 1994
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Taxa	Station 1			Station 2			Station 3			Station 4		
	A	B	Total	A	B	Total	A	B	Total	A	B	Total
Annelida												
Oligochaeta												
Tubificidae w.o.h.c.	4	2	6	1	0	1	2	5	7	0	0	0
Limnodrilus sp.	0	0	0	1	0	1	0	0	0	0	0	0
Limnodrilus hoffmeisteri	0	0	0	0	2	2	0	1	1	0	0	0
Arthropoda												
Crustacea												
Orconectes sp.	0	0	0	1	0	1	0	2	2	1	7	8
Insecta												
Ephemeroptera												
Stenacron sp.	1	0	1	0	0	0	1	0	1	0	0	0
Odonata												
Gomphidae												
Gomphus sp.	0	0	0	0	0	0	0	0	0	0	1	1
Megaloptera												
Corydalidae												
Nigronia serricornis	0	1	1	0	0	0	0	0	0	0	0	0
Sialidae												
Sialis sp.	0	0	0	0	0	0	0	1	1	0	0	0
Trichloptera												
Hydropsychidae												
Ceratopsyche morosa	0	0	0	0	0	0	0	0	0	0	3	3
Cheumatopsyche sp.	0	0	0	0	0	0	0	0	0	0	5	5
Diptera												
Chironomidae	0	0	0	0	0	0	0	0	0	1	0	1
Conchapelopia sp.	0	0	0	0	0	0	0	0	0	1	0	1
Cricotopus sp.	0	0	0	0	0	0	0	0	0	0	5	5
Procladius sp.	0	0	0	0	0	0	0	1	1	0	0	0

TABLE 8-7

Results of Benthic Invertebrate Sampling in the North Branch Potomac River - July 1994

Focused RI/FS

Site 5, Allegany Ballistics Laboratory

Rocket Center, West Virginia

Taxa	Station 1			Station 2			Station 3			Station 4		
	A	B	Total	A	B	Total	A	B	Total	A	B	Total
Mollusca												
Gastropoda												
Ferrissia sp.	1	0	1	0	4	4	0	0	0	0	13	13
Total No. of Organisms	6	3	9	3	6	9	3	10	13	3	34	37
Total No. Of Taxa	3	2	4	3	2	5	2	5	6	3	6	8

Note: A, B = two replicates at each station.

Source: CH2M HILL (1995)

TABLE 8-8
Results of Benthic Invertebrate Sampling (Hester-Dendy) in the North Branch Potomac River - July 1998
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Taxa	Station[a]					
	BIOTA 1	BIOTA 2	BIOTA 3	BIOTA 4	BIOTA 5	BIOTA 6
MOLLUSCA	0	0	0	0	0	0
Gastropoda	0	0	0	0	0	0
Basommatophora	0	0	0	0	0	0
Ancylidae	0	0	0	0	0	0
Ferrissia rivularis	3	6	7	13	12	10
ANNELIDA	0	0	0	0	0	0
Oligochaeta	0	0	0	0	0	0
Haplotaxida	0	0	0	0	0	0
Enchytraeidae	0	0	2	0	1	0
Lumbricidae	0	0	0	0	0	0
Naididae	4	1	10	1	1	5
Nais behningi	2	1	0	0	0	2
Nais bretscheri	0	4	0	0	0	0
Nais communis	10	4	6	1	0	1
Slavina appendiculata	0	0	0	2	0	0
Tubificidae w.o.h.c.	1	0	1	0	2	3
Lumbriculida	0	0	0	0	0	0
Lumbriculidae	0	0	0	0	0	0
Lumbriculus sp.	0	0	2	0	0	0
ARTHROPODA	0	0	0	0	0	0
Insecta	0	0	0	0	0	0
Ephemeroptera	0	0	0	0	0	0
Heptageniidae	4	2	5	1	2	0
Stenacron interpunctatum	8	2	1	2	1	0
Stenonema sp.	0	0	1	0	0	0
Megaloptera	0	0	0	0	0	0
Sialidae	0	0	0	0	0	0
Nigronia serricornis	2	0	5	3	15	12

TABLE 8-8
Results of Benthic Invertebrate Sampling (Hester-Dendy) in the North Branch Potomac River - July 1998
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Taxa	Station[a]					
	BIOTA 1	BIOTA 2	BIOTA 3	BIOTA 4	BIOTA 5	BIOTA 6
Sialis sp.	0	2	2	2	1	2
Trichoptera	0	0	0	0	0	0
Brachycentridae	0	0	0	0	0	0
Brachycentrus sp.	0	0	0	0	0	1
Hydropsychidae	11	5	33	1	18	25
Ceratopsyche morosa	10	2	33	4	23	32
Cheumatopsyche sp.	18	7	54	9	30	30
Hydropsyche sp.	0	0	0	0	3	1
Hydropsyche betteni	0	0	0	0	1	0
Psychomyiidae	0	0	0	2	0	0
Lype diversa	2	0	0	0	0	0
Coleoptera	0	0	0	0	0	0
Gyrinidae	0	0	0	0	0	0
Gyrinus sp.	1	0	0	0	0	0
Diptera	0	0	0	0	0	0
Athericidae	0	0	0	0	0	0
Atherix lantha	1	0	1	0	0	0
Chironomidae	13	4	16	8	7	11
Ablabesmyia mallochi	0	6	0	4	0	0
Brillia flavifrons	3	2	1	2	0	0
Chironomus sp.	0	0	0	0	0	1
Cricotopus sp.	43	42	29	8	45	79
Cricotopus bicinctus	0	0	0	0	0	1
Cricotopus tremulus	10	11	3	0	4	7
Diamesa sp.	0	0	0	0	0	1
Labrundinia sp.	0	0	0	0	0	1
Nanocladius sp.	15	3	20	6	11	19
Parakiefferiella sp.	0	0	0	0	0	2

TABLE 8-8

Results of Benthic Invertebrate Sampling (Hester-Dendy) in the North Branch Potomac River - July 1998

Focused RI/FS

Site 5, Allegany Ballistics Laboratory

Rocket Center, West Virginia

Taxa	Station[a]					
	BIOTA 1	**BIOTA 2**	**BIOTA 3**	**BIOTA 4**	**BIOTA 5**	**BIOTA 6**
Paratendipes sp.	0	0	1	1	0	0
Phaenopsectra sp.	3	2	5	5	5	1
Polypedilum sp.	0	4	2	0	1	0
Polypedilum fallax	5	7	5	9	4	13
Polypedilum halterale	120	272	94	226	88	107
Rheocricotopus robacki	98	48	77	38	67	66
Rheotanytarsus sp.	122	31	55	42	102	66
Robackia demeijerei	0	0	1	0	0	0
Tanytarsus sp.	1	0	0	0	0	0
Thienemannimyia gp.	39	42	19	31	42	58
Xylotopus par	0	0	1	0	0	0
Empididae	0	0	1	0	0	0
Hemerodromia sp.	3	1	0	0	5	8
TOTAL NUMBER OF ORGANISMS	**552**	**511**	**493**	**421**	**491**	**565**
TOTAL NUMBER OF TAXA	**27**	**25**	**31**	**24**	**25**	**28**

[a]Total of 3 replicates

TABLE 8-9
Results of Benthic Invertebrate Sampling (Hester-Dendy) in the North Branch Potomac River - July 2000
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Taxa	Station[a]					
	BIOTA 1	BIOTA 2	BIOTA 3	BIOTA 4	BIOTA 5	BIOTA 6
PLATYHELMINTHES	0	0	0	0	0	0
Turbellaria	0	0	0	0	0	0
Tricladida	0	0	0	0	0	0
Planariidae	0	0	0	0	0	0
Dugesia tigrina	10	0	0	0	0	1
MOLLUSCA	0	0	0	0	0	0
Bivalvia	0	0	0	0	0	0
Veneroida	0	0	0	0	0	0
Sphaeriidae	0	0	1	0	0	0
Gastropoda	0	0	0	0	0	0
Basommatophora	0	0	0	0	0	0
Ancylidae	0	0	0	0	0	0
Ferrissia rivularis	51	19	56	90	11	2
Planorbidae	0	0	0	0	0	0
Menetus dilatatus	5	1	0	0	0	0
Physidae	0	0	0	0	0	0
Physella sp.	0	2	1	0	0	3
ANNELIDA	0	0	0	0	0	0
Oligochaeta	0	0	0	0	0	0
Haplotaxida	0	0	0	0	0	0
Lumbricidae	0	0	0	0	0	0
Naididae	5	174	112	24	33	2
Nais sp.	3	1	18	0	0	0
Nais communis	3	0	0	0	0	2
Pristina sp.	0	0	0	38	0	0
Pristina leidyi	58	265	643	155	239	4
Slavina appendiculata	2	2	3	1	43	13
Stylaria lacustris	1	1	0	0	0	2
Tubificidae w.o.h.c.	0	0	0	1	0	0
Hirudinea	0	0	6	0	0	0

TABLE 8-9
Results of Benthic Invertebrate Sampling (Hester-Dendy) in the North Branch Potomac River - July 2000
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Taxa	Station[a]					
	BIOTA 1	BIOTA 2	BIOTA 3	BIOTA 4	BIOTA 5	BIOTA 6
ARTHROPODA	0	0	0	0	0	0
Insecta	0	0	0	0	0	0
Collembola	0	0	0	0	0	0
Isotomidae	0	0	0	0	1	1
Ephemeroptera	0	0	0	0	0	0
Baetidae	0	0	1	0	0	0
Baetis intercalaris	0	0	1	0	0	0
Heptageniidae	4	0	2	0	0	1
Stenacron interpunctatum	152	2	17	18	3	35
Leptophlebiidae	0	0	0	0	0	0
Paraleptophlebia sp.	0	0	2	0	0	0
Odonata	0	0	0	0	0	0
Aeshnidae	0	0	0	0	0	0
Boyeria vinosa	0	0	0	0	0	1
Calopterygidae	0	0	0	0	0	2
Calopteryx sp.	0	1	0	0	0	0
Plecoptera	0	0	0	0	0	0
Pteronarcidae	0	0	0	0	0	0
Pteronarcys dorsata	0	0	0	0	0	1
Hemiptera	0	0	0	0	0	0
Corixidae	1	0	0	0	0	0
Veliidae	0	0	0	0	0	0
Rhagovelia obesa	0	0	0	0	0	1
Megaloptera	0	0	0	0	0	0
Corydalidae	0	0	1	0	0	0
Corydalus cornutus	0	0	1	1	0	0
Nigronia serricornis	7	18	21	15	12	1
Sialidae	0	0	0	0	0	0
Sialis sp.	0	0	0	0	1	0
Trichoptera	0	0	0	0	0	0
Hydropsychidae	55	3	100	21	0	0
Cheumatopsyche sp.	94	19	115	48	1	0
Hydropsyche sp.	0	1	11	9	0	0
Hydropsyche betteni	0	0	15	3	0	1
Hydropsyche venularis	51	2	157	28	1	0
Polycentropodidae	0	0	0	1	0	0
Polycentropus sp.	8	3	2	0	6	1

TABLE 8-9
Results of Benthic Invertebrate Sampling (Hester-Dendy) in the North Branch Potomac River - July 2000
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Taxa	Station[a]					
	BIOTA 1	BIOTA 2	BIOTA 3	BIOTA 4	BIOTA 5	BIOTA 6
Coleoptera	0	0	0	0	0	0
Elmidae	0	0	1	0	0	0
Gyrinidae	0	0	0	0	0	0
Dineutus sp.	1	0	0	0	0	0
Diptera	0	0	0	0	0	0
Athericidae	0	0	0	0	0	0
Atherix lantha	1	0	0	0	0	0
Ceratopogonidae	0	0	0	0	0	0
Bezzia/Palpomyia gp.	1	1	0	1	0	0
Chironomidae	32	38	60	36	27	18
Ablabesmyia mallochi	0	2	10	2	12	21
Chironomus sp.	0	3	0	0	0	0
Cricotopus sp.	3	57	21	9	34	3
Cricotopus bicinctus	0	3	0	0	15	1
Cryptochironomus fulvus	0	0	0	2	0	0
Dicrotendipes sp.	0	0	0	0	0	1
Nanocladius sp.	0	0	5	6	0	2
Nilotanypus sp.	0	3	10	2	9	0
Phaenopsectra sp.	0	0	0	0	4	10
Polypedilum fallax	0	0	4	11	11	0
Polypedilum halterale	412	182	437	376	280	58
Polypedilum illinoense	0	123	23	0	71	137
Procladius sp.	0	0	0	0	0	1
Rheocricotopus robacki	263	328	611	164	286	40
Rheotanytarsus sp.	31	16	58	32	4	0
Stenochironomus sp.	10	3	56	7	0	0
Synorthocladius semivirens	0	10	0	0	0	0
Tanytarsus sp.	0	3	0	0	0	0
Thienemannimyia gp.	114	101	110	83	132	24
Empididae	0	1	0	0	0	0
Hemerodromia sp.	0	0	2	0	0	0
Muscidae	0	0	0	0	0	1
TOTAL NUMBER OF ORGANISMS	**1,378**	**1,388**	**2,694**	**1,184**	**1,236**	**391**
TOTAL NUMBER OF TAXA	**27**	**32**	**36**	**28**	**23**	**31**

[a]Total of 3 replicates

TABLE 8-10
Results of Benthic Invertebrate Sampling (Hester-Dendy) in the North Branch Potomac River - July 2002
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Taxa	Station[a]					
	BIOTA 1	BIOTA 2	BIOTA 3	BIOTA 4	BIOTA 5	BIOTA 6
PLATYHELMINTHES	0	0	0	0	0	0
Turbellaria	0	0	0	0	0	0
Tricladida	0	0	0	0	0	0
Planariidae	0	0	0	0	0	0
Dugesia tigrina	0	0	0	0	3	10
MOLLUSCA	0	0	0	0	0	0
Gastropoda	0	0	0	0	0	0
Basommatophora	0	0	0	0	0	0
Ancylidae	0	0	0	0	0	0
Ferrissia rivularis	21	36	12	0	4	30
Physidae	0	0	0	0	0	0
Physella sp.	0	1	1	0	2	0
ANNELIDA	0	0	0	0	0	0
Oligochaeta	0	0	0	0	0	0
Haplotaxida	0	0	0	0	0	0
Lumbricidae	0	5	0	0	0	0
Naididae	10	10	0	0	6	0
Dero sp.	0	0	0	0	2	0
Nais sp.	20	10	0	0	2	0
Pristina sp.	0	0	0	0	1	0
Pristina leidyi	0	120	60	3	1	0
Slavina appendiculata	0	0	0	3	7	0
Tubificidae w.h.c.	0	0	0	3	0	0
Tubificidae w.o.h.c.	0	0	0	3	0	0
ARTHROPODA	0	0	0	0	0	0
Crustacea	0	0	0	0	0	0
Copepoda	0	10	0	0	0	0
Cyclopoida	0	0	1	0	0	0

TABLE 8-10
Results of Benthic Invertebrate Sampling (Hester-Dendy) in the North Branch Potomac River - July 2002
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Taxa	Station[a]					
	BIOTA 1	BIOTA 2	BIOTA 3	BIOTA 4	BIOTA 5	BIOTA 6
Ostracoda	0	0	1	0	0	0
Amphipoda	0	0	0	0	0	0
Crangonyctidae	0	0	0	0	0	0
Crangonyx sp.	0	0	0	0	1	0
Insecta	0	0	0	0	0	0
Ephemeroptera	0	0	0	0	0	0
Baetidae	0	0	0	0	1	10
Baetis intercalaris	1	0	0	0	0	0
Plauditus sp.	0	5	0	0	0	0
Heptageniidae	0	0	0	0	0	50
Leucrocuta sp.	0	0	0	0	0	1
Stenacron interpunctatum	2	0	3	0	3	15
Stenonema mediopunctatum	0	0	0	0	0	2
Stenonema modestum	1	0	0	0	0	0
Odonata	0	0	0	0	0	0
Aeshnidae	0	0	0	0	0	0
Boyeria vinosa	0	1	0	0	1	0
Megaloptera	0	0	0	0	0	0
Corydalidae	0	0	0	0	0	0
Nigronia serricornis	13	1	0	0	0	0
Sialidae	0	0	0	0	0	0
Sialis sp.	0	0	1	0	1	0
Trichoptera	0	0	0	0	0	0
Brachycentridae	0	0	0	0	0	0
Brachycentrus sp.	0	1	0	0	0	0
Hydropsychidae	990	15	0	0	0	220
Ceratopsyche morosa	10	0	0	0	0	0
Cheumatopsyche sp.	62	11	1	0	0	69

TABLE 8-10
Results of Benthic Invertebrate Sampling (Hester-Dendy) in the North Branch Potomac River - July 2002
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Taxa	Station[a]					
	BIOTA 1	BIOTA 2	BIOTA 3	BIOTA 4	BIOTA 5	BIOTA 6
Hydropsyche sp.	126	0	0	0	0	52
Hydropsyche betteni gp.	13	0	0	0	0	13
Hydroptilidae	0	0	0	0	0	0
Hydroptila sp.	0	0	0	0	0	10
Polycentropodidae	0	0	0	0	0	0
Nyctiophylax	0	1	0	0	0	
Polycentropus sp.	10	34	94	67	21	50
Psychomyiidae	0	0	0	0	0	0
Lype diversa	0	1	10	0	2	0
Psychomyia flavida	0	5	0	0	0	30
Coleoptera	0	0	0	0	0	0
Gyrinidae	0	0	0	0	0	0
Dineutus sp.	0	0	0	0	0	1
Diptera	0	0	0	0	0	0
Chironomidae	70	55	150	40	12	40
Ablabesmyia mallochi	20	12	2	90	50	20
Cricotopus sp.	140	24	0	0	0	80
Cricotopus bicinctus	0	12	0	0	0	0
Nanocladius sp.	20	0	0	0	0	0
Parakiefferiella sp.	0	12	0	0	0	0
Phaenopsectra sp.	0	0	0	35	34	20
Polypedilum fallax	20	12	0	0	0	40
Polypedilum halterale	40	428	157	335	206	170
Polypedilum illinoense	140	274	20	25	88	110
Rheocricotopus robacki	1,180	178	4	0	0	1,140
Rheotanytarsus sp.	480	95	4	0	0	300
Stenochironomus sp.	0	0	0	0	0	20
Tanytarsus sp.	20	0	2	0	0	20

TABLE 8-10

Results of Benthic Invertebrate Sampling (Hester-Dendy) in the North Branch Potomac River - July 2002

Focused RI/FS

Site 5, Allegany Ballistics Laboratory

Rocket Center, West Virginia

Taxa	Station[a]					
	BIOTA 1	**BIOTA 2**	**BIOTA 3**	**BIOTA 4**	**BIOTA 5**	**BIOTA 6**
Thienemanniella xena	20	0	0	0	0	0
Thienemannimyia gp.	40	131	12	5	4	190
Tipulidae	0	0	0	0	0	0
Antocha sp.	20	0	0	0	0	10
TOTAL NUMBER OF ORGANISMS	**3,489**	**1,500**	**535**	**609**	**452**	**2,723**
TOTAL NUMBER OF TAXA	**26**	**28**	**18**	**11**	**22**	**28**

[a]Total of 3 replicates

TABLE 8-11
Rare, Threatened, and Endangered Species From Mineral County, West Virginia
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Common Name	Scientific Name	Taxa	State Rank[a]	Federal Status	Comments
Eastern cricket frog	*Acris c. crepitans*	Amphibian	S2	--	
Jefferson salamander	*Ambystoma jeffersonianum*	Amphibian	S3	--	
Peregrine falcon	*Falco peregrinus*	Bird	S1B/S2N	--	Removed from federal list 8/25/99
Loggerhead shrike	*Lanius ludovicians*	Bird	S1B/S1N	--	State rank for *migrans* subspecies
Bald eagle	*Lhaliaeetus leucocephalus*	Bird	S2B/S2N	Threatened	Proposed for delisting (7/6/99)
Northern metalmark	*Calephelis boarealis*	Butterfly	S2	--	
Columbine duskywing	*Erynnis lucilius*	Butterfly	S2	--	
Olympia marble	*Euchloe olympia*	Butterfly	S2/S3	--	
Grizzled skipper	*Pyrgus wyanpot*	Butterfly	S1	--	
Allegheny woodrat	*Noetoma magister*	Mammal	S3	--	Found on ABL
Meadow jumping mouse	*Zapus hudsonius*	Mammal	S3	--	
Lesser snakeroot	*Ageratine aromaticum var aromaticum*	Plant	S1	--	
Bent milk-vetch	*Astragalus distortus*	Plant	S2	--	
Side-oats grama	*Bouteloua curtipendula*	Plant	S3	--	Found on ABL
American harebell (Bluebell)	*Campanula rotundifolia*	Plant	S2	--	Found on ABL
Hoary sedge	*Carex canescens*	Plant	S3	--	
Ebony sedge	*Carex eburnea*	Plant	S3	--	Found on ABL
Troublesome sedge	*Carex molesta*	Plant	S1	--	
Necklace sedge	*Carex projecta*	Plant	S1	--	
Goldthread	*Coptis trifolia groenlandica*	Plant	S2	--	
Roundleaf dogwood	*Cornus rugosa*	Plant	S1	--	
Beaked dodder	*Cuscuta rostrata*	Plant	S2	--	
Reflexed flatsedge	*Cyperus refractus*	Plant	S2	--	
Tall larkspur	*Delphinium exaltatum*	Plant	S2	--	
Nuttall waterweed	*Elodea nuttallii*	Plant	S1	--	
Blue ash	*Fraxinus quadrangulata*	Plant	S1	--	
Flatleaf rush	*Juncus platyphyllus*	Plant	Not listed	--	
Torrey's rush	*Juncus torreyi*	Plant	S1	--	
False pimpernel	*Lindernai dubia var anagallidea*	Plant	SH	--	

TABLE 8-11
Rare, Threatened, and Endangered Species From Mineral County, West Virginia
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Common Name	Scientific Name	Taxa	State Rank[a]	Federal Status	Comments
Shale barren evening primrose	*Oenothera argillicola*	Plant	S3	--	
Black-fruit mountain ricegrass	*Oryzopsis racemosa*	Plant	S2	--	
Canby's mountain-lover	*Paxistima canbyi*	Plant	S2	--	
Jacobs ladder	*Polemonium vanbruntiae*	Plant	S2	--	
Allegheny plum	*Prunus alleghaniensis*	Plant	S3	--	Found on ABL
Basil mountain-mint	*Pycnanthemum clinopodioides*	Plant	SH	--	
Bristly black currant	*Ribes lacustre*	Plant	S1	--	
Swamp red currant	*Ribes triste*	Plant	SH	--	
Glaucous willow	*Salix discolor*	Plant	S2	--	
Swamp saxifrage	*Saxifraga pensylvanica*	Plant	S2	--	
Balsam squaw-weed	*Senecio pauperculus*	Plant	S1	--	
Poison sumac	*Toxicodendron vernix*	Plant	S2	--	
Kates mountain clover	*Trifolium virginicum*	Plant	S3	--	
Marsh speedwell	*Veronica scutellata*	Plant	S1	--	
Netted chainfern	*Woodwardia areolata*	Plant	S1	--	
Oceanorous	*Zigadenus leimanthoides*	Plant	S2	--	

[a]State rank (June 2000): S1 - Extremely rare; S2 - Very rare; S3 - Somewhat vulnerable to extirpation; SH - Historical. B - Breeding populations; N - Non-breeding populations

TABLE 8-12
Rare, Threatened, and Endangered Species From Maryland
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Common Name	Scientific Name	Taxa	State Rank[a]	State Status[b]	Federal Status	Comments
Sora	*Porzana carolina*	Bird	S1B	--	--	
Eastern small-footed bat	*Myotis leibii*	Mammal	S1B	I	--	No longer federal candidate
Side-oats grama	*Bouteloua curtipendula*	Plant	S2	--	--	
Harebell	*Campanula rotundifolia*	Plant	S2	--	--	
Virginia mountain mint	*Pycnanthemum virginianum*	Plant	S2	--	--	
Cliff stonecrop	*Sedum glaucophyllum*	Plant	S1B	E	--	

[a]State rank (October 1997 [animals]; December 1996 [plants]): S1 - Highly rare; S2 - Rare. B - Breeding populations
[b]E - Endangered; I - In need of conservation

TABLE 8-13

Summary of Available Data and Data Selected for Use in the Site 5 Ecological Risk Assessment

Focused RI/FS

Site 5, Allegany Ballistics Laboratory

Rocket Center, West Virginia

Groundwater							Fish Tissue	Sediment				Surface Water				
		Metals												Metals		
VOCs	SVOCs	Total	Dissolved	Explosives	Pesticides	PCBs	Metals	VOCs	SVOCs	Metals	Explosives	VOCs	SVOCs	Total	Dissolved	Explosives
3 (1984)																
3 (1986)																
3 (1987)																
5(1992)		5 (1992)														
13 (1994)	12 (1994)	13 (1994)	8 (1994)	12 (1994)				***2 (1994)***	***2 (1994)***	***2 (1994)***	***2 (1994)***	2 (1994)	2 (1994)	2 (1994)		2 (1994)
4 (1996)		4 (1996)	4 (1996)													
13 (98-R1)	8 (98-R1)	13 (98-R1)	6 (98-R1)	7 (98-R1)	8 (98-R1)	8 (98-R1)		***2 (1998)***	***2 (1998)***	***2 (1998)***	***2 (1998)***					
12 (98-R2)		12 (98-R2)	12 (98-R2)													
11 (99-R3)		11 (99-R3)	11 (99-R3)													
7 (99-R4)		10 (99-R4)	10 (99-R4)													
3 (99-R4)	1 (99-R4)			1 (99-R4)				2 (1999)	2 (1999)	2 (1999)	2 (1999)					2 (1999)
12 (00-R5)		12 (00-R5)	11 (00-R5)													
7 (00-R5)		***7 (00-R5)***	***6 (00-R5)***					***4 (2000)***	***4 (2000)***	***4 (2000)***	***4 (2000)***	***4 (2000)***		***4 (2000)***		
12 (01-R6)		3 (01-R6)	12 (01-R6)													
7 (01-R6)			***7 (01-R6)***					***4 (2001)***	***4 (2001)***	***4 (2001)***	***4 (2001)***	***4 (2001)***		***4 (2001)***	***4 (2001)***	
12 (02-R7)		12 (02-R7)														
7 (02-R7)		***7 (02-R7)***					***3 (2002)***	***4 (2002)***	***16 (2002)***	***16 (2002)***	***3 (2002)***	***4 (2002)***		***4 (2002)***		

BOLD AND ITALIC ENTRIES - DATA USED IN THE ECOLOGICAL RISK ASSESSMENT. SHADED DATA ARE NOT FULLY VALIDATED OR VALIDATION STATUS UNKNOWN.

TABLE 8-14
Summary Statistics - Site 5 - Surface Water (Downgradient)
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Chemical	Reporting Limit Range	Frequency of Detection	Maximum Concentration Detected	Sample ID of Maximum Concentration	Arithmetic Mean[1]	Standard Deviation of Mean
Inorganics (UG/L)						
Aluminum	17.2 - 45.7	7 / 9	419	AS05-5SW03-R05	223	78.5
Antimony	3.70 - 5.00	0 / 9	--	--	2.39	0.55
Arsenic	3.80 - 5.10	1 / 9	5.10	AS05-5SW04-R07	2.60	0.98
Barium	0.20 - 2.00	9 / 9	65.9	AS05-5SW03-R07	56.3	7.88
Beryllium	0.10 - 0.10	0 / 9	--	--	0.06	0.01
Cadmium	0.40 - 3.00	0 / 9	--	--	0.85	0.56
Calcium	10.7 - 15.9	9 / 9	60,600	AS05-5SW03-R05	55,656	2,487
Chromium	0.60 - 5.00	1 / 9	1.30	AS05-5SW04-R07	1.16	1.05
Cobalt	1.10 - 1.80	5 / 9	2.50	AS05-5SW02-R05	1.57	0.74
Copper	0.70 - 2.20	0 / 9	--	--	0.93	0.17
Cyanide	10.0 - 10.0	0 / 9	--	--	5.00	0.00
Iron	7.00 - 15.9	9 / 9	970	AS05-5SW02-R05	484	311
Lead	2.00 - 3.00	4 / 9	4.80	AS05-5SW02-R05	2.50	1.36
Magnesium	12.3 - 75.9	9 / 9	15,600	AS05-5SW02-R06	13,078	1,590
Manganese	0.30 - 1.20	9 / 9	376	AS05-5SW03-R07	251	58.4
Mercury	0.10 - 0.20	1 / 9	0.39	AS05-5SW02-R06	0.12	0.11
Nickel	2.00 - 4.00	6 / 9	9.30	AS05-5SW04-R07	5.31	2.87
Potassium	21.9 - 49.7	9 / 9	4,010	AS05-5SW03-R05	3,582	257
Selenium	2.20 - 5.00	0 / 9	--	--	1.87	0.61
Silver	0.60 - 5.00	0 / 9	--	--	1.03	1.10
Sodium	308 - 497	9 / 9	40,300	AS05-5SW04-R07	32,311	5,279
Thallium	2.30 - 5.70	0 / 9	--	--	2.29	0.68
Vanadium	0.80 - 3.20	0 / 9	--	--	0.99	0.49
Zinc	1.50 - 8.50	5 / 9	47.7	AS05-5SW04-R07	24.6	11.0
Dissolved Metals (UG/L)						
Aluminum	16.9 - 16.9	0 / 3	--	--	40.6	5.35

1 - One-half of the reporting limit was used for non-detected samples when calculating the mean

TABLE 8-14
Summary Statistics - Site 5 - Surface Water (Downgradient)
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Chemical	Reporting Limit Range	Frequency of Detection	Maximum Concentration Detected	Sample ID of Maximum Concentration	Arithmetic Mean[1]	Standard Deviation of Mean
Antimony	8.90 - 8.90	0 / 3	--	--	4.45	0.00
Arsenic	6.20 - 6.20	0 / 3	--	--	3.10	0.00
Barium	1.30 - 1.30	3 / 3	54.0	AS05-5SW02-R06	52.5	1.29
Beryllium	0.10 - 0.10	0 / 3	--	--	0.05	0.00
Cadmium	0.60 - 0.60	0 / 3	--	--	0.30	0.00
Calcium	3.40 - 3.40	3 / 3	53,800	AS05-5SW02-R06	53,200	1,039
Chromium	0.60 - 0.60	3 / 3	1.70	AS05-5SW02-R06	1.26	0.52
Cobalt	0.90 - 0.90	0 / 3	--	--	0.45	0.00
Copper	1.50 - 1.50	1 / 3	4.00	AS05-5SW02-R06	2.43	1.36
Iron	15.8 - 15.8	2 / 3	44.8	AS05-5SW02-R06	28.1	17.0
Lead	3.00 - 3.00	0 / 3	--	--	1.50	0.00
Magnesium	16.2 - 16.2	3 / 3	14,400	AS05-5SW02-R06	14,233	289
Manganese	0.20 - 0.20	0 / 3	--	--	3.75	0.69
Mercury	0.20 - 0.20	0 / 3	--	--	0.10	0.00
Nickel	1.60 - 1.60	0 / 3	--	--	3.00	0.65
Potassium	18.4 - 18.4	3 / 3	3,520	AS05-5SW02-R06	3,440	98.5
Selenium	1.60 - 1.60	0 / 3	--	--	0.80	0.00
Silver	1.70 - 1.70	0 / 3	--	--	0.85	0.00
Sodium	357 - 357	3 / 3	30,100	AS05-5SW02-R06	29,233	902
Thallium	4.30 - 4.30	0 / 3	--	--	2.15	0.00
Vanadium	1.20 - 1.20	0 / 3	--	--	0.60	0.00
Zinc	1.10 - 1.10	3 / 3	36.2	AS05-5SW02-R06	31.2	4.38
Volatile Organic Compounds (UG/L)						
1,1,1-Trichloroethane	1.00 - 1.00	0 / 9	--	--	0.50	0.00
1,1,2,2-Tetrachloroethane	1.00 - 1.00	0 / 9	--	--	0.50	0.00
1,1,2-Trichloroethane	1.00 - 1.00	0 / 9	--	--	0.50	0.00
1,1-Dichloroethane	1.00 - 1.00	0 / 9	--	--	0.50	0.00

1 - One-half of the reporting limit was used for non-detected samples when calculating the mean

TABLE 8-14
Summary Statistics - Site 5 - Surface Water (Downgradient)
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Chemical	Reporting Limit Range	Frequency of Detection	Maximum Concentration Detected	Sample ID of Maximum Concentration	Arithmetic Mean[1]	Standard Deviation of Mean
1,1-Dichloroethene	1.00 - 1.00	0 / 9	--	--	0.50	0.00
1,2,4-Trichlorobenzene	1.00 - 1.00	0 / 9	--	--	0.50	0.00
1,2-Dibromo-3-chloropropane	1.00 - 1.00	0 / 6	--	--	0.50	0.00
1,2-Dibromoethane	1.00 - 1.00	0 / 9	--	--	0.50	0.00
1,2-Dichlorobenzene	1.00 - 1.00	0 / 9	--	--	0.50	0.00
1,2-Dichloroethane	1.00 - 1.00	0 / 9	--	--	0.50	0.00
1,2-Dichloropropane	1.00 - 1.00	0 / 9	--	--	0.50	0.00
1,3-Dichlorobenzene	1.00 - 1.00	0 / 9	--	--	0.50	0.00
1,4-Dichlorobenzene	1.00 - 1.00	0 / 9	--	--	0.50	0.00
2-Butanone	-- - --	0 / 0	--	--	--	--
2-Hexanone	5.00 - 5.00	0 / 6	--	--	2.50	0.00
4-Methyl-2-pentanone	5.00 - 5.00	0 / 9	--	--	2.50	0.00
Acetone	-- - --	0 / 0	--	--	--	--
Benzene	1.00 - 1.00	0 / 9	--	--	0.50	0.00
Bromochloromethane	1.00 - 1.00	0 / 9	--	--	0.50	0.00
Bromodichloromethane	1.00 - 1.00	0 / 9	--	--	0.50	0.00
Bromoform	1.00 - 1.00	0 / 9	--	--	0.50	0.00
Bromomethane	1.00 - 1.00	0 / 9	--	--	0.50	0.00
Carbon disulfide	1.00 - 1.00	0 / 9	--	--	0.50	0.00
Carbon tetrachloride	1.00 - 1.00	0 / 9	--	--	0.50	0.00
Chlorobenzene	1.00 - 1.00	0 / 9	--	--	0.50	0.00
Chloroethane	1.00 - 1.00	0 / 9	--	--	0.50	0.00
Chloroform	1.00 - 1.00	0 / 9	--	--	0.50	0.00
Chloromethane	1.00 - 1.00	0 / 9	--	--	0.50	0.00
Dibromochloromethane	1.00 - 1.00	0 / 9	--	--	0.50	0.00
Ethylbenzene	1.00 - 1.00	0 / 9	--	--	0.50	0.00
Methylene chloride	1.00 - 2.00	0 / 9	--	--	0.89	0.16

1 - One-half of the reporting limit was used for non-detected samples when calculating the mean

TABLE 8-14
Summary Statistics - Site 5 - Surface Water (Downgradient)
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Chemical	Reporting Limit Range	Frequency of Detection	Maximum Concentration Detected	Sample ID of Maximum Concentration	Arithmetic Mean[1]	Standard Deviation of Mean
Styrene	1.00 - 1.00	0 / 9	--	--	0.50	0.00
Tetrachloroethene	1.00 - 1.00	0 / 9	--	--	0.50	0.00
Toluene	1.00 - 1.00	0 / 9	--	--	0.50	0.00
Trichloroethene	1.00 - 1.00	0 / 9	--	--	0.50	0.00
Vinyl chloride	1.00 - 1.00	0 / 9	--	--	0.50	0.00
Xylene, total	1.00 - 1.00	0 / 9	--	--	0.50	0.00
cis-1,2-Dichloroethene	1.00 - 1.00	0 / 9	--	--	0.50	0.00
cis-1,3-Dichloropropene	1.00 - 1.00	0 / 9	--	--	0.50	0.00
m- and p-Xylene	1.00 - 1.00	0 / 3	--	--	0.50	0.00
o-Xylene	1.00 - 1.00	0 / 9	--	--	0.50	0.00
trans-1,2-Dichloroethene	1.00 - 1.00	0 / 9	--	--	0.50	0.00
trans-1,3-Dichloropropene	1.00 - 1.00	0 / 9	--	--	0.50	0.00
Other Parameters (MG/L)						
Hardness	1.00 - 1.00	3 / 3	210	AS05-5SW02-R06	200	10.0

1 - One-half of the reporting limit was used for non-detected samples when calculating the mean

TABLE 8-15
Summary Statistics - Site 5 - Sediment (Downgradient)
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Chemical	Reporting Limit Range	Frequency of Detection	Maximum Concentration Detected	Sample ID of Maximum Concentration	Arithmetic Mean[1]	Standard Deviation of Mean
Inorganics (MG/KG)						
Aluminum	4.87 - 93.9	21 / 21	13,700	AS05-5SD02-R01	6,340	2,830
Antimony	0.73 - 28.2	1 / 21	1.60	AS05-5SD02-R06	0.93	1.00
Arsenic	0.73 - 4.70	21 / 21	24.1	AS05-5SD02-R01	10.4	4.97
Barium	0.05 - 93.9	20 / 21	208	AS05-5SD03-R06	85.9	50.0
Beryllium	0.03 - 2.30	21 / 21	2.90	AS05-5SD02-R01	1.62	0.59
Cadmium	0.10 - 2.30	3 / 21	1.50	5SD-2(94)	0.27	0.35
Calcium	3.24 - 2,350	21 / 21	94,100	AS05-5SD02-R05	8,138	20,366
Chromium	0.18 - 4.70	21 / 21	80.9	AS05-5SD02-R05	17.4	15.7
Cobalt	0.28 - 23.5	21 / 21	72.6	AS05-5SD03-R06	34.8	13.8
Copper	0.18 - 11.7	21 / 21	67.5	AS05-5SD02-R01	29.2	16.6
Cyanide	0.63 - 2.50	0 / 10	--	--	0.61	0.28
Iron	2.12 - 46.9	21 / 21	47,100	AS05-5SD02-R01	28,462	8,471
Lead	0.51 - 1.99	21 / 21	43.6	AS05-5SD02-R01	24.2	8.92
Magnesium	3.45 - 2,350	20 / 21	3,620	AS05-5SD02-R05	1,000	718
Manganese	0.08 - 7.00	21 / 21	1,700	AS05-5SD03-R06	807	455
Mercury	0.06 - 0.31	8 / 21	4.80	AS05-5SD02-R05	0.38	1.06
Nickel	0.51 - 18.8	21 / 21	110	AS05-5SD03-R06	58.0	20.6
Potassium	6.63 - 2,350	20 / 21	1,320	AS05-5SD03-R06	691	242
Selenium	0.54 - 2.60	1 / 21	2.10	AS05-5SD06A	0.64	0.47
Silver	0.15 - 4.70	0 / 21	--	--	0.33	0.41
Sodium	25.5 - 2,350	15 / 21	1,890	AS05-5SD02-R05	281	389
Thallium	0.54 - 4.70	9 / 21	1.90	AS05-5SD02B	1.15	0.42
Vanadium	0.25 - 23.5	21 / 21	33.2	AS05-5SD07A	17.5	5.93
Zinc	0.38 - 9.40	21 / 21	343	AS05-5SD02-R05	185	69.2
Semivolatile Organic Compounds (UG/KG)						
1,1-Biphenyl	510 - 810	0 / 5	--	--	313	57.2

1 - One-half of the reporting limit was used for non-detected samples when calculating the mean

TABLE 8-15
Summary Statistics - Site 5 - Sediment (Downgradient)
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Chemical	Reporting Limit Range	Frequency of Detection	Maximum Concentration Detected	Sample ID of Maximum Concentration	Arithmetic Mean[1]	Standard Deviation of Mean
1-Methylnaphthalene	2.10 - 9.00	13 / 13	28.0	AS05-5SD04-R07	10.1	8.38
2,2'-Oxybis(1-chloropropane)	420 - 1,700	0 / 10	--	--	356	183
2,4,5-Trichlorophenol	1,100 - 4,200	0 / 10	--	--	885	450
2,4,6-Trichlorophenol	420 - 1,700	0 / 10	--	--	356	183
2,4-Dichlorophenol	420 - 1,700	0 / 10	--	--	356	183
2,4-Dimethylphenol	420 - 1,700	0 / 10	--	--	356	183
2,4-Dinitrophenol	1,100 - 4,200	0 / 10	--	--	885	450
2-Chloronaphthalene	420 - 1,700	0 / 10	--	--	356	183
2-Chlorophenol	420 - 1,700	0 / 10	--	--	356	183
2-Methylnaphthalene	2.10 - 1,700	15 / 21	110	5SD-2(94)	140	206
2-Methylphenol	420 - 1,700	0 / 10	--	--	356	183
2-Nitroaniline	1,100 - 4,200	0 / 10	--	--	885	450
2-Nitrophenol	420 - 1,700	0 / 10	--	--	356	183
3,3'-Dichlorobenzidine	420 - 1,700	0 / 10	--	--	356	183
3- and 4-Methylphenol	420 - 1,700	3 / 7	7,800	AS05-5SD03-R06	1,401	2,833
3-Nitroaniline	1,100 - 4,200	0 / 10	--	--	885	450
4,6-Dinitro-2-methylphenol	1,100 - 4,200	0 / 10	--	--	885	450
4-Bromophenyl-phenylether	420 - 1,700	0 / 10	--	--	356	183
4-Chloro-3-methylphenol	420 - 1,700	0 / 10	--	--	356	183
4-Chloroaniline	420 - 1,700	0 / 10	--	--	356	183
4-Chlorophenyl-phenylether	420 - 1,700	0 / 10	--	--	356	183
4-Methylphenol	600 - 650	2 / 3	330	AS05-5SD03-R07	270	79.4
4-Nitroaniline	1,100 - 4,200	0 / 10	--	--	885	450
4-Nitrophenol	1,100 - 4,200	0 / 10	--	--	885	450
Acenaphthene	2.10 - 1,700	11 / 21	90.0	AS05-5SD03-R07	147	216
Acenaphthylene	2.10 - 1,700	11 / 21	19.0	AS05-5SD04-R07	143	217
Acetophenone	510 - 810	0 / 5	--	--	313	57.2

1 - One-half of the reporting limit was used for non-detected samples when calculating the mean

TABLE 8-15
Summary Statistics - Site 5 - Sediment (Downgradient)
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Chemical	Reporting Limit Range	Frequency of Detection	Maximum Concentration Detected	Sample ID of Maximum Concentration	Arithmetic Mean[1]	Standard Deviation of Mean
Anthracene	2.10 - 1,700	12 / 21	36.0	AS05-5SD04-R07	147	215
Atrazine	510 - 810	0 / 5	--	--	313	57.2
Benzaldehyde	510 - 810	2 / 5	680	AS05-5SD03-R07	433	178
Benzo(a)anthracene	2.10 - 1,700	15 / 21	230	AS05-5SD04-R07	158	203
Benzo(a)pyrene	2.10 - 1,700	15 / 21	260	AS05-5SD04-R07	157	204
Benzo(b)fluoranthene	2.10 - 1,700	15 / 21	260	AS05-5SD03-R07	167	202
Benzo(g,h,i)perylene	2.10 - 1,700	13 / 21	170	AS05-5SD04-R07	167	206
Benzo(k)fluoranthene	2.10 - 1,700	14 / 21	250	AS05-5SD04-R07	165	205
Butylbenzylphthalate	420 - 1,700	0 / 10	--	--	356	183
Caprolactam	590 - 650	0 / 2	--	--	310	21.2
Carbazole	420 - 1,700	0 / 10	--	--	356	183
Chrysene	2.10 - 1,700	15 / 21	290	AS05-5SD03-R07	173	202
Di-n-butylphthalate	420 - 1,700	5 / 10	1,000	AS05-5SD02-R07	301	260
Di-n-octylphthalate	420 - 1,700	0 / 10	--	--	356	183
Dibenz(a,h)anthracene	2.10 - 1,700	13 / 21	56.0	AS05-5SD04-R07	149	214
Dibenzofuran	420 - 1,700	0 / 10	--	--	356	183
Diethylphthalate	420 - 1,700	1 / 10	200	AS05-5SD03-R07	344	190
Dimethyl phthalate	420 - 1,700	0 / 10	--	--	356	183
Fluoranthene	2.10 - 1,700	15 / 21	390	AS05-5SD03-R07	192	204
Fluorene	2.10 - 1,700	13 / 21	35.0	AS05-5SD04-R07	147	215
Hexachlorobenzene	420 - 1,700	0 / 10	--	--	356	183
Hexachlorobutadiene	420 - 1,700	0 / 10	--	--	356	183
Hexachlorocyclopentadiene	420 - 1,700	0 / 10	--	--	356	183
Hexachloroethane	420 - 1,700	0 / 10	--	--	356	183
Indeno(1,2,3-cd)pyrene	2.10 - 1,700	13 / 21	160	AS05-5SD04-R07	164	207
Isophorone	420 - 1,700	0 / 10	--	--	356	183
Naphthalene	2.10 - 1,700	13 / 21	81.0	AS05-5SD03-R07	140	214

1 - One-half of the reporting limit was used for non-detected samples when calculating the mean

TABLE 8-15
Summary Statistics - Site 5 - Sediment (Downgradient)
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Chemical	Reporting Limit Range	Frequency of Detection	Maximum Concentration Detected	Sample ID of Maximum Concentration	Arithmetic Mean[1]	Standard Deviation of Mean
Pentachlorophenol	1,100 - 4,200	0 / 10	--	--	885	450
Phenanthrene	2.10 - 1,700	15 / 21	380	AS05-5SD03-R07	194	201
Phenol	420 - 1,700	1 / 10	510	AS05-5SD03-R06	367	189
Pyrene	2.10 - 1,700	15 / 21	420	AS05-5SD03-R07	196	204
bis(2-Chloroethoxy)methane	420 - 1,700	0 / 10	--	--	356	183
bis(2-Chloroethyl)ether	420 - 1,700	0 / 10	--	--	356	183
bis(2-Ethylhexyl)phthalate	420 - 1,700	2 / 10	95.0	AS05-5SD03-R06	272	223
n-Nitroso-di-n-propylamine	420 - 1,700	0 / 10	--	--	356	183
n-Nitrosodiphenylamine	420 - 1,700	0 / 10	--	--	356	183
Explosives (UG/KG)						
2,4-Dinitrotoluene	420 - 1,700	0 / 10	--	--	356	183
2,6-Dinitrotoluene	420 - 1,700	0 / 10	--	--	356	183
Nitrobenzene	420 - 1,700	0 / 10	--	--	356	183
Volatile Organic Compounds (UG/KG)						
1,1,1-Trichloroethane	13.0 - 50.0	0 / 11	--	--	10.0	6.05
1,1,2,2-Tetrachloroethane	13.0 - 50.0	0 / 11	--	--	11.3	5.30
1,1,2-Trichloro-1,2,2-trifluoroethane(Freon-113)	15.0 - 33.0	0 / 6	--	--	10.6	3.35
1,1,2-Trichloroethane	13.0 - 50.0	0 / 11	--	--	11.3	5.30
1,1-Dichloroethane	13.0 - 50.0	0 / 11	--	--	11.3	5.30
1,1-Dichloroethene	13.0 - 50.0	0 / 11	--	--	11.3	5.30
1,2,4-Trichlorobenzene	15.0 - 1,700	0 / 11	--	--	187	261
1,2-Dibromo-3-chloropropane	15.0 - 33.0	0 / 6	--	--	10.6	3.35
1,2-Dibromoethane	15.0 - 33.0	0 / 6	--	--	10.6	3.35
1,2-Dichlorobenzene	15.0 - 1,700	0 / 11	--	--	187	261
1,2-Dichloroethane	13.0 - 50.0	0 / 11	--	--	11.3	5.30
1,2-Dichloroethene (total)	18.0 - 18.0	0 / 2	--	--	9.00	0.0
1,2-Dichloropropane	13.0 - 50.0	0 / 11	--	--	11.3	5.30

1 - One-half of the reporting limit was used for non-detected samples when calculating the mean

TABLE 8-15
Summary Statistics - Site 5 - Sediment (Downgradient)
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Chemical	Reporting Limit Range	Frequency of Detection	Maximum Concentration Detected	Sample ID of Maximum Concentration	Arithmetic Mean[1]	Standard Deviation of Mean
1,3-Dichlorobenzene	15.0 - 1,700	0 / 11	--	--	187	261
1,4-Dichlorobenzene	15.0 - 1,700	0 / 11	--	--	187	261
2-Butanone	13.0 - 50.0	1 / 11	12.0	5SD-2(94)	11.6	5.24
2-Hexanone	13.0 - 50.0	0 / 11	--	--	11.3	5.30
4-Methyl-2-pentanone	13.0 - 50.0	0 / 11	--	--	11.3	5.30
Acetone	13.0 - 50.0	0 / 11	--	--	12.7	6.45
Benzene	13.0 - 50.0	0 / 11	--	--	11.3	5.30
Bromodichloromethane	13.0 - 50.0	0 / 11	--	--	11.3	5.30
Bromoform	13.0 - 50.0	0 / 11	--	--	11.3	5.30
Bromomethane	13.0 - 50.0	0 / 11	--	--	11.3	5.30
Carbon disulfide	13.0 - 50.0	0 / 11	--	--	11.3	5.30
Carbon tetrachloride	13.0 - 50.0	0 / 11	--	--	11.3	5.30
Chlorobenzene	13.0 - 50.0	0 / 11	--	--	11.3	5.30
Chloroethane	13.0 - 50.0	0 / 11	--	--	11.3	5.30
Chloroform	13.0 - 50.0	0 / 11	--	--	11.3	5.30
Chloromethane	13.0 - 50.0	0 / 11	--	--	11.3	5.30
Cumene	15.0 - 33.0	0 / 6	--	--	10.6	3.35
Cyclohexane	15.0 - 33.0	0 / 6	--	--	10.6	3.35
Dibromochloromethane	13.0 - 50.0	0 / 11	--	--	11.3	5.30
Dichlorodifluoromethane(Freon-12)	15.0 - 33.0	0 / 6	--	--	10.6	3.35
Ethylbenzene	13.0 - 50.0	0 / 11	--	--	11.3	5.30
Methyl acetate	15.0 - 33.0	0 / 6	--	--	10.6	3.35
Methyl-tert-butyl ether (MTBE)	15.0 - 33.0	0 / 6	--	--	10.6	3.35
Methylcyclohexane	15.0 - 33.0	0 / 6	--	--	10.6	3.35
Methylene chloride	13.0 - 50.0	1 / 11	32.0	AS05-5SD02-R01	9.45	10.1
Styrene	13.0 - 50.0	0 / 11	--	--	11.3	5.30
Tetrachloroethene	13.0 - 50.0	0 / 11	--	--	11.3	5.30

1 - One-half of the reporting limit was used for non-detected samples when calculating the mean

TABLE 8-15
Summary Statistics - Site 5 - Sediment (Downgradient)
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Chemical	Reporting Limit Range	Frequency of Detection	Maximum Concentration Detected	Sample ID of Maximum Concentration	Arithmetic Mean[1]	Standard Deviation of Mean
Toluene	13.0 - 50.0	0 / 11	--	--	11.3	5.30
Trichloroethene	13.0 - 50.0	0 / 11	--	--	11.3	5.30
Trichlorofluoromethane(Freon-11)	15.0 - 33.0	0 / 6	--	--	10.6	3.35
Vinyl chloride	13.0 - 50.0	0 / 11	--	--	11.3	5.30
Xylene, total	13.0 - 50.0	0 / 11	--	--	11.3	5.30
cis-1,2-Dichloroethene	13.0 - 50.0	0 / 9	--	--	11.8	5.78
cis-1,3-Dichloropropene	13.0 - 50.0	0 / 11	--	--	11.3	5.30
m- and p-Xylene	13.0 - 50.0	0 / 3	--	--	14.3	9.57
o-Xylene	13.0 - 50.0	0 / 9	--	--	11.8	5.78
trans-1,2-Dichloroethene	13.0 - 50.0	0 / 9	--	--	11.8	5.78
trans-1,3-Dichloropropene	13.0 - 50.0	0 / 11	--	--	11.3	5.30
Other Parameters						
Total organic carbon (MG/KG)	500 - 5,000	13 / 13	130,000	AS05-5SD05	39,723	44,446
pH	0.10 - 0.10	13 / 13	7.60	AS05-5SD07A	7.25	0.29

1 - One-half of the reporting limit was used for non-detected samples when calculating the mean

TABLE 8-16
Summary Statistics - Site 5 - Fish Tissue
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Chemical	Reporting Limit Range	Frequency of Detection	Maximum Concentration Detected	Sample ID of Maximum Concentration	Arithmetic Mean[1]	Standard Deviation of Mean
Inorganics (MG/KG Wet-Weight)						
Aluminum	37.7 - 38.5	0 / 3	--	--	8.58	3.83
Antimony	11.3 - 11.5	0 / 3	--	--	0.28	0.003
Arsenic	1.90 - 1.90	0 / 3	--	--	0.26	0.003
Barium	38.0 - 38.0	1 / 3	3.00	AS05-S901(02)-R01	1.28	1.50
Beryllium	0.94 - 0.96	0 / 3	--	--	0.03	0.0003
Cadmium	0.94 - 0.96	0 / 3	--	--	0.02	0.0003
Calcium	943 - 962	3 / 3	13,400	AS05-S701(02)-R01	10,207	4,073
Chromium	1.90 - 1.90	3 / 3	0.28	AS05-S701(02)-R01	0.25	0.03
Cobalt	9.40 - 9.60	3 / 3	0.19	AS05-S901(02)-R01	0.17	0.02
Copper	4.70 - 4.80	0 / 3	--	--	0.31	0.17
Iron	18.9 - 19.2	3 / 3	45.2	AS05-S901(02)-R01	28.6	15.4
Lead	0.57 - 0.58	0 / 3	--	--	0.13	0.003
Magnesium	943 - 962	0 / 3	--	--	177	20.8
Manganese	2.80 - 2.90	3 / 3	22.4	AS05-S901(02)-R01	17.5	5.67
Mercury	0.10 - 0.10	1 / 3	0.029	AS05-S801(02)-R01	0.019	0.009
Nickel	7.50 - 7.70	0 / 3	--	--	0.16	0.01
Potassium	943 - 962	0 / 3	--	--	1,343	62.1
Selenium	0.94 - 0.96	3 / 3	1.50	AS05-S901(02)-R01	1.27	0.21
Silver	1.90 - 1.90	0 / 3	--	--	0.08	0.003
Sodium	943 - 962	1 / 3	1,050	AS05-S801(02)-R01	656	349
Thallium	1.90 - 1.90	1 / 3	0.94	AS05-S801(02)-R01	0.57	0.32
Vanadium	9.40 - 9.60	2 / 3	0.35	AS05-S701(02)-R01	0.24	0.12
Zinc	3.80 - 3.80	1 / 3	28.7	AS05-S901(02)-R01	16.4	10.6
Other Parameters (Percent)						
Moisture	-- - --	3 / 3	74.8	AS05-S701(02)-R01	74.4	0.69
Lipids	-- - --	3 / 3	6.60	AS05-S901(02)-R01	4.90	1.48

1 - One-half of the reporting limit was used for non-detected samples when calculating the mean

TABLE 8-17
Summary Statistics - Site 5 - Groundwater (Downgradient)
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Chemical	Reporting Limit Range	Frequency of Detection	Maximum Concentration Detected	Sample ID of Maximum Concentration	Arithmetic Mean[1]	Standard Deviation of Mean
Inorganics (UG/L)						
Aluminum	17.2 - 19.2	8 / 12	16,300	AS05-5GW19-R05	2,496	4,948
Antimony	4.90 - 5.00	0 / 12	--	--	2.51	0.11
Arsenic	3.80 - 5.10	1 / 12	6.90	AS05-5GW11-R07	2.81	1.37
Barium	0.20 - 1.60	12 / 12	366	AS05-5GW19-R05	121	110
Beryllium	0.10 - 0.10	3 / 12	1.10	AS05-5GW19-R05	0.21	0.33
Boron	10.0 - 50.0	7 / 10	83.6	AS05-5GW09-R05	33.7	18.7
Cadmium	0.40 - 1.70	0 / 12	--	--	0.53	0.34
Calcium	15.9 - 15.9	12 / 12	90,700	AS05-5GW09-R05	50,583	17,962
Chromium	0.60 - 0.70	5 / 12	33.8	AS05-5GW19-R05	6.42	9.88
Cobalt	1.10 - 1.30	9 / 12	72.3	AS05-5GW09-R07	19.0	22.6
Copper	0.70 - 1.50	5 / 12	39.0	AS05-5GW11-R07	9.46	14.3
Cyanide	1.00 - 10.0	3 / 18	19.0	AS05-5GW09-R06	5.33	3.65
Iron	12.2 - 15.9	10 / 12	28,500	AS05-5GW19-R05	7,694	8,939
Lead	2.00 - 2.90	4 / 12	29.9	AS05-5GW19-R05	6.03	9.02
Magnesium	12.3 - 13.6	12 / 12	32,400	AS05-5GW09-R05	16,196	7,902
Manganese	0.30 - 0.60	12 / 12	2,900	AS05-5GW19-R05	969	942
Mercury	0.10 - 0.20	0 / 12	--	--	0.08	0.02
Molybdenum	10.0 - 10.0	0 / 11	--	--	5.00	0.0
Nickel	2.00 - 2.10	11 / 12	91.8	AS05-5GW07-R07	35.2	30.0
Potassium	26.9 - 49.7	12 / 12	4,820	AS05-5GW11-R07	2,195	1,396
Selenium	2.20 - 4.00	0 / 12	--	--	1.55	0.47
Silver	0.60 - 0.60	1 / 12	1.30	AS05-5GW11-R07	0.41	0.29
Sodium	308 - 497	10 / 12	17,100	AS05-5GW07-R07	9,146	5,666
Thallium	2.30 - 5.00	0 / 12	--	--	1.83	0.71
Vanadium	0.80 - 1.00	4 / 12	32.9	AS05-5GW19-R05	5.19	9.79
Zinc	1.50 - 3.20	6 / 12	150	AS05-5GW19-R05	58.8	50.3

1 - One-half of the reporting limit was used for non-detected samples when calculating the mean

TABLE 8-17
Summary Statistics - Site 5 - Groundwater (Downgradient)
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Chemical	Reporting Limit Range	Frequency of Detection	Maximum Concentration Detected	Sample ID of Maximum Concentration	Arithmetic Mean[1]	Standard Deviation of Mean
Dissolved Metals (UG/L)						
Aluminum	7.90 - 19.2	1 / 11	259	AS05-5GW20-R06	48.0	71.8
Antimony	3.10 - 4.90	1 / 11	3.40	AS05-5GW11-R06	2.19	0.68
Arsenic	2.50 - 3.80	2 / 11	3.40	AS05-5GW19-R06	2.15	0.80
Barium	0.20 - 0.30	10 / 11	92.6	AS05-5GW20-R06	60.2	21.4
Beryllium	0.10 - 0.10	0 / 11	--	--	0.10	0.06
Boron	40.0 - 50.0	4 / 10	112	AS05-5GW09-R06	48.9	34.0
Cadmium	0.40 - 0.40	0 / 11	--	--	0.24	0.063
Calcium	3.10 - 15.9	11 / 11	122,000	AS05-5GW09-R06	58,200	28,986
Chromium	0.70 - 0.80	1 / 11	4.60	AS05-5GW20-R06	0.96	1.25
Cobalt	1.00 - 1.10	7 / 11	37.2	AS05-5GW07-R06	8.75	13.4
Copper	0.70 - 0.80	4 / 11	8.90	AS05-5GW11-R06	1.78	2.53
Iron	14.7 - 15.9	8 / 11	12,100	AS05-5GW07-R06	2,226	4,527
Lead	2.00 - 2.50	0 / 11	--	--	1.24	0.31
Magnesium	7.90 - 13.6	11 / 11	36,300	AS05-5GW09-R06	17,186	10,379
Manganese	0.20 - 0.30	11 / 11	2,110	AS05-5GW09-R05	698	782
Mercury	0.10 - 0.20	0 / 11	--	--	0.12	0.13
Molybdenum	10.0 - 10.0	0 / 10	--	--	5.00	0.00
Nickel	1.70 - 2.00	9 / 11	95.3	AS05-5GW07-R06	26.2	33.6
Potassium	31.0 - 49.7	10 / 11	4,550	AS05-5GW09-R06	1,982	1,646
Selenium	2.20 - 3.20	0 / 11	--	--	2.12	2.03
Silver	0.60 - 1.30	0 / 11	--	--	0.53	0.17
Sodium	267 - 308	10 / 11	19,500	AS05-5GW09-R06	11,189	6,770
Thallium	2.30 - 3.90	3 / 11	5.80	AS05-5GW19-R06	2.58	1.81
Vanadium	1.00 - 34.9	0 / 11	--	--	9.75	8.85
Zinc	0.50 - 1.50	3 / 11	105	AS05-5GW07-R05	32.8	30.6
Volatile Organic Compounds (UG/L)						

1 - One-half of the reporting limit was used for non-detected samples when calculating the mean

TABLE 8-17
Summary Statistics - Site 5 - Groundwater (Downgradient)
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Chemical	Reporting Limit Range	Frequency of Detection	Maximum Concentration Detected	Sample ID of Maximum Concentration	Arithmetic Mean[1]	Standard Deviation of Mean
1,1,1-Trichloroethane	1.00 - 1.00	1 / 18	0.50	AS05-5GW09-R05	0.50	0.00
1,1,2,2-Tetrachloroethane	1.00 - 1.00	0 / 18	--	--	0.50	0.00
1,1,2-Trichloroethane	1.00 - 1.00	0 / 18	--	--	0.50	0.00
1,1-Dichloroethane	1.00 - 1.00	0 / 18	--	--	0.50	0.00
1,1-Dichloroethene	1.00 - 1.00	0 / 18	--	--	0.50	0.00
1,2,4-Trichlorobenzene	1.00 - 1.00	0 / 18	--	--	0.50	0.00
1,2-Dibromo-3-chloropropane	1.00 - 1.00	0 / 12	--	--	0.50	0.00
1,2-Dibromoethane	1.00 - 1.00	0 / 18	--	--	0.50	0.00
1,2-Dichlorobenzene	1.00 - 1.00	0 / 18	--	--	0.50	0.00
1,2-Dichloroethane	1.00 - 1.00	0 / 18	--	--	0.50	0.00
1,2-Dichloropropane	1.00 - 1.00	0 / 18	--	--	0.50	0.00
1,3-Dichlorobenzene	1.00 - 1.00	0 / 18	--	--	0.50	0.00
1,4-Dichlorobenzene	1.00 - 1.00	0 / 18	--	--	0.50	0.00
2-Butanone	5.00 - 5.00	0 / 9	--	--	2.50	0.00
2-Hexanone	5.00 - 5.00	0 / 18	--	--	2.50	0.00
4-Methyl-2-pentanone	5.00 - 5.00	0 / 18	--	--	2.50	0.00
Acetone	5.00 - 5.00	0 / 6	--	--	2.50	0.00
Benzene	1.00 - 1.00	0 / 18	--	--	0.50	0.00
Bromochloromethane	1.00 - 1.00	0 / 18	--	--	0.50	0.00
Bromodichloromethane	1.00 - 1.00	0 / 18	--	--	0.50	0.00
Bromoform	1.00 - 1.00	0 / 18	--	--	0.50	0.00
Bromomethane	1.00 - 1.00	0 / 18	--	--	0.50	0.00
Carbon disulfide	1.00 - 1.00	0 / 18	--	--	0.50	0.00
Carbon tetrachloride	1.00 - 1.00	0 / 18	--	--	0.50	0.00
Chlorobenzene	1.00 - 1.00	0 / 18	--	--	0.50	0.00
Chloroethane	1.00 - 1.00	0 / 18	--	--	0.50	0.00
Chloroform	1.00 - 1.00	0 / 18	--	--	0.50	0.00

1 - One-half of the reporting limit was used for non-detected samples when calculating the mean

TABLE 8-17
Summary Statistics - Site 5 - Groundwater (Downgradient)
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Chemical	Reporting Limit Range	Frequency of Detection	Maximum Concentration Detected	Sample ID of Maximum Concentration	Arithmetic Mean[1]	Standard Deviation of Mean
Chloromethane	1.00 - 1.00	0 / 18	--	--	0.50	0.00
Dibromochloromethane	1.00 - 1.00	0 / 18	--	--	0.50	0.00
Ethylbenzene	1.00 - 1.00	0 / 18	--	--	0.50	0.00
Methylene chloride	1.00 - 2.00	2 / 18	4.10	AS05-5GW19-R05	0.89	1.12
Styrene	1.00 - 1.00	0 / 18	--	--	0.50	0.00
Tetrachloroethene	1.00 - 1.00	0 / 18	--	--	0.50	0.00
Toluene	1.00 - 1.00	0 / 18	--	--	0.50	0.00
Trichloroethene	1.00 - 5.00	10 / 18	48.0	AS05-5GW09-R05	12.6	16.1
Vinyl chloride	1.00 - 1.00	0 / 18	--	--	0.50	0.00
Xylene, total	1.00 - 1.00	0 / 6	--	--	0.50	0.00
cis-1,2-Dichloroethene	1.00 - 1.00	9 / 18	7.10	AS05-5GW09-R05	1.50	1.76
cis-1,3-Dichloropropene	1.00 - 1.00	0 / 18	--	--	0.50	0.00
m- and p-Xylene	1.00 - 1.00	0 / 18	--	--	0.50	0.00
o-Xylene	1.00 - 1.00	0 / 18	--	--	0.50	0.00
trans-1,2-Dichloroethene	1.00 - 1.00	0 / 18	--	--	0.50	0.00
trans-1,3-Dichloropropene	1.00 - 1.00	0 / 18	--	--	0.50	0.00
Other Parameters (MG/L)						
Hardness	0.20 - 1.00	18 / 18	454	AS05-5GW09-R06	205	91.2

1 - One-half of the reporting limit was used for non-detected samples when calculating the mean

TABLE 8-18
Preliminary Assessment Endpoints, Risk Hypotheses, and Measurement Endpoints
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Assessment Endpoint	Risk Hypothesis	Measurement Endpoint	Receptor
Survival, growth, and reproduction of benthic invertebrate communities	Are site-related chemical concentrations in surface water and sediment sufficient to adversely effect benthic invertebrate communities?	Comparison of maximum chemical concentrations in surface water and sediment with medium-specific screening values	Benthic invertebrates
Survival, growth, and reproduction of aquatic plant communities	Are site-related chemical concentrations in surface water and sediment sufficient to adversely effect aquatic plant communities?	Comparison of maximum chemical concentrations in surface water and sediment with medium-specific screening values	Aquatic plants
Survival, growth, and reproduction of fish communities	Are site-related chemical concentrations in surface water and sediment sufficient to adversely effect fish communities?	Comparison of maximum chemical concentrations in surface water and sediment with medium-specific screening values	Freshwater fish
		Comparison of maximum detected fish tissue concentrations with tissue-based screening values	
Survival, growth, and reproduction of amphibian communities	Are site-related chemical concentrations in surface water and sediment sufficient to adversely effect amphibian communities?	Comparison of maximum chemical concentrations in surface water and sediment with medium-specific screening values	Amphibians
Survival, growth, and reproduction of amphibian populations	Are site-related chemical concentrations in surface water and sediment sufficient to cause adverse effects (on growth, survival, or reproduction) to amphibian	Evidence of potential risk to other upper trophic level aquatic receptors evaluated in the ERA	--
Survival, growth, and reproduction of aquatic reptile populations	Are site-related chemical concentrations in surface water and sediment sufficient to cause adverse effects (on growth, survival, or reproduction) to aquatic reptile	Evidence of potential risk to other upper trophic level aquatic receptors evaluated in the ERA	--
Survival, growth, and reproduction of avian semi-aquatic omnivore populations	Are site-related chemical concentrations in surface water and sediment sufficient to cause adverse effects (on growth, survival, or reproduction) to avian omnivore populations that may consume aquatic prey from the portion of the river adjacent to the site?	Comparison of literature-derived chronic No Observed Adverse Effect Level (NOAEL) values for survival, growth, and/or reproductive effects with modeled dietary exposure doses based on maximum surface water and sediment concentrations	Mallard

TABLE 8-18
Preliminary Assessment Endpoints, Risk Hypotheses, and Measurement Endpoints
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Assessment Endpoint	Risk Hypothesis	Measurement Endpoint	Receptor
Survival, growth, and reproduction of avian semi-aquatic piscivore populations	Are site-related chemical concentrations in surface water and sediment sufficient to cause adverse effects (on growth, survival, or reproduction) to avian piscivore populations that may consume fish from the portion of the river adjacent to the site?	Comparison of literature-derived chronic No Observed Adverse Effect Level (NOAEL) values for survival, growth, and/or reproductive effects with modeled dietary exposure doses based on maximum surface water and sediment concentrations	Belted kingfisher Great blue heron
Survival, growth, and reproduction of mammalian semi-aquatic omnivore populations	Are site-related chemical concentrations in surface water and sediment sufficient to cause adverse effects (on growth, survival, or reproduction) to mammalian omnivore populations that may consume aquatic prey from the portion of the river adjacent to the site?	Comparison of literature-derived chronic No Observed Adverse Effect Level (NOAEL) values for survival, growth, and/or reproductive effects with modeled dietary exposure doses based on maximum surface water and sediment concentrations	Raccoon
Survival, growth, and reproduction of mammalian semi-aquatic piscivore populations	Are site-related chemical concentrations in surface water and sediment sufficient to cause adverse effects (on growth, survival, or reproduction) to mammalian piscivore populations that may consume fish from the portion of the river adjacent to the site?	Comparison of literature-derived chronic No Observed Adverse Effect Level (NOAEL) values for survival, growth, and/or reproductive effects with modeled dietary exposure doses based on maximum surface water and sediment concentrations	Mink

TABLE 8-19

Bioaccumulative Chemicals List and Log K_{ow} Values for Relevant Chemicals

Focused RI/FS

Site 5, Allegany Ballistics Laboratory

Rocket Center, West Virginia

Chemical	CAS Number	Log K_{ow} Range	Selected log K_{ow}	Reference
Inorganics				
Arsenic	7440-38-2	-- - --	--	--
Cadmium	7440-43-9	-- - --	--	--
Chromium	7440-47-3	-- - --	--	--
Copper	7440-50-8	-- - --	--	--
Lead	7439-92-1	-- - --	--	--
Mercury	7439-97-6	-- - --	--	--
Nickel	7440-02-0	-- - --	--	--
Selenium	7782-49-2	-- - --	--	--
Silver	7440-22-4	-- - --	--	--
Zinc	7440-66-6	-- - --	--	--
Volatile and Semivolatile Organics				
1,1,2,2-Tetrachloroethane	79-34-5	2.31 - 2.64	2.39	USEPA 1995b
1,2,4-Trichlorobenzene	120-82-1	3.89 - 4.23	4.01	USEPA 1995b
1,2-Dichlorobenzene	95-50-1	3.20 - 3.61	3.43	USEPA 1995b
1,3-Dichlorobenzene	541-73-1	-- - --	3.50	USEPA 1996a
1,4-Dichlorobenzene	106-46-7	3.26 - 3.62	3.42	USEPA 1995b
4-Bromophenyl-phenylether	101-55-3	4.89 - 5.24	5.00	USEPA 1995b
4-Chlorophenyl-phenylether	7005-72-3	4.08 - 5.09	4.95	USEPA 1995b
Acenaphthene	83-32-9	3.77 - 4.49	3.92	USEPA 1995b
Acenaphthylene	208-96-8	-- - --	4.10	USEPA 1996a
Anthracene	120-12-7	4.44 - 4.80	4.55	USEPA 1995b
Benzo(a)anthracene	56-55-3	5.61 - 5.79	5.70	USEPA 1995b
Benzo(a)pyrene	50-32-8	5.98 - 6.34	6.11	USEPA 1995b
Benzo(b)fluoranthene	205-99-2	5.79 - 6.40	6.20	USEPA 1995b
Benzo(g,h,i)perylene	191-24-2	6.58 - 7.05	6.70	USEPA 1995b
Benzo(k)fluoranthene	207-08-9	6.12 - 6.27	6.20	USEPA 1995b
Chrysene	218-01-9	5.41 - 5.79	5.70	USEPA 1995b
Dibenz(a,h)anthracene	53-70-3	6.50 - 6.88	6.69	USEPA 1995b

TABLE 8-19

Bioaccumulative Chemicals List and Log K_{ow} Values for Relevant Chemicals

Focused RI/FS

Site 5, Allegany Ballistics Laboratory

Rocket Center, West Virginia

Chemical	CAS Number	Log K_{ow} Range	Selected log K_{ow}	Reference
Fluoranthene	206-44-0	4.84 - 5.39	5.12	USEPA 1995b
Fluorene	86-73-7	4.04 - 4.40	4.21	USEPA 1995b
Hexachlorobenzene	118-74-1	5.23 - 6.92	5.89	USEPA 1995b
Hexachlorobutadiene	87-68-3	4.74 - 5.16	4.81	USEPA 1995b
Hexachlorocyclopentadiene	77-47-4	5.05 - 5.51	5.39	USEPA 1995b
Hexachloroethane	67-72-1	3.82 - 4.14	4.00	USEPA 1995b
Indeno(1,2,3-cd)pyrene	193-39-5	6.58 - 6.72	6.65	USEPA 1995b
Pentachlorophenol	87-86-5	5.01 - 5.24	5.09	USEPA 1995b
Phenanthrene	85-01-8	4.37 - 4.57	4.55	USEPA 1995b
Pyrene	129-00-0	4.76 - 5.52	5.11	USEPA 1995b

TABLE 8-20
Sediment Bioaccumulation and Bioconcentrtion Factors For Benthic Invertebrates and Plants - Step 2
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Chemical	Sediment-Invertebrate BAF (dry weight)		Sediment-Plant BCF (dry weight)	
	Value	Reference	Value	Reference
Metals				
Arsenic	0.68	Bechtel Jacobs 1998b	1.10	Bechtel Jacobs 1998a
Cadmium	3.07	Bechtel Jacobs 1998b	3.25	Bechtel Jacobs 1998a
Chromium	0.19	Bechtel Jacobs 1998b	0.008	Baes et al. 1984
Copper	7.96	Bechtel Jacobs 1998b	0.63	Bechtel Jacobs 1998a
Lead	0.33	Bechtel Jacobs 1998b	0.47	Bechtel Jacobs 1998a
Mercury	1.74	Bechtel Jacobs 1998b	5.00	Bechtel Jacobs 1998a
Nickel	0.21	Bechtel Jacobs 1998b	1.41	Bechtel Jacobs 1998a
Selenium	1.00	--	3.01	Bechtel Jacobs 1998a
Silver	0.18	Hirsch 1998	0.40	Baes et al. 1984
Zinc	4.76	Bechtel Jacobs 1998b	1.82	Bechtel Jacobs 1998a
Volatile and Semivolatile Organics				
1,1,2,2-Tetrachloroethane	1.00	--	1.609	Travis and Arms 1988
1,2,4-Trichlorobenzene	1.00	--	0.186	Travis and Arms 1988
1,2-Dichlorobenzene	1.00	--	0.403	Travis and Arms 1988
1,3-Dichlorobenzene	1.00	--	0.367	Travis and Arms 1988
1,4-Dichlorobenzene	1.00	--	0.409	Travis and Arms 1988
4-Bromophenyl-phenylether	1.00	--	0.050	Travis and Arms 1988
4-Chlorophenyl-phenylether	1.00	--	0.053	Travis and Arms 1988
Acenaphthene	2.04	Maruya et al. 1997	0.210	Travis and Arms 1988
Acenaphthylene	1.00	--	0.165	Travis and Arms 1988
Anthracene	0.27	Maruya et al. 1997	0.091	Travis and Arms 1988
Benzo(a)anthracene	1.40	Maruya et al. 1997	0.020	Travis and Arms 1988
Benzo(a)pyrene	0.19	Maruya et al. 1997	0.011	Travis and Arms 1988
Benzo(b)fluoranthene	0.16	Maruya et al. 1997	0.010	Travis and Arms 1988
Benzo(g,h,i)perylene	0.30	Maruya et al. 1997	0.005	Travis and Arms 1988
Benzo(k)fluoranthene	0.42	Maruya et al. 1997	0.010	Travis and Arms 1988
Chrysene	0.34	Maruya et al. 1997	0.020	Travis and Arms 1988

TABLE 8-20
Sediment Bioaccumulation and Bioconcentrtion Factors For Benthic Invertebrates and Plants - Step 2
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Chemical	Sediment-Invertebrate BAF (dry weight)		Sediment-Plant BCF (dry weight)	
	Value	Reference	Value	Reference
Dibenz(a,h)anthracene	1.00	--	0.005	Travis and Arms 1988
Fluoranthene	0.31	Maruya et al. 1997	0.043	Travis and Arms 1988
Fluorene	1.13	Maruya et al. 1997	0.143	Travis and Arms 1988
Hexachlorobenzene	1.00	--	0.015	Travis and Arms 1988
Hexachlorobutadiene	1.00	--	0.064	Travis and Arms 1988
Hexachlorocyclopentadiene	1.00	--	0.030	Travis and Arms 1988
Hexachloroethane	1.00	--	0.189	Travis and Arms 1988
Indeno(1,2,3-cd)pyrene	0.36	Maruya et al. 1997	0.006	Travis and Arms 1988
Pentachlorophenol	1.00	--	0.044	Travis and Arms 1988
Phenanthrene	0.65	Maruya et al. 1997	0.091	Travis and Arms 1988
Pyrene	0.80	Maruya et al. 1997	0.043	Travis and Arms 1988

TABLE 8-21
Exposure Parameters for Upper Trophic Level Ecological Receptors - Step 2
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Receptor	Body Weight (kg)		Water Ingestion Rate (L/day)		Food Ingestion Rate (kg/day - dry)	
	Value	Reference	Value	Reference	Value	Reference
Birds						
Belted kingfisher	0.125	Dunning 1993	0.0211	allometric equation	0.0245	USEPA 1993
Great blue heron	2.100	Butler 1992	0.1090	allometric equation	0.4389	allometric equation
Mallard	0.612	Bellrose 1980	0.0850	allometric equation	0.0830	allometric equation
Mammals						
Mink	0.726	Silva and Downing 1995	0.0286	USEPA 1993	0.0340	USEPA 1993
Raccoon	4.230	Silva and Downing 1995	0.6092	allometric equation	0.1268	Conover 1989

TABLE 8-21
Exposure Parameters for Upper Trophic Level Ecological Receptors - Step 2
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Receptor	Dietary Composition (percent)							Sediment Ingestion (percent)	
	Terr. Plants	Soil Invert.	Small Mammals	Fish	Aquatic Plants	Benthic Invert.	Reference	Value	Reference
Birds									
Belted kingfisher	0	0	0	84.0	0	16.0	USEPA 1993	0	Sample and Suter 1994
Great blue heron	0	0	0	100	0	0	USEPA 1993; Quinney and Smith 1980	0	Sample and Suter 1994
Mallard	0	0	0	0	86.7	10.0	Palmer 1976	3.3	Beyer et al. 1994
Mammals									
Mink	0	0	0	94.0	1.0	5.0	USEPA 1993	0	Sample and Suter 1994
Raccoon	0	0	0	7.0	40.0	43.6	USEPA 1993	9.4	Beyer et al. 1994

TABLE 8-22
Medium-Specific Screening Values Used in the ERA
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Chemical	Screening Value	Units	Reference	Hardness
Surface Water				
1,1,1-Trichloroethane	9,400	ug/L	USEPA 1995a	
1,1,2,2-Tetrachloroethane	2,400	ug/L	USEPA 1995a	
1,1,2-Trichloroethane	9,400	ug/L	USEPA 1995a	
1,1-Dichloroethane	1,600	ug/L	USEPA 1995a (with safety factor of 100)	
1,1-Dichloroethene	1,160	ug/L	USEPA 1995a (with safety factor of 10)	
1,2,4-Trichlorobenzene	50.0	ug/L	USEPA 1995a	
1,2-Dibromoethane	180	ug/L	USEPA 1995a (with safety factor of 100)	
1,2-Dichlorobenzene	763	ug/L	USEPA 1995a	
1,2-Dichloroethane	20,000	ug/L	USEPA 1995a	
1,2-Dichloropropane	5,700	ug/L	USEPA 1995a	
1,3-Dichlorobenzene	763	ug/L	USEPA 1995a	
1,4-Dichlorobenzene	763	ug/L	USEPA 1995a	
2-Butanone	14,000	ug/L	Suter and Tsao 1996	
2-Hexanone	4,280	ug/L	USEPA 1995a (with safety factor of 100)	
4-Methyl-2-pentanone	4,600	ug/L	USEPA 1995a (with safety factor of 100)	
Acetone	90,000	ug/L	USEPA 1995a (with safety factor of 100)	
Aluminum	87.0	ug/L	USEPA 1999b	
Antimony	30.0	ug/L	USEPA 1995a	
Arsenic	150	ug/L	USEPA 1999b	
Barium	1,000	ug/L	USEPA 1995a (with safety factor of 10)	
Benzene	530	ug/L	USEPA 1995a (with safety factor of 10)	
Beryllium	5.30	ug/L	USEPA 1995a	
Bromochloromethane	1,100	ug/L	USEPA 1995a (with safety factor of 10)	
Bromodichloromethane	1,100	ug/L	USEPA 1995a (with safety factor of 10)	
Bromoform	320	ug/L	USEPA 1996b	
Bromomethane	110	ug/L	USEPA 1999a	
Cadmium (total)	4.16	ug/L	USEPA 1999b	195
Cadmium (dissolved)	3.66	ug/L	USEPA 1999b	195
Carbon disulfide	2.00	ug/L	USEPA 1995a	
Carbon tetrachloride	3,520	ug/L	USEPA 1995a (with safety factor of 10)	
Chlorobenzene	130	ug/L	USEPA 1996b	
Chloroform	1,240	ug/L	USEPA 1995a	
Chloromethane	5,500	ug/L	USEPA 1999a	
Chromium (total)	11.4	ug/L	USEPA 1999b	
Chromium (dissolved)	11.0	ug/L	USEPA 1999b	
cis-1,2-Dichloroethene	1,160	ug/L	USEPA 1995a (with safety factor of 10)	
cis-1,3-Dichloropropene	244	ug/L	USEPA 1995a	
Cobalt	23.0	ug/L	Suter and Tsao 1996	
Copper (total)	16.5	ug/L	USEPA 1999b	195
Copper (dissolved)	15.8	ug/L	USEPA 1999b	195
Cyanide	5.20	ug/L	USEPA 1995a	
Dibromochloromethane	1,100	ug/L	USEPA 1995a (with safety factor of 10)	
Ethylbenzene	3,200	ug/L	USEPA 1995a (with safety factor of 10)	
Iron	1,000	ug/L	USEPA 1999b	

TABLE 8-22
Medium-Specific Screening Values Used in the ERA
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Chemical	Screening Value	Units	Reference	Hardness
Lead (total)	7.44	ug/L	USEPA 1999b	195
Lead (dissolved)	5.16	ug/L	USEPA 1999b	195
Manganese	120	ug/L	Suter and Tsao 1996	
Mercury (total)	0.91	ug/L	USEPA 1999b	
Mercury (dissolved)	0.77	ug/L	USEPA 1999b	
Methylene chloride	2,200	ug/L	Suter and Tsao 1996	
Nickel (total)	91.8	ug/L	USEPA 1999b	195
Nickel (dissolved)	91.5	ug/L	USEPA 1999b	195
Selenium (total)	5.00	ug/L	USEPA 1995a	
Selenium (dissolved)	4.60	ug/L	USEPA 1995a	
Silver	0.36	ug/L	Suter and Tsao 1996	
Styrene	241	ug/L	AQUIRE 2000	
Tetrachloroethene	840	ug/L	USEPA 1995a	
Thallium	40.0	ug/L	USEPA 1995a	
Toluene	1,700	ug/L	USEPA 1995a (with safety factor of 10)	
trans-1,2-Dichloroethene	1,160	ug/L	USEPA 1995a (with safety factor of 10)	
trans-1,3-Dichloropropene	244	ug/L	USEPA 1995a	
Trichloroethene	21,900	ug/L	USEPA 1995a	
Vanadium	10,000	ug/L	USEPA 1995a	
Vinyl chloride	1,160	ug/L	USEPA 1995a (with safety factor of 10)	
Xylene, total	130	ug/L	USEPA 1995a	
Zinc (total)	211	ug/L	USEPA 1999b	195
Zinc (dissolved)	208	ug/L	USEPA 1999b	195
Sediment				
1,1,1-Trichloroethane	31.0	ug/kg	USEPA 1995a	
1,1,2-Trichloroethane	31.0	ug/kg	USEPA 1995a	
1,2,4-Trichlorobenzene	40.0	ug/kg	USEPA 1995a	
1,2-Dichlorobenzene	35.0	ug/kg	USEPA 1995a	
1,4-Dichlorobenzene	110	ug/kg	USEPA 1995a	
1-Methylnaphthalene	70.0	ug/kg	2-Methylnaphthalene value	
2,4-Dimethylphenol	29.0	ug/kg	USEPA 1995a	
2-Methylnaphthalene	70.0	ug/kg	USEPA 1995a	
2-Methylphenol	63.0	ug/kg	USEPA 1995a	
4-Methylphenol	670	ug/kg	USEPA 1995a	
Acenaphthene	16.0	ug/kg	USEPA 1995a	
Acenaphthylene	44.0	ug/kg	USEPA 1995a	
Aluminum	25,500	mg/kg	Buchman 1999	
Anthracene	85.3	ug/kg	USEPA 1995a	
Antimony	150	mg/kg	USEPA 1995a	
Arsenic	8.20	mg/kg	USEPA 1995a	
Barium	500	mg/kg	Beyer 1990	
Benzo(a)anthracene	261	ug/kg	USEPA 1995a	
Benzo(a)pyrene	430	ug/kg	USEPA 1995a	
Benzo(b)fluoranthene	3,200	ug/kg	USEPA 1995a	
Benzo(g,h,i)perylene	670	ug/kg	USEPA 1995a	

TABLE 8-22
Medium-Specific Screening Values Used in the ERA
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Chemical	Screening Value	Units	Reference	Hardness
Benzo(k)fluoranthene	240	ug/kg	Ontario Ministry of the Environment 1993	
bis(2-Ethylhexyl)phthalate	1,300	ug/kg	USEPA 1995a	
Butylbenzylphthalate	63.0	ug/kg	USEPA 1995a	
Cadmium	1.20	mg/kg	USEPA 1995a	
Chromium	81.0	mg/kg	Long et al. 1995	
Chrysene	384	ug/kg	USEPA 1995a	
Cobalt	50.0	mg/kg	Ontario Ministry of the Environment 1993	
Copper	34.0	mg/kg	USEPA 1995a	
Cyanide	0.10	mg/kg	Ontario Ministry of the Environment 1993	
Dibenz(a,h)anthracene	63.4	ug/kg	USEPA 1995a	
Dibenzofuran	540	ug/kg	USEPA 1995a	
Diethylphthalate	200	ug/kg	USEPA 1995a	
Dimethylphthalate	71.0	ug/kg	USEPA 1995a	
Di-n-butylphthalate	1,400	ug/kg	USEPA 1995a	
Di-n-octyl phthalate	6,200	ug/kg	USEPA 1995a	
Ethylbenzene	10.0	ug/kg	USEPA 1995a	
Fluoranthene	600	ug/kg	USEPA 1995a	
Fluorene	19.0	ug/kg	USEPA 1995a	
Hexachlorobenzene	22.0	ug/kg	USEPA 1995a	
Hexachlorobutadiene	11.0	ug/kg	USEPA 1995a	
Indeno(1,2,3-cd)pyrene	600	ug/kg	USEPA 1995a	
Iron	188,400	mg/kg	Buchman 1999	
Lead	46.7	mg/kg	USEPA 1995a	
Manganese	460	mg/kg	Ontario Ministry of the Environment 1993	
Mercury	0.15	mg/kg	USEPA 1995a	
Naphthalene	160	ug/kg	USEPA 1995a	
Nickel	20.9	mg/kg	USEPA 1995a	
n-Nitrosodiphenylamine	28.0	ug/kg	USEPA 1995a	
PAH (total)	4,022	ug/kg	Long et al. 1995	
Pentachlorophenol	360	ug/kg	USEPA 1995a	
Phenanthrene	240	ug/kg	USEPA 1995a	
Phenol	420	ug/kg	USEPA 1995a	
Pyrene	665	ug/kg	USEPA 1995a	
Selenium	1.00	mg/kg	Buchman 1999	
Silver	1.00	mg/kg	USEPA 1995a	
Tetrachloroethene	57.0	ug/kg	USEPA 1995a	
Trichloroethene	41.0	ug/kg	Buchman 1999	
Vanadium	57.0	mg/kg	Buchman 1999	
Xylene, total	40.0	ug/kg	USEPA 1995a	
Zinc	150	mg/kg	USEPA 1995a	

TABLE 8-23
Ingestion Screening Values for Mammals
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Chemical	Test Organism	Body Weight (kg)	Duration	Exposure Route	Effect/Endpoint	LOAEL (mg/kg/d)	NOAEL (mg/kg/d)	Reference
Inorganics								
Arsenic	mouse	0.03	3 generations	oral in water	reproduction	1.26	0.13	Sample et al. 1996
Cadmium	dog	10.0	3 months	oral in diet	reproduction	7.50	0.75	ATSDR 1993
Chromium	rat	0.35	3 months	oral in water	survival	131	13.1	Sample et al. 1996
Copper	mink	1.00	357 days	oral in diet	reproduction	15.1	11.7	Sample et al. 1996
Lead	rat	0.35	3 generations	oral in diet	reproduction	80.0	8.00	Sample et al. 1996
Mercury	mink	1.00	93 days	oral in diet	survival/weight loss	0.25	0.15	Sample et al. 1996
Nickel	rat	0.35	3 generations	oral in diet	reproduction	80.0	40.0	Sample et al. 1996
Selenium	rat	0.35	1 year	oral in water	reproduction	0.33	0.20	Sample et al. 1996
Silver	rat	0.35	2 weeks	oral in water	survival	181	18.1	ATSDR 1990
Zinc	mink	1.00	25 weeks	oral	reproduction	208	20.8	ATSDR 1992
Volatile and Semivolatile Organics								
1,1,2,2-Tetrachloroethane	rat	0.35	78 weeks	oral (gavage)	reproduction	760	76.0	ATSDR 1996
1,2,4-Trichlorobenzene	rat	0.35	3 generations	oral in water	reproduction	106	53.0	Coulston and Kolbye 1994
1,2-Dichlorobenzene	rat	0.35	chronic	oral (gavage)	liver/kidney	857	85.7	Coulston and Kolbye 1994
1,3-Dichlorobenzene	rat	0.35	chronic	oral (gavage)	liver/kidney	857	85.7	Coulston and Kolbye 1994
1,4-Dichlorobenzene	rat	0.35	GD 6-15	oral (gavage)	reproduction	500	250	Coulston and Kolbye 1994
4-Bromophenyl-phenylether	--	--	--	--	--	NA	NA	--
4-Chlorophenyl-phenylether	--	--	--	--	--	NA	NA	--
Acenaphthene	mouse	0.03	13 weeks	oral (gavage)	reproduction	3,500	350	ATSDR 1995
Acenaphthylene	mouse	0.03	13 weeks	oral (gavage)	reproduction	3,500	350	ATSDR 1995
Anthracene	mouse	0.03	13 weeks	oral (gavage)	reproduction	10,000	1,000	ATSDR 1995
Benzo(a)anthracene	mouse	0.03	GD 7-16	oral (gavage)	reproduction	10.0	1.00	Sample et al. 1996
Benzo(a)pyrene	mouse	0.03	GD 7-16	oral (gavage)	reproduction	10.0	1.00	Sample et al. 1996
Benzo(b)fluoranthene	mouse	0.03	GD 7-16	oral (gavage)	reproduction	10.0	1.00	Sample et al. 1996
Benzo(g,h,i)perylene	mouse	0.03	19 to 29 days	oral in diet	reproduction	1,330	133	ATSDR 1995
Benzo(k)fluoranthene	mouse	0.03	GD 7-16	oral (gavage)	reproduction	10.0	1.00	Sample et al. 1996
Chrysene	mouse	0.03	GD 7-16	oral (gavage)	reproduction	10.0	1.00	Sample et al. 1996

TABLE 8-23
Ingestion Screening Values for Mammals
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Chemical	Test Organism	Body Weight (kg)	Duration	Exposure Route	Effect/Endpoint	LOAEL (mg/kg/d)	NOAEL (mg/kg/d)	Reference
Dibenz(a,h)anthracene	mouse	0.03	GD 7-16	oral (gavage)	reproduction	10.0	1.00	Sample et al. 1996
Fluoranthene	mouse	0.03	13 weeks	oral (gavage)	hepatic	1,250	125	ATSDR 1995
Fluorene	mouse	0.03	13 weeks	oral (gavage)	hematological	1,250	125	ATSDR 1995
Hexachlorobenzene	rat	0.35	2 years	oral	reproduction	16.0	1.60	ATSDR 1989
Hexachlorobutadiene	rat	0.35	90 days +	oral	reproduction	20.0	2.00	IPCS 1994
Hexachlorocyclopentadiene	rat	0.35	GD 6-15	oral	reproduction	30.0	10.0	USEPA 1984
Hexachloroethane	--	--	--	--	--	NA	NA	--
Indeno(1,2,3-cd)pyrene	mouse	0.03	GD 7-16	oral (gavage)	reproduction	10.0	1.00	Sample et al. 1996
Pentachlorophenol	rat	0.35	up to 24 months	oral in diet	reproduction	30.0	3.00	Coulston and Kolbye 1994
Phenanthrene	mouse	0.03	19 to 29 days	oral in diet	reproduction	1,330	133	ATSDR 1995
Pyrene	mouse	0.03	19 to 29 days	oral in diet	reproduction	1,330	133	ATSDR 1995

TABLE 8-24
Ingestion Screening Values for Birds
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Chemical	Test Organism	Body Weight (kg)	Duration	Exposure Route	Effect/Endpoint	LOAEL (mg/kg/d)	NOAEL (mg/kg/d)	Reference
Inorganics								
Arsenic	mallard	1.00	128 days	oral in diet	survival	12.8	5.14	Sample et al. 1996
Cadmium	mallard	1.15	90 days	oral in diet	reproduction	20.0	1.45	Sample et al. 1996
Chromium	American black duck	1.25	10 months	oral in diet	reproduction	5.00	1.00	Sample et al. 1996
Copper	chicks	0.53	10 weeks	oral in diet	growth/survival	61.7	47.0	Sample et al. 1996
Lead	Japanese quail	0.15	12 weeks	oral in diet	reproduction	11.3	1.13	Sample et al. 1996
Lead	American kestrel	0.13	7 months	oral in diet	reproduction	38.5	3.85	Sample et al. 1996
Mercury	mallard	1.00	3 generations	oral in diet	reproduction	0.078	0.026	USEPA 1997b
Nickel	mallard	0.78	90 days	oral in diet	growth/survival	107	77.4	Sample et al. 1996
Selenium	mallard	1.00	100 days	oral in diet	reproduction	0.80	0.40	Sample et al. 1996
Silver	mallard	1.10	14 days	oral in diet	survival	1,780	178	USEPA 1999c
Zinc	chicken	1.94	44 weeks	oral in diet	reproduction	131	14.5	Sample et al. 1996
Volatile and Semivolatile Organics								
1,1,2,2-Tetrachloroethane	--	--	--	--	--	NA	NA	--
1,2,4-Trichlorobenzene	northern bobwhite	0.16	14 days	oral (gavage)	growth/survival	2,500	250	Grimes and Jaber 1989
1,2-Dichlorobenzene	northern bobwhite	0.16	14 days	oral (gavage)	growth/survival	2,500	250	Grimes and Jaber 1989
1,3-Dichlorobenzene	northern bobwhite	0.16	14 days	oral (gavage)	growth/survival	2,500	250	Grimes and Jaber 1989
1,4-Dichlorobenzene	northern bobwhite	0.16	14 days	oral (gavage)	growth/survival	2,500	250	Grimes and Jaber 1989
4-Bromophenyl-phenylether	--	--	--	--	--	NA	NA	--
4-Chlorophenyl-phenylether	--	--	--	--	--	NA	NA	--
Acenaphthene	chicken	1.50	34 days	oral in diet	reproduction	395	39.5	Rigdon and Neal 1963
Acenaphthylene	chicken	1.50	34 days	oral in diet	reproduction	395	39.5	Rigdon and Neal 1963
Anthracene	chicken	1.50	34 days	oral in diet	reproduction	395	39.5	Rigdon and Neal 1963
Benzo(a)anthracene	chicken	1.50	34 days	oral in diet	reproduction	395	39.5	Rigdon and Neal 1963
Benzo(a)pyrene	chicken	1.50	34 days	oral in diet	reproduction	395	39.5	Rigdon and Neal 1963
Benzo(b)fluoranthene	chicken	1.50	34 days	oral in diet	reproduction	395	39.5	Rigdon and Neal 1963
Benzo(g,h,i)perylene	chicken	1.50	34 days	oral in diet	reproduction	395	39.5	Rigdon and Neal 1963
Benzo(k)fluoranthene	chicken	1.50	34 days	oral in diet	reproduction	395	39.5	Rigdon and Neal 1963

TABLE 8-24
Ingestion Screening Values for Birds
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Chemical	Test Organism	Body Weight (kg)	Duration	Exposure Route	Effect/Endpoint	LOAEL (mg/kg/d)	NOAEL (mg/kg/d)	Reference
Chrysene	chicken	1.50	34 days	oral in diet	reproduction	395	39.5	Rigdon and Neal 1963
Dibenz(a,h)anthracene	chicken	1.50	34 days	oral in diet	reproduction	395	39.5	Rigdon and Neal 1963
Fluoranthene	chicken	1.50	34 days	oral in diet	reproduction	395	39.5	Rigdon and Neal 1963
Fluorene	chicken	1.50	34 days	oral in diet	reproduction	395	39.5	Rigdon and Neal 1963
Hexachlorobenzene	Japanese quail	0.19	90 days	oral in diet	reproduction	0.80	0.08	Coulston and Kolbye 1994
Hexachlorobutadiene	Japanese quail	0.19	90 days	oral in diet	reproduction	8.00	2.50	Coulston and Kolbye 1994; IPCS 1994
Hexachlorocyclopentadiene	--	--	--	--	--	NA	NA	--
Hexachloroethane	--	--	--	--	--	NA	NA	--
Indeno(1,2,3-cd)pyrene	chicken	1.50	34 days	oral in diet	reproduction	395	39.5	Rigdon and Neal 1963
Pentachlorophenol	chicken	1.50	8 weeks	oral in diet	growth	200	100	Eisler 1989
Phenanthrene	chicken	1.50	34 days	oral in diet	reproduction	395	39.5	Rigdon and Neal 1963
Pyrene	chicken	1.50	34 days	oral in diet	reproduction	395	39.5	Rigdon and Neal 1963

TABLE 8-25
Step 2 Screening Statistics - Site 5 - Surface Water (Downgradient)
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Chemical	Reporting Limit Range	Frequency of Detection	Maximum Concentration Detected	Sample ID of Maximum Concentration	Screening Value	Frequency of Exceedance	Maximum Hazard Quotient[1]	COPC?
Inorganics (UG/L)								
Aluminum	17.2 - 45.7	7 / 9	419	AS05-5SW03-R05	87.0	7 / 9	4.82	**YES**
Antimony	3.70 - 5.00	0 / 9	--	--	30.0	-- / --	0.17	NO
Arsenic	3.80 - 5.10	1 / 9	5.10	AS05-5SW04-R07	150	0 / 9	0.03	NO
Barium	0.20 - 2.00	9 / 9	65.9	AS05-5SW03-R07	1,000	0 / 9	0.07	NO
Beryllium	0.10 - 0.10	0 / 9	--	--	5.30	-- / --	0.02	NO
Cadmium	0.40 - 3.00	0 / 9	--	--	4.16	-- / --	0.72	NO
Calcium [2]	10.7 - 15.9	9 / 9	60,600	AS05-5SW03-R05	NSV	-- / --	NSV	NO
Chromium	0.60 - 5.00	1 / 9	1.30	AS05-5SW04-R07	11.4	0 / 9	0.11	NO
Cobalt	1.10 - 1.80	5 / 9	2.50	AS05-5SW02-R05	23.0	0 / 9	0.11	NO
Copper	0.70 - 2.20	0 / 9	--	--	16.5	-- / --	0.13	NO
Cyanide	10.0 - 10.0	0 / 9	--	--	5.20	-- / --	1.92	**YES**
Iron	7.00 - 15.9	9 / 9	970	AS05-5SW02-R05	1,000	0 / 9	0.97	NO
Lead	2.00 - 3.00	4 / 9	4.80	AS05-5SW02-R05	7.44	0 / 9	0.65	NO
Magnesium [2]	12.3 - 75.9	9 / 9	15,600	AS05-5SW02-R06	NSV	-- / --	NSV	NO
Manganese	0.30 - 1.20	9 / 9	376	AS05-5SW03-R07	120	9 / 9	3.13	**YES**
Mercury	0.10 - 0.20	1 / 9	0.39	AS05-5SW02-R06	0.91	0 / 9	0.43	NO
Nickel	2.00 - 4.00	6 / 9	9.30	AS05-5SW04-R07	91.8	0 / 9	0.10	NO
Potassium [2]	21.9 - 49.7	9 / 9	4,010	AS05-5SW03-R05	NSV	-- / --	NSV	NO
Selenium	2.20 - 5.00	0 / 9	--	--	5.00	-- / --	1.00	**YES**
Silver	0.60 - 5.00	0 / 9	--	--	0.36	-- / --	13.9	**YES**
Sodium [2]	308 - 497	9 / 9	40,300	AS05-5SW04-R07	NSV	-- / --	NSV	NO
Thallium	2.30 - 5.70	0 / 9	--	--	40.0	-- / --	0.14	NO
Vanadium	0.80 - 3.20	0 / 9	--	--	10,000	-- / --	0.0003	NO
Zinc	1.50 - 8.50	5 / 9	47.7	AS05-5SW04-R07	211	0 / 9	0.23	NO

NSV - No Screening Value
1 - Shaded cells indicate hazard quotient based on reporting limits
2 - Macronutrient - Not considered to be a COPC

TABLE 8-25
Step 2 Screening Statistics - Site 5 - Surface Water (Downgradient)
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Chemical	Reporting Limit Range	Frequency of Detection	Maximum Concentration Detected	Sample ID of Maximum Concentration	Screening Value	Frequency of Exceedance	Maximum Hazard Quotient[1]	COPC?
Dissolved Metals (UG/L)								
Aluminum	16.9 - 16.9	0 / 3	--	--	87.0	-- / --	0.19	NO
Antimony	8.90 - 8.90	0 / 3	--	--	30.0	-- / --	0.30	NO
Arsenic	6.20 - 6.20	0 / 3	--	--	150	-- / --	0.04	NO
Barium	1.30 - 1.30	3 / 3	54.0	AS05-5SW02-R06	1,000	0 / 3	0.05	NO
Beryllium	0.10 - 0.10	0 / 3	--	--	5.30	-- / --	0.02	NO
Cadmium	0.60 - 0.60	0 / 3	--	--	3.66	-- / --	0.16	NO
Calcium [2]	3.40 - 3.40	3 / 3	53,800	AS05-5SW02-R06	NSV	-- / --	NSV	NO
Chromium	0.60 - 0.60	3 / 3	1.70	AS05-5SW02-R06	11.0	0 / 3	0.15	NO
Cobalt	0.90 - 0.90	0 / 3	--	--	23.0	-- / --	0.04	NO
Copper	1.50 - 1.50	1 / 3	4.00	AS05-5SW02-R06	15.8	0 / 3	0.25	NO
Iron	15.8 - 15.8	2 / 3	44.8	AS05-5SW02-R06	1,000	0 / 3	0.04	NO
Lead	3.00 - 3.00	0 / 3	--	--	5.16	-- / --	0.58	NO
Magnesium [2]	16.2 - 16.2	3 / 3	14,400	AS05-5SW02-R06	NSV	-- / --	NSV	NO
Manganese	0.20 - 0.20	0 / 3	--	--	120	-- / --	0.002	NO
Mercury	0.20 - 0.20	0 / 3	--	--	0.77	-- / --	0.26	NO
Nickel	1.60 - 1.60	0 / 3	--	--	91.5	-- / --	0.02	NO
Potassium [2]	18.4 - 18.4	3 / 3	3,520	AS05-5SW02-R06	NSV	-- / --	NSV	NO
Selenium	1.60 - 1.60	0 / 3	--	--	4.60	-- / --	0.35	NO
Silver	1.70 - 1.70	0 / 3	--	--	0.36	-- / --	4.72	**YES**
Sodium [2]	357 - 357	3 / 3	30,100	AS05-5SW02-R06	NSV	-- / --	NSV	NO
Thallium	4.30 - 4.30	0 / 3	--	--	40.0	-- / --	0.11	NO
Vanadium	1.20 - 1.20	0 / 3	--	--	10,000	-- / --	0.0001	NO
Zinc	1.10 - 1.10	3 / 3	36.2	AS05-5SW02-R06	208	0 / 3	0.17	NO
Volatile Organic Compounds (UG/L)								

NSV - No Screening Value
1 - Shaded cells indicate hazard quotient based on reporting limits
2 - Macronutrient - Not considered to be a COPC

TABLE 8-25
Step 2 Screening Statistics - Site 5 - Surface Water (Downgradient)
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Chemical	Reporting Limit Range	Frequency of Detection	Maximum Concentration Detected	Sample ID of Maximum Concentration	Screening Value	Frequency of Exceedance	Maximum Hazard Quotient[1]	COPC?
1,1,1-Trichloroethane	1.00 - 1.00	0 / 9	--	--	9,400	-- / --	0.0001	NO
1,1,2,2-Tetrachloroethane	1.00 - 1.00	0 / 9	--	--	2,400	-- / --	0.0004	NO
1,1,2-Trichloroethane	1.00 - 1.00	0 / 9	--	--	9,400	-- / --	0.0001	NO
1,1-Dichloroethane	1.00 - 1.00	0 / 9	--	--	1,600	-- / --	0.001	NO
1,1-Dichloroethene	1.00 - 1.00	0 / 9	--	--	1,160	-- / --	0.001	NO
1,2,4-Trichlorobenzene	1.00 - 1.00	0 / 9	--	--	50.0	-- / --	0.02	NO
1,2-Dibromo-3-chloropropane	1.00 - 1.00	0 / 6	--	--	NSV	-- / --	NSV	NO
1,2-Dibromoethane	1.00 - 1.00	0 / 9	--	--	180	-- / --	0.01	NO
1,2-Dichlorobenzene	1.00 - 1.00	0 / 9	--	--	763	-- / --	0.001	NO
1,2-Dichloroethane	1.00 - 1.00	0 / 9	--	--	20,000	-- / --	0.0001	NO
1,2-Dichloropropane	1.00 - 1.00	0 / 9	--	--	5,700	-- / --	0.0002	NO
1,3-Dichlorobenzene	1.00 - 1.00	0 / 9	--	--	763	-- / --	0.001	NO
1,4-Dichlorobenzene	1.00 - 1.00	0 / 9	--	--	763	-- / --	0.001	NO
2-Butanone	-- - --	0 / 0	--	--	14,000		--	NO
2-Hexanone	5.00 - 5.00	0 / 6	--	--	4,280	-- / --	0.001	NO
4-Methyl-2-pentanone	5.00 - 5.00	0 / 9	--	--	4,600	-- / --	0.001	NO
Acetone	-- - --	0 / 0	--	--	90,000		--	NO
Benzene	1.00 - 1.00	0 / 9	--	--	530	-- / --	0.002	NO
Bromochloromethane	1.00 - 1.00	0 / 9	--	--	1,100	-- / --	0.001	NO
Bromodichloromethane	1.00 - 1.00	0 / 9	--	--	1,100	-- / --	0.001	NO
Bromoform	1.00 - 1.00	0 / 9	--	--	320	-- / --	0.003	NO
Bromomethane	1.00 - 1.00	0 / 9	--	--	110	-- / --	0.01	NO
Carbon disulfide	1.00 - 1.00	0 / 9	--	--	2.00	-- / --	0.50	NO
Carbon tetrachloride	1.00 - 1.00	0 / 9	--	--	3,520	-- / --	0.0003	NO
Chlorobenzene	1.00 - 1.00	0 / 9	--	--	130	-- / --	0.01	NO

NSV - No Screening Value
1 - Shaded cells indicate hazard quotient based on reporting limits
2 - Macronutrient - Not considered to be a COPC

TABLE 8-25
Step 2 Screening Statistics - Site 5 - Surface Water (Downgradient)
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Chemical	Reporting Limit Range	Frequency of Detection	Maximum Concentration Detected	Sample ID of Maximum Concentration	Screening Value	Frequency of Exceedance	Maximum Hazard Quotient[1]	COPC?
Chloroethane	1.00 - 1.00	0 / 9	--	--	NSV	-- / --	NSV	NO
Chloroform	1.00 - 1.00	0 / 9	--	--	1,240	-- / --	0.001	NO
Chloromethane	1.00 - 1.00	0 / 9	--	--	5,500	-- / --	0.0002	NO
Dibromochloromethane	1.00 - 1.00	0 / 9	--	--	1,100	-- / --	0.001	NO
Ethylbenzene	1.00 - 1.00	0 / 9	--	--	3,200	-- / --	0.0003	NO
Methylene chloride	1.00 - 2.00	0 / 9	--	--	2,200	-- / --	0.001	NO
Styrene	1.00 - 1.00	0 / 9	--	--	241	-- / --	0.004	NO
Tetrachloroethene	1.00 - 1.00	0 / 9	--	--	840	-- / --	0.001	NO
Toluene	1.00 - 1.00	0 / 9	--	--	1,700	-- / --	0.001	NO
Trichloroethene	1.00 - 1.00	0 / 9	--	--	21,900	-- / --	0.00005	NO
Vinyl chloride	1.00 - 1.00	0 / 9	--	--	1,160	-- / --	0.001	NO
Xylene, total	1.00 - 1.00	0 / 9	--	--	130	-- / --	0.01	NO
cis-1,2-Dichloroethene	1.00 - 1.00	0 / 9	--	--	1,160	-- / --	0.001	NO
cis-1,3-Dichloropropene	1.00 - 1.00	0 / 9	--	--	244	-- / --	0.004	NO
m- and p-Xylene	1.00 - 1.00	0 / 3	--	--	130	-- / --	0.01	NO
o-Xylene	1.00 - 1.00	0 / 9	--	--	130	-- / --	0.01	NO
trans-1,2-Dichloroethene	1.00 - 1.00	0 / 9	--	--	1,160	-- / --	0.001	NO
trans-1,3-Dichloropropene	1.00 - 1.00	0 / 9	--	--	244	-- / --	0.004	NO

NSV - No Screening Value
1 - Shaded cells indicate hazard quotient based on reporting limits
2 - Macronutrient - Not considered to be a COPC

TABLE 8-26
Step 2 Screening Statistics - Site 5 - Sediment (Downgradient)
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Chemical	Reporting Limit Range	Frequency of Detection	Maximum Concentration Detected	Sample ID of Maximum Concentration	Screening Value	Frequency of Exceedance	Maximum Hazard Quotient[1]	COPC?
Inorganics (MG/KG)								
Aluminum	4.87 - 93.9	21 / 21	13,700	AS05-5SD02-R01	25,500	0 / 21	0.54	NO
Antimony	0.73 - 28.2	1 / 21	1.60	AS05-5SD02-R06	150	0 / 21	0.01	NO
Arsenic	0.73 - 4.70	21 / 21	24.1	AS05-5SD02-R01	8.20	14 / 21	2.94	**YES**
Barium	0.05 - 93.9	20 / 21	208	AS05-5SD03-R06	500	0 / 21	0.42	NO
Beryllium	0.03 - 2.30	21 / 21	2.90	AS05-5SD02-R01	NSV	-- / --	NSV	**YES**
Cadmium	0.10 - 2.30	3 / 21	1.50	5SD-2(94)	1.20	1 / 21	1.25	**YES**
Calcium [2]	3.24 - 2,350	21 / 21	94,100	AS05-5SD02-R05	NSV	-- / --	NSV	NO
Chromium	0.18 - 4.70	21 / 21	80.9	AS05-5SD02-R05	81.0	0 / 21	1.00	NO
Cobalt	0.28 - 23.5	21 / 21	72.6	AS05-5SD03-R06	50.0	3 / 21	1.45	**YES**
Copper	0.18 - 11.7	21 / 21	67.5	AS05-5SD02-R01	34.0	8 / 21	1.99	**YES**
Cyanide	0.63 - 2.50	0 / 10	--	--	0.10	-- / --	25.0	**YES**
Iron	2.12 - 46.9	21 / 21	47,100	AS05-5SD02-R01	188,400	0 / 21	0.25	NO
Lead	0.51 - 1.99	21 / 21	43.6	AS05-5SD02-R01	46.7	0 / 21	0.93	NO
Magnesium [2]	3.45 - 2,350	20 / 21	3,620	AS05-5SD02-R05	NSV	-- / --	NSV	NO
Manganese	0.08 - 7.00	21 / 21	1,700	AS05-5SD03-R06	460	14 / 21	3.70	**YES**
Mercury	0.06 - 0.31	8 / 21	4.80	AS05-5SD02-R05	0.15	5 / 21	32.0	**YES**
Nickel	0.51 - 18.8	21 / 21	110	AS05-5SD03-R06	20.9	21 / 21	5.26	**YES**
Potassium [2]	6.63 - 2,350	20 / 21	1,320	AS05-5SD03-R06	NSV	-- / --	NSV	NO
Selenium	0.54 - 2.60	1 / 21	2.10	AS05-5SD06A	1.00	1 / 21	2.10	**YES**
Silver	0.15 - 4.70	0 / 21	--	--	1.00	-- / --	4.70	**YES**
Sodium [2]	25.5 - 2,350	15 / 21	1,890	AS05-5SD02-R05	NSV	-- / --	NSV	NO
Thallium	0.54 - 4.70	9 / 21	1.90	AS05-5SD02B	NSV	-- / --	NSV	**YES**
Vanadium	0.25 - 23.5	21 / 21	33.2	AS05-5SD07A	57.0	0 / 21	0.58	NO
Zinc	0.38 - 9.40	21 / 21	343	AS05-5SD02-R05	150	12 / 21	2.29	**YES**

NSV - No Screening Value
1 - Shaded cells indicate hazard quotient based on reporting limits
2 - Macronutrient - Not considered to be a COPC

TABLE 8-26
Step 2 Screening Statistics - Site 5 - Sediment (Downgradient)
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Chemical	Reporting Limit Range	Frequency of Detection	Maximum Concentration Detected	Sample ID of Maximum Concentration	Screening Value	Frequency of Exceedance	Maximum Hazard Quotient[1]	COPC?
Semivolatile Organic Compounds (UG/KG)								
1,1-Biphenyl	510 - 810	0 / 5	--	--	NSV	-- / --	NSV	NO
1-Methylnaphthalene	2.10 - 9.00	13 / 13	28.0	AS05-5SD04-R07	70.0	0 / 13	0.40	NO
2,2'-Oxybis(1-chloropropane)	420 - 1,700	0 / 10	--	--	NSV	-- / --	NSV	NO
2,4,5-Trichlorophenol	1,100 - 4,200	0 / 10	--	--	NSV	-- / --	NSV	NO
2,4,6-Trichlorophenol	420 - 1,700	0 / 10	--	--	NSV	-- / --	NSV	NO
2,4-Dichlorophenol	420 - 1,700	0 / 10	--	--	NSV	-- / --	NSV	NO
2,4-Dimethylphenol	420 - 1,700	0 / 10	--	--	29.0	-- / --	58.6	**YES**
2,4-Dinitrophenol	1,100 - 4,200	0 / 10	--	--	NSV	-- / --	NSV	NO
2-Chloronaphthalene	420 - 1,700	0 / 10	--	--	NSV	-- / --	NSV	NO
2-Chlorophenol	420 - 1,700	0 / 10	--	--	NSV	-- / --	NSV	NO
2-Methylnaphthalene	2.10 - 1,700	15 / 21	110	5SD-2(94)	70.0	4 / 21	1.57	**YES**
2-Methylphenol	420 - 1,700	0 / 10	--	--	63.0	-- / --	27.0	**YES**
2-Nitroaniline	1,100 - 4,200	0 / 10	--	--	NSV	-- / --	NSV	NO
2-Nitrophenol	420 - 1,700	0 / 10	--	--	NSV	-- / --	NSV	NO
3,3'-Dichlorobenzidine	420 - 1,700	0 / 10	--	--	NSV	-- / --	NSV	NO
3- and 4-Methylphenol	420 - 1,700	3 / 7	7,800	AS05-5SD03-R06	670	1 / 7	11.6	**YES**
3-Nitroaniline	1,100 - 4,200	0 / 10	--	--	NSV	-- / --	NSV	NO
4,6-Dinitro-2-methylphenol	1,100 - 4,200	0 / 10	--	--	NSV	-- / --	NSV	NO
4-Bromophenyl-phenylether	420 - 1,700	0 / 10	--	--	NSV	-- / --	NSV	NO
4-Chloro-3-methylphenol	420 - 1,700	0 / 10	--	--	NSV	-- / --	NSV	NO
4-Chloroaniline	420 - 1,700	0 / 10	--	--	NSV	-- / --	NSV	NO
4-Chlorophenyl-phenylether	420 - 1,700	0 / 10	--	--	NSV	-- / --	NSV	NO
4-Methylphenol	600 - 650	2 / 3	330	AS05-5SD03-R07	670	0 / 3	0.49	NO
4-Nitroaniline	1,100 - 4,200	0 / 10	--	--	NSV	-- / --	NSV	NO

NSV - No Screening Value
1 - Shaded cells indicate hazard quotient based on reporting limits
2 - Macronutrient - Not considered to be a COPC

TABLE 8-26
Step 2 Screening Statistics - Site 5 - Sediment (Downgradient)
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Chemical	Reporting Limit Range	Frequency of Detection	Maximum Concentration Detected	Sample ID of Maximum Concentration	Screening Value	Frequency of Exceedance	Maximum Hazard Quotient[1]	COPC?
4-Nitrophenol	1,100 - 4,200	0 / 10	--	--	NSV	-- / --	NSV	NO
Acenaphthene	2.10 - 1,700	11 / 21	90.0	AS05-5SD03-R07	16.0	1 / 21	5.63	**YES**
Acenaphthylene	2.10 - 1,700	11 / 21	19.0	AS05-5SD04-R07	44.0	0 / 21	0.43	NO
Acetophenone	510 - 810	0 / 5	--	--	NSV	-- / --	NSV	NO
Anthracene	2.10 - 1,700	12 / 21	36.0	AS05-5SD04-R07	85.3	0 / 21	0.42	NO
Atrazine	510 - 810	0 / 5	--	--	NSV	-- / --	NSV	NO
Benzaldehyde	510 - 810	2 / 5	680	AS05-5SD03-R07	NSV	-- / --	NSV	**YES**
Benzo(a)anthracene	2.10 - 1,700	15 / 21	230	AS05-5SD04-R07	261	0 / 21	0.88	NO
Benzo(a)pyrene	2.10 - 1,700	15 / 21	260	AS05-5SD04-R07	430	0 / 21	0.60	NO
Benzo(b)fluoranthene	2.10 - 1,700	15 / 21	260	AS05-5SD03-R07	3,200	0 / 21	0.08	NO
Benzo(g,h,i)perylene	2.10 - 1,700	13 / 21	170	AS05-5SD04-R07	670	0 / 21	0.25	NO
Benzo(k)fluoranthene	2.10 - 1,700	14 / 21	250	AS05-5SD04-R07	240	1 / 21	1.04	**YES**
Butylbenzylphthalate	420 - 1,700	0 / 10	--	--	63.0	-- / --	27.0	**YES**
Caprolactam	590 - 650	0 / 2	--	--	NSV	-- / --	NSV	NO
Carbazole	420 - 1,700	0 / 10	--	--	NSV	-- / --	NSV	NO
Chrysene	2.10 - 1,700	15 / 21	290	AS05-5SD03-R07	384	0 / 21	0.76	NO
Di-n-butylphthalate	420 - 1,700	5 / 10	1,000	AS05-5SD02-R07	1,400	0 / 10	0.71	NO
Di-n-octylphthalate	420 - 1,700	0 / 10	--	--	6,200	-- / --	0.27	NO
Dibenz(a,h)anthracene	2.10 - 1,700	13 / 21	56.0	AS05-5SD04-R07	63.4	0 / 21	0.88	NO
Dibenzofuran	420 - 1,700	0 / 10	--	--	540	-- / --	3.15	**YES**
Diethylphthalate	420 - 1,700	1 / 10	200	AS05-5SD03-R07	200	1 / 10	1.00	**YES**
Dimethyl phthalate	420 - 1,700	0 / 10	--	--	71.0	-- / --	23.9	**YES**
Fluoranthene	2.10 - 1,700	15 / 21	390	AS05-5SD03-R07	600	0 / 21	0.65	NO
Fluorene	2.10 - 1,700	13 / 21	35.0	AS05-5SD04-R07	19.0	2 / 21	1.84	**YES**
Hexachlorobenzene	420 - 1,700	0 / 10	--	--	22.0	-- / --	77.3	**YES**

NSV - No Screening Value
1 - Shaded cells indicate hazard quotient based on reporting limits
2 - Macronutrient - Not considered to be a COPC

TABLE 8-26
Step 2 Screening Statistics - Site 5 - Sediment (Downgradient)
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Chemical	Reporting Limit Range	Frequency of Detection	Maximum Concentration Detected	Sample ID of Maximum Concentration	Screening Value	Frequency of Exceedance	Maximum Hazard Quotient[1]	COPC?
Hexachlorobutadiene	420 - 1,700	0 / 10	--	--	11.0	-- / --	155	**YES**
Hexachlorocyclopentadiene	420 - 1,700	0 / 10	--	--	NSV	-- / --	NSV	NO
Hexachloroethane	420 - 1,700	0 / 10	--	--	NSV	-- / --	NSV	NO
Indeno(1,2,3-cd)pyrene	2.10 - 1,700	13 / 21	160	AS05-5SD04-R07	600	0 / 21	0.27	NO
Isophorone	420 - 1,700	0 / 10	--	--	NSV	-- / --	NSV	NO
Naphthalene	2.10 - 1,700	13 / 21	81.0	AS05-5SD03-R07	160	0 / 21	0.51	NO
PAH, total	-- - --	15 / 21	4,066	AS05-5SD02-R01	4,022	1 / 21	1.01	**YES**
Pentachlorophenol	1,100 - 4,200	0 / 10	--	--	360	-- / --	11.7	**YES**
Phenanthrene	2.10 - 1,700	15 / 21	380	AS05-5SD03-R07	240	2 / 21	1.58	**YES**
Phenol	420 - 1,700	1 / 10	510	AS05-5SD03-R06	420	1 / 10	1.21	**YES**
Pyrene	2.10 - 1,700	15 / 21	420	AS05-5SD03-R07	665	0 / 21	0.63	NO
bis(2-Chloroethoxy)methane	420 - 1,700	0 / 10	--	--	NSV	-- / --	NSV	NO
bis(2-Chloroethyl)ether	420 - 1,700	0 / 10	--	--	NSV	-- / --	NSV	NO
bis(2-Ethylhexyl)phthalate	420 - 1,700	2 / 10	95.0	AS05-5SD03-R06	1,300	0 / 10	0.07	NO
n-Nitroso-di-n-propylamine	420 - 1,700	0 / 10	--	--	NSV	-- / --	NSV	NO
n-Nitrosodiphenylamine	420 - 1,700	0 / 10	--	--	28.0	-- / --	60.7	**YES**
Explosives (UG/KG)								
2,4-Dinitrotoluene	420 - 1,700	0 / 10	--	--	NSV	-- / --	NSV	NO
2,6-Dinitrotoluene	420 - 1,700	0 / 10	--	--	NSV	-- / --	NSV	NO
Nitrobenzene	420 - 1,700	0 / 10	--	--	NSV	-- / --	NSV	NO
Volatile Organic Compounds (UG/KG)								
1,1,1-Trichloroethane	13.0 - 50.0	0 / 11	--	--	31.0	-- / --	1.61	**YES**
1,1,2,2-Tetrachloroethane	13.0 - 50.0	0 / 11	--	--	NSV	-- / --	NSV	NO
1,1,2-Trichloro-1,2,2-trifluoroethane(Freon-113)	15.0 - 33.0	0 / 6	--	--	NSV	-- / --	NSV	NO
1,1,2-Trichloroethane	13.0 - 50.0	0 / 11	--	--	31.0	-- / --	1.61	**YES**

NSV - No Screening Value
1 - Shaded cells indicate hazard quotient based on reporting limits
2 - Macronutrient - Not considered to be a COPC

TABLE 8-26
Step 2 Screening Statistics - Site 5 - Sediment (Downgradient)
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Chemical	Reporting Limit Range	Frequency of Detection	Maximum Concentration Detected	Sample ID of Maximum Concentration	Screening Value	Frequency of Exceedance	Maximum Hazard Quotient[1]	COPC?
1,1-Dichloroethane	13.0 - 50.0	0 / 11	--	--	NSV	-- / --	NSV	NO
1,1-Dichloroethene	13.0 - 50.0	0 / 11	--	--	NSV	-- / --	NSV	NO
1,2,4-Trichlorobenzene	15.0 - 1,700	0 / 11	--	--	40.0	-- / --	42.5	**YES**
1,2-Dibromo-3-chloropropane	15.0 - 33.0	0 / 6	--	--	NSV	-- / --	NSV	NO
1,2-Dibromoethane	15.0 - 33.0	0 / 6	--	--	NSV	-- / --	NSV	NO
1,2-Dichlorobenzene	15.0 - 1,700	0 / 11	--	--	35.0	-- / --	48.6	**YES**
1,2-Dichloroethane	13.0 - 50.0	0 / 11	--	--	NSV	-- / --	NSV	NO
1,2-Dichloroethene (total)	18.0 - 18.0	0 / 2	--	--	NSV	-- / --	NSV	NO
1,2-Dichloropropane	13.0 - 50.0	0 / 11	--	--	NSV	-- / --	NSV	NO
1,3-Dichlorobenzene	15.0 - 1,700	0 / 11	--	--	NSV	-- / --	NSV	NO
1,4-Dichlorobenzene	15.0 - 1,700	0 / 11	--	--	110	-- / --	15.5	**YES**
2-Butanone	13.0 - 50.0	1 / 11	12.0	5SD-2(94)	NSV	-- / --	NSV	**YES**
2-Hexanone	13.0 - 50.0	0 / 11	--	--	NSV	-- / --	NSV	NO
4-Methyl-2-pentanone	13.0 - 50.0	0 / 11	--	--	NSV	-- / --	NSV	NO
Acetone	13.0 - 50.0	0 / 11	--	--	NSV	-- / --	NSV	NO
Benzene	13.0 - 50.0	0 / 11	--	--	NSV	-- / --	NSV	NO
Bromodichloromethane	13.0 - 50.0	0 / 11	--	--	NSV	-- / --	NSV	NO
Bromoform	13.0 - 50.0	0 / 11	--	--	NSV	-- / --	NSV	NO
Bromomethane	13.0 - 50.0	0 / 11	--	--	NSV	-- / --	NSV	NO
Carbon disulfide	13.0 - 50.0	0 / 11	--	--	NSV	-- / --	NSV	NO
Carbon tetrachloride	13.0 - 50.0	0 / 11	--	--	NSV	-- / --	NSV	NO
Chlorobenzene	13.0 - 50.0	0 / 11	--	--	NSV	-- / --	NSV	NO
Chloroethane	13.0 - 50.0	0 / 11	--	--	NSV	-- / --	NSV	NO
Chloroform	13.0 - 50.0	0 / 11	--	--	NSV	-- / --	NSV	NO
Chloromethane	13.0 - 50.0	0 / 11	--	--	NSV	-- / --	NSV	NO

NSV - No Screening Value
1 - Shaded cells indicate hazard quotient based on reporting limits
2 - Macronutrient - Not considered to be a COPC

TABLE 8-26
Step 2 Screening Statistics - Site 5 - Sediment (Downgradient)
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Chemical	Reporting Limit Range	Frequency of Detection	Maximum Concentration Detected	Sample ID of Maximum Concentration	Screening Value	Frequency of Exceedance	Maximum Hazard Quotient[1]	COPC?
Cumene	15.0 - 33.0	0 / 6	--	--	NSV	-- / --	NSV	NO
Cyclohexane	15.0 - 33.0	0 / 6	--	--	NSV	-- / --	NSV	NO
Dibromochloromethane	13.0 - 50.0	0 / 11	--	--	NSV	-- / --	NSV	NO
Dichlorodifluoromethane(Freon-12)	15.0 - 33.0	0 / 6	--	--	NSV	-- / --	NSV	NO
Ethylbenzene	13.0 - 50.0	0 / 11	--	--	10.0	-- / --	5.00	**YES**
Methyl acetate	15.0 - 33.0	0 / 6	--	--	NSV	-- / --	NSV	NO
Methyl-tert-butyl ether (MTBE)	15.0 - 33.0	0 / 6	--	--	NSV	-- / --	NSV	NO
Methylcyclohexane	15.0 - 33.0	0 / 6	--	--	NSV	-- / --	NSV	NO
Methylene chloride	13.0 - 50.0	1 / 11	32.0	AS05-5SD02-R01	NSV	-- / --	NSV	**YES**
Styrene	13.0 - 50.0	0 / 11	--	--	NSV	-- / --	NSV	NO
Tetrachloroethene	13.0 - 50.0	0 / 11	--	--	57.0	-- / --	0.88	NO
Toluene	13.0 - 50.0	0 / 11	--	--	NSV	-- / --	NSV	NO
Trichloroethene	13.0 - 50.0	0 / 11	--	--	41.0	-- / --	1.22	**YES**
Trichlorofluoromethane(Freon-11)	15.0 - 33.0	0 / 6	--	--	NSV	-- / --	NSV	NO
Vinyl chloride	13.0 - 50.0	0 / 11	--	--	NSV	-- / --	NSV	NO
Xylene, total	13.0 - 50.0	0 / 11	--	--	40.0	-- / --	1.25	**YES**
cis-1,2-Dichloroethene	13.0 - 50.0	0 / 9	--	--	NSV	-- / --	NSV	NO
cis-1,3-Dichloropropene	13.0 - 50.0	0 / 11	--	--	NSV	-- / --	NSV	NO
m- and p-Xylene	13.0 - 50.0	0 / 3	--	--	40.0	-- / --	1.25	**YES**
o-Xylene	13.0 - 50.0	0 / 9	--	--	40.0	-- / --	1.25	**YES**
trans-1,2-Dichloroethene	13.0 - 50.0	0 / 9	--	--	NSV	-- / --	NSV	NO
trans-1,3-Dichloropropene	13.0 - 50.0	0 / 11	--	--	NSV	-- / --	NSV	NO

NSV - No Screening Value
1 - Shaded cells indicate hazard quotient based on reporting limits
2 - Macronutrient - Not considered to be a COPC

TABLE 8-27
Comparison of Fish Tissue Concentrations With Tissue-Based Screening Values
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Chemical	Maximum Whole-body Fish Tissue Concentration (mg/kg wet-weight)	Mean Whole-body Fish Tissue Concentration (mg/kg wet-weight)	Screening Value (mg/kg wet-weight)	Type	Basis[1]	Organism	Reference	Maximum Hazard Quotient
Barium	3.00	1.28	NSV	--	--	--	--	--
Chromium	0.28	0.25	0.58	Muscle	NOEC - S	Rainbow trout	Jarvinen and Ankley 1999	0.48
Cobalt	0.19	0.17	NSV	--	--	--	--	--
Manganese	22.4	17.5	NSV	--	--	--	--	--
Mercury	0.029	0.019	2.84	Whole body	NOEC - R	Fathead minnow	Jarvinen and Ankley 1999	0.01
Selenium	1.50	1.27	4.54	Whole body	NOEC - S,G,R	Bluegill	Jarvinen and Ankley 1999	0.33
Thallium	0.94	0.57	NSV	--	--	--	--	--
Vanadium	0.35	0.24	0.57	Whole body	NOEC - G	Flagfish	Jarvinen and Ankley 1999	0.61
Zinc	28.7	16.4	280	Whole body	NOEC - S,G,R	Guppy	Jarvinen and Ankley 1999	0.10

NSV - No Screening Value
1 - NOEC - No Observed Effect Concentration; S - Survival, G - Growth, R - Reproduction

TABLE 8-28
Summary of Hazard Quotients For Upper Trophic Level Receptors - Step 2
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Chemical	Raccoon		Mink		Belted kingfisher		Great blue heron		Mallard	
	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL
Inorganics										
Arsenic	4.77	0.48	0.57	0.06	0.11	0.05	0.02	<0.01	0.67	0.27
Cadmium	0.17	0.02	0.03	<0.01	0.13	<0.01	0.03	<0.01	0.44	0.03
Chromium	0.03	<0.01	<0.01	<0.01	0.48	0.10	0.01	<0.01	0.64	0.13
Copper	0.66	0.51	0.11	0.09	0.36	0.28	<0.01	<0.01	0.27	0.20
Lead	0.07	<0.01	<0.01	<0.01	0.12	0.01	<0.01	<0.01	2.47	0.25
Mercury	2.73	1.64	0.21	0.12	10.1	3.36	0.06	0.02	114	37.9
Nickel	0.06	0.03	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	0.25	0.18
Selenium	0.55	0.34	0.12	0.07	0.32	0.16	0.20	0.10	1.96	0.98
Silver	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	1.43	0.14	0.21	0.02	3.61	0.40	0.10	0.01	6.69	0.74
Volatile and Semivolatile Organics										
1,1,2,2-Tetrachloroethane	<0.01	<0.01	<0.01	<0.01	NA	NA	NA	NA	NA	NA
1,2,4-Trichlorobenzene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
1,2-Dichlorobenzene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
1,3-Dichlorobenzene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
1,4-Dichlorobenzene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
4-Bromophenyl-Phenylether	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4-Chlorophenyl-Phenylether	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Acenaphthene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Acenaphthylene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Anthracene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo(a)anthracene	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo(a)pyrene	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo(b)fluoranthene	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo(g,h,i)perylene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo(k)fluoranthene	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Chrysene	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

TABLE 8-28
Summary of Hazard Quotients For Upper Trophic Level Receptors - Step 2
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Chemical	Raccoon		Mink		Belted kingfisher		Great blue heron		Mallard	
	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL
Dibenz(a,h)anthracene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Fluoranthene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Fluorene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Hexachlorobenzene	0.02	<0.01	0.05	<0.01	4.16	0.42	4.44	0.44	0.42	0.04
Hexachlorobutadiene	0.02	<0.01	0.04	<0.01	0.13	0.04	0.14	0.04	0.02	<0.01
Hexachlorocyclopentadiene	<0.01	<0.01	<0.01	<0.01	NA	NA	NA	NA	NA	NA
Hexachloroethane	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Pentachlorophenol	0.03	<0.01	0.06	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Phenanthrene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Pyrene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

TABLE 8-29
Summary of COPCs - Step 2
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Chemical	Surface Water			Sediment			Food Web		
	MD	MRL	NSV	MD	MRL	NSV	MD	MRL	NSV
Inorganics									
Aluminum	X								
Arsenic				X			X		
Beryllium						X			
Cadmium				X					
Cobalt				X					
Copper				X					
Cyanide		X			X				
Lead							X		
Manganese	X			X					
Mercury				X			X		
Nickel				X					
Selenium		X		X			X		
Silver		X			X				
Thallium						X			
Zinc				X			X		
Semivolatile Organic Compounds									
2,4-Dimethylphenol					X				
2-Methylnaphthalene				X					
2-Methylphenol					X				
3- and 4-Methylphenol				X					
Acenaphthene				X					
Benaldehyde						X			
Benzo(k)fluoranthene				X					
Butylbenzylphthalate					X				
Dibenzofuran					X				
Diethylphthalate				X					

MD - Maximum Detect
MRL - Maximum Reporting Limit
NSV - No Screening Value

TABLE 8-29
Summary of COPCs - Step 2
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Chemical	Surface Water			Sediment			Food Web		
	MD	MRL	NSV	MD	MRL	NSV	MD	MRL	NSV
Dimethyl phthalate					X				
Fluorene				X					
Hexachlorobenzene					X			X	
Hexachlorobutadiene					X				
PAHs (total)				X					
Pentachlorophenol					X				
Phenanthrene				X					
Phenol				X					
n-Nitrosodiphenylamine					X				
Volatile Organic Compounds									
1,1,1-Trichloroethane					X				
1,1,2-Trichloroethane					X				
1,2,4-Trichlorobenzene					X				
1,2-Dichlorobenzene					X				
1,4-Dichlorobenzene					X				
2-Butanone						X			
Ethylbenzene					X				
Methylene chloride						X			
Trichloroethene					X				
Xylene, total					X				
m- and p-Xylene					X				
o-Xylene					X				

MD - Maximum Detect
MRL - Maximum Reporting Limit
NSV - No Screening Value

TABLE 8-30
Sediment Bioaccumulation and Bioconcentration Factors For Benthic Invertebrates and Plants - Step 3
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Chemical	Sediment-Invertebrate BAF (dry weight)		Sediment-Plant BCF (dry weight)	
	Value	Reference	Value	Reference
Inorganics				
Arsenic	0.44	Bechtel Jacobs 1998b	0.037	Bechtel Jacobs 1998a
Lead	0.34	Bechtel Jacobs 1998b	0.038	Bechtel Jacobs 1998a
Mercury	1.02	Bechtel Jacobs 1998b	0.344	Bechtel Jacobs 1998a
Selenium	1.00	--	0.567	Bechtel Jacobs 1998a
Zinc	0.95	Bechtel Jacobs 1998b	0.358	Bechtel Jacobs 1998a
Semivolatile Organics				
Hexachlorobenzene	1.00	--	0.015	Travis and Arms 1988

TABLE 8-31
Exposure Parameters for Upper Trophic Level Ecological Receptors - Step 3
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Receptor	Body Weight (kg)		Water Ingestion Rate (L/day)		Food Ingestion Rate (kg/day - dry)	
	Value	Reference	Value	Reference	Value	Reference
Birds						
Belted kingfisher	0.148	Dunning 1993	0.0164	allometric equation	0.0168	USEPA 1993
Great blue heron	2.23	Quinney 1982	0.1010	allometric equation	0.3931	allometric equation
Mallard	1.177	Bellrose 1980	0.0658	allometric equation	0.0647	allometric equation
Mammals						
Raccoon	5.94	Silva and Downing 1995	0.4921	allometric equation	0.1000	Conover 1989

TABLE 8-31
Exposure Parameters for Upper Trophic Level Ecological Receptors - Step 3
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Receptor	Dietary Composition (percent)							Sediment Ingestion (percent)	
	Terr. Plants	Soil Invert.	Small Mammals	Fish	Aquatic Plants	Benthic Invert.	Reference	Value	Reference
Birds									
Belted kingfisher	0	0	0	84	0	16	USEPA 1993	0	Sample and Suter 1994
Great blue heron	0	0	0	100	0	0	USEPA 1993; Quinney and Smith 1980	0	Sample and Suter 1994
Mallard	0	0	0	0	86.7	10	Palmer 1976	3.3	Beyer et al. 1994
Mammals									
Raccoon	0	0	0	7	40	43.6	USEPA 1993	9.4	Beyer et al. 1994

TABLE 8-32
Assessment Endpoints, Risk Hypotheses, and Measurement Endpoints - Step 3
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Assessment Endpoint	Risk Hypothesis	Measurement Endpoint	Receptor
Survival, growth, and reproduction of benthic invertebrate communities	Are site-related chemical concentrations in surface water and sediment sufficient to adversely effect benthic invertebrate communities?	Comparison of mean chemical concentrations in surface water and sediment with medium-specific screening values	Benthic invertebrates
Survival, growth, and reproduction of aquatic plant communities	Are site-related chemical concentrations in surface water and sediment sufficient to adversely effect aquatic plant communities?	Comparison of mean chemical concentrations in surface water and sediment with medium-specific screening values	Aquatic plants
Survival, growth, and reproduction of fish communities	Are site-related chemical concentrations in surface water and sediment sufficient to adversely effect fish	Comparison of mean chemical concentrations in surface water and sediment with medium-specific screening values	Freshwater fish
Survival, growth, and reproduction of amphibian communities	Are site-related chemical concentrations in surface water and sediment sufficient to adversely effect amphibian communities?	Comparison of mean chemical concentrations in surface water and sediment with medium-specific screening values	Amphibians
Survival, growth, and reproduction of amphibian populations	Are site-related chemical concentrations in surface water and sediment sufficient to cause adverse effects (on growth, survival, or reproduction) to amphibian	Evidence of potential risk to other upper trophic level aquatic receptors evaluated in the ERA	--
Survival, growth, and reproduction of aquatic reptile populations	Are site-related chemical concentrations in surface water and sediment sufficient to cause adverse effects (on growth, survival, or reproduction) to aquatic reptile	Evidence of potential risk to other upper trophic level aquatic receptors evaluated in the ERA	--
Survival, growth, and reproduction of avian aquatic omnivore populations	Are site-related chemical concentrations in surface water and sediment sufficient to cause adverse effects (on growth, survival, or reproduction) to avian omnivore populations that may consume aquatic prey from the portion of the river adjacent to the site?	Comparison of literature-derived chronic No Observed Adverse Effect Level (NOAEL) and Lowest Observed Adverse Effect Level (LOAEL) values for survival, growth, and/or reproductive effects with modeled dietary exposure doses based on mean surface water and sediment concentrations	Mallard
Survival, growth, and reproduction of avian semi-aquatic piscivore populations	Are site-related chemical concentrations in surface water and sediment sufficient to cause adverse effects (on growth, survival, or reproduction) to avian piscivore populations that may consume fish from the portion of the river adjacent to the site?	Comparison of literature-derived chronic No Observed Adverse Effect Level (NOAEL) and Lowest Observed Adverse Effect Level (LOAEL) values for survival, growth, and/or reproductive effects with modeled dietary exposure doses based on mean surface water and sediment concentrations	Belted kingfisher Great blue heron

TABLE 8-32
Assessment Endpoints, Risk Hypotheses, and Measurement Endpoints - Step 3
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Assessment Endpoint	Risk Hypothesis	Measurement Endpoint	Receptor
Survival, growth, and reproduction of mammalian semi-aquatic omnivore populations	Are site-related chemical concentrations in surface water and sediment sufficient to cause adverse effects (on growth, survival, or reproduction) to mammalian omnivore populations that may consume aquatic prey from the portion of the river adjacent to the site?	Comparison of literature-derived chronic No Observed Adverse Effect Level (NOAEL) and Lowest Observed Adverse Effect Level (LOAEL) values for survival, growth, and/or reproductive effects with modeled dietary exposure doses based on mean surface water and sediment concentrations	Raccoon

TABLE 8-33
Step 3 Screening Statistics - Site 5 - Surface Water (Downgradient)
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Chemical	Reporting Limit Range	Frequency of Detection	Maximum Concentration Detected	Sample ID of Maximum Concentration	Arithmetic Mean	Screening Value	Frequency of Exceedance	Mean Hazard Quotient[1]	PCOC?
Inorganics (UG/L)									
Aluminum	17.2 - 45.7	7 / 9	419	AS05-5SW03-R05	223	87.0	7 / 9	2.56	**YES**
Cyanide	10.0 - 10.0	0 / 9	--	--	5.00	5.20	-- / --	0.96	NO
Manganese	0.30 - 1.20	9 / 9	376	AS05-5SW03-R07	251	120	9 / 9	2.09	**YES**
Selenium	2.20 - 5.00	0 / 9	--	--	1.87	5.00	-- / --	0.37	NO
Silver	0.60 - 5.00	0 / 9	--	--	1.03	0.36	-- / --	2.87	(NO)
Dissolved Metals (UG/L)									
Silver	1.70 - 1.70	0 / 3	--	--	0.85	0.36	-- / --	2.36	(NO)

1 - Shaded cells indicate hazard quotient based on reporting limits

TABLE 8-34
Step 3 Screening Statistics - Site 5 - Sediment (Downgradient)
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Chemical	Reporting Limit Range	Frequency of Detection	Maximum Concentration Detected	Sample ID of Maximum Concentration	Arithmetic Mean	Screening Value	Frequency of Exceedance	Mean Hazard Quotient[1]	PCOC?
Inorganics (MG/KG)									
Arsenic	0.73 - 4.70	21 / 21	24.1	AS05-5SD02-R01	10.4	8.20	14 / 21	1.27	**YES**
Beryllium	0.03 - 2.30	21 / 21	2.90	AS05-5SD02-R01	1.62	NSV	-- / --	NSV	**YES**
Cadmium	0.10 - 2.30	3 / 21	1.50	5SD-2(94)	0.27	1.20	1 / 21	0.22	NO
Cobalt	0.28 - 23.5	21 / 21	72.6	AS05-5SD03-R06	34.8	50.0	3 / 21	0.70	NO
Copper	0.18 - 11.7	21 / 21	67.5	AS05-5SD02-R01	29.2	34.0	8 / 21	0.86	NO
Cyanide	0.63 - 2.50	0 / 10	--	--	0.61	0.10	-- / --	6.09	(NO)
Manganese	0.08 - 7.00	21 / 21	1,700	AS05-5SD03-R06	807	460	14 / 21	1.76	**YES**
Mercury	0.06 - 0.31	8 / 21	4.80	AS05-5SD02-R05	0.38	0.15	5 / 21	2.51	**YES**
Nickel	0.51 - 18.8	21 / 21	110	AS05-5SD03-R06	58.0	20.9	21 / 21	2.78	**YES**
Selenium	0.54 - 2.60	1 / 21	2.10	AS05-5SD06A	0.64	1.00	1 / 21	0.64	NO
Silver	0.15 - 4.70	0 / 21	--	--	0.33	1.00	-- / --	0.33	NO
Thallium	0.54 - 4.70	9 / 21	1.90	AS05-5SD02B	1.15	NSV	-- / --	NSV	**YES**
Zinc	0.38 - 9.40	21 / 21	343	AS05-5SD02-R05	185	150	12 / 21	1.24	**YES**
Semivolatile Organic Compounds (UG/KG)									
2,4-Dimethylphenol	420 - 1,700	0 / 10	--	--	356	29.0	-- / --	12.3	(NO)
2-Methylnaphthalene	2.10 - 1,700	15 / 21	110	5SD-2(94)	140	70.0	4 / 21	1.57	**YES**
2-Methylphenol	420 - 1,700	0 / 10	--	--	356	63.0	-- / --	5.65	(NO)
3- and 4-Methylphenol	420 - 1,700	3 / 7	7,800	AS05-5SD03-R06	1,401	670	1 / 7	2.09	**YES**
Acenaphthene	2.10 - 1,700	11 / 21	90.0	AS05-5SD03-R07	147	16.0	1 / 21	5.63	**YES**
Benzaldehyde	510 - 810	2 / 5	680	AS05-5SD03-R07	433	NSV	-- / --	NSV	**YES**
Benzo(k)fluoranthene	2.10 - 1,700	14 / 21	250	AS05-5SD04-R07	165	240	1 / 21	0.69	NO
Butylbenzylphthalate	420 - 1,700	0 / 10	--	--	356	63.0	-- / --	5.65	(NO)
Dibenzofuran	420 - 1,700	0 / 10	--	--	356	540	-- / --	0.66	NO
Diethylphthalate	420 - 1,700	1 / 10	200	AS05-5SD03-R07	344	200	1 / 10	1.00	**YES**
Dimethyl phthalate	420 - 1,700	0 / 10	--	--	356	71.0	-- / --	5.01	(NO)
Fluorene	2.10 - 1,700	13 / 21	35.0	AS05-5SD04-R07	147	19.0	2 / 21	1.84	**YES**

NSV - No Screening Value
1 - Shaded cells indicate hazard quotient based on reporting limits

TABLE 8-34
Step 3 Screening Statistics - Site 5 - Sediment (Downgradient)
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Chemical	Reporting Limit Range	Frequency of Detection	Maximum Concentration Detected	Sample ID of Maximum Concentration	Arithmetic Mean	Screening Value	Frequency of Exceedance	Mean Hazard Quotient[1]	PCOC?
Hexachlorobenzene	420 - 1,700	0 / 10	--	--	356	22.0	-- / --	16.2	(NO)
Hexachlorobutadiene	420 - 1,700	0 / 10	--	--	356	11.0	-- / --	32.4	(NO)
PAH (total)	-- - --	15 / 21	4,066	AS05-5SD02-R01	2,927	4,022	1 / 21	0.73	NO
Pentachlorophenol	1,100 - 4,200	0 / 10	--	--	885	360	-- / --	2.46	(NO)
Phenanthrene	2.10 - 1,700	15 / 21	380	AS05-5SD03-R07	194	240	2 / 21	0.81	NO
Phenol	420 - 1,700	1 / 10	510	AS05-5SD03-R06	367	420	1 / 10	0.87	NO
n-Nitrosodiphenylamine	420 - 1,700	0 / 10	--	--	356	28.0	-- / --	12.7	(NO)
Volatile Organic Compounds (UG/KG)									
1,1,1-Trichloroethane	13.0 - 50.0	0 / 11	--	--	10.0	31.0	-- / --	0.32	NO
1,1,2-Trichloroethane	13.0 - 50.0	0 / 11	--	--	11.3	31.0	-- / --	0.37	NO
1,2,4-Trichlorobenzene	15.0 - 1,700	0 / 11	--	--	187	40.0	-- / --	4.68	(NO)
1,2-Dichlorobenzene	15.0 - 1,700	0 / 11	--	--	187	35.0	-- / --	5.35	(NO)
1,4-Dichlorobenzene	15.0 - 1,700	0 / 11	--	--	187	110	-- / --	1.70	(NO)
2-Butanone	13.0 - 50.0	1 / 11	12.0	5SD-2(94)	11.6	NSV	-- / --	NSV	**YES**
Ethylbenzene	13.0 - 50.0	0 / 11	--	--	11.3	10.0	-- / --	1.13	(NO)
Methylene chloride	13.0 - 50.0	1 / 11	32.0	AS05-5SD02-R01	9.45	NSV	-- / --	NSV	**YES**
Trichloroethene	13.0 - 50.0	0 / 11	--	--	11.3	41.0	-- / --	0.28	NO
Xylene, total	13.0 - 50.0	0 / 11	--	--	11.3	40.0	-- / --	0.28	NO
m- and p-Xylene	13.0 - 50.0	0 / 3	--	--	14.3	40.0	-- / --	0.36	NO
o-Xylene	13.0 - 50.0	0 / 9	--	--	11.8	40.0	-- / --	0.30	NO

NSV - No Screening Value
1 - Shaded cells indicate hazard quotient based on reporting limits

TABLE 8-35
Summary of Hazard Quotients For Upper Trophic Level Receptors - Step 3
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Chemical	Raccoon		Belted kingfisher		Great blue heron		Mallard	
	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL
Inorganics								
Arsenic	0.42	0.04	0.02	<0.01	<0.01	<0.01	0.01	<0.01
Lead	0.01	<0.01	0.04	<0.01	<0.01	<0.01	0.12	0.01
Mercury	0.03	0.02	0.29	0.10	0.03	0.01	0.35	0.12
Selenium	0.04	0.03	0.11	0.05	0.14	0.07	0.06	0.03
Zinc	0.10	<0.01	0.25	0.03	0.05	<0.01	0.31	0.03
Semivolatile Organics								
Hexachlorobenzene	<0.01	<0.01	0.51	0.05	0.78	0.08	0.04	<0.01

TABLE 8-36
Summary of Preliminary COCs - Step 3A
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Chemical	Surface Water				Sediment				Food Web		
	FOD	FOE	Maximum HQ	Mean HQ	FOD	FOE	Maximum Conc or HQ	Mean Conc or HQ	Receptor	Endpoint	Mean HQ
Detected Chemicals With Screening Values											
Aluminum (total)	7 / 9	7 / 9	4.82	2.56							
Arsenic					21 / 21	14 / 21	2.94	1.27			
Manganese (total)	9 / 9	9 / 9	3.13	2.09	21 / 21	14 / 21	3.70	1.76			
Mercury					8 / 21	5 / 21	32.0	2.51			
Nickel					21 / 21	21 / 21	5.26	2.78			
Zinc					21 / 21	12 / 21	2.29	1.24			
2-Methylnaphthalene					15 / 21	4 / 21	1.57	--			
3- and 4-Methylphenol					3 / 7	1 / 7	11.6	2.09			
Acenaphthene					11 / 21	1 / 21	5.63	--			
Diethylphthalate					1 / 10	1 / 10	1.00	--			
Fluorene					13 / 21	2 / 21	1.84	--			
Detected Chemicals Without Screening Values											
Beryllium					21 / 21	--	2.90 mg/kg	1.62 mg/kg			
Thallium					9 / 21	--	1.90 mg/kg	1.15 mg/kg			
Benzaldehyde					2 / 5	--	680 ug/kg	433 ug/kg			
2-Butanone					1 / 11	--	12.0 ug/kg	11.6 ug/kg			
Methylene chloride					1 / 11	--	32.0 ug/kg	9.45 ug/kg			

FOD - Frequency of Detection
FOE - Frequency of Exceedance

TABLE 8-37
Summary Statistics - Site 5 - Surface Water (Upgradient)
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Chemical	Reporting Limit Range	Frequency of Detection	Maximum Concentration Detected	Sample ID of Maximum Concentration	Arithmetic Mean[1]	Standard Deviation of Mean
Inorganics (UG/L)						
Aluminum	17.2 - 45.7	3 / 3	405	AS05-5SW01-R05	242	142
Manganese	0.30 - 1.20	3 / 3	278	AS05-5SW01-R07	222	51.6
Dissolved Metals (UG/L)						
Aluminum	16.9 - 16.9	0 / 1	--	--	46.9	--
Manganese	0.20 - 0.20	0 / 1	--	--	3.80	--

1 - One-half of the reporting limit was used for non-detected samples when calculating the mean

TABLE 8-38
Comparison of Site 5 Surface Water PCOC Concentrations to Upgradient Concentrations
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Chemical	Adjacent/Downgradient			Upgradient			Ratio of Maximums	Ratio of Means
	Frequency of Detection	Maximum	Arithmetic Mean	Frequency of Detection	Maximum	Arithmetic Mean		
Inorganics (UG/L)								
Aluminum	7 / 9	419	223	3 / 3	405	242	1.04	0.92
Manganese	9 / 9	376	251	3 / 3	278	222	1.35	1.13

TABLE 8-39
Summary Statistics - Site 5 - Sediment (Upgradient)
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Chemical	Reporting Limit Range	Frequency of Detection	Maximum Concentration Detected	Sample ID of Maximum Concentration	Arithmetic Mean[1]	Standard Deviation of Mean
Inorganics (MG/KG)						
Arsenic	0.65 - 3.20	7 / 7	17.5	AS05-5SD01-R07	9.71	3.70
Beryllium	0.03 - 1.60	7 / 7	2.70	AS05-5SD01-R07	1.69	0.58
Manganese	0.09 - 4.80	7 / 7	1,240	AS05-5SD01-R07	984	260
Mercury	0.06 - 0.27	1 / 7	0.46	AS05-5SD01-R07	0.11	0.16
Nickel	0.62 - 12.7	7 / 7	132	AS05-5SD01-R07	67.9	29.7
Thallium	0.48 - 3.20	2 / 7	1.50	AS05-5SD01B	1.10	0.56
Zinc	0.46 - 6.40	7 / 7	388	AS05-5SD01-R07	203	89.3
Semivolatile Organic Compounds (UG/KG)						
2-Methylnaphthalene	2.40 - 960	5 / 7	52.0	5SD-1(94)	102	125
3- and 4-Methylphenol	510 - 620	0 / 2	--	--	283	38.9
Acenaphthene	2.40 - 960	3 / 7	89.0	AS05-5SD01-R07	160	127
Benzaldehyde	620 - 960	1 / 2	1,400	AS05-5SD01-R07	855	771
Diethylphthalate	440 - 960	2 / 5	260	AS05-5SD01-R07	228	41.0
Fluorene	2.40 - 960	3 / 7	22.0	AS05-5SD01-R07	152	134
Volatile Organic Compounds (UG/KG)						
2-Butanone	14.0 - 30.0	1 / 5	5.00	5SD-1(94)	8.90	3.76
Methylene chloride	14.0 - 30.0	0 / 5	--	--	6.79	4.33
Other Parameters						
Total organic carbon (MG/KG)	500 - 5,000	3 / 3	78,000	AS05-5SD01-R07	38,000	34,699
pH	0.10 - 0.10	3 / 3	7.30	AS05-5SD01A	7.13	0.21

1 - One-half of the reporting limit was used for non-detected samples when calculating the mean

TABLE 8-40
Comparison of Site 5 Sediment PCOC Concentrations to Upgradient Concentrations
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Chemical	Adjacent/Downgradient			Upgradient			Ratio of Maximums	Ratio of Means
	Frequency of Detection	Maximum	Arithmetic Mean	Frequency of Detection	Maximum	Arithmetic Mean		
Inorganics (MG/KG)								
Arsenic	21 / 21	24.1	10.4	7 / 7	17.5	9.71	1.38	1.07
Beryllium	21 / 21	2.90	1.62	7 / 7	2.70	1.69	1.07	0.96
Manganese	21 / 21	1,700	807	7 / 7	1,240	984	1.37	0.82
Mercury	8 / 21	4.80	0.38	1 / 7	0.46	0.11	10.4	3.51
Nickel	21 / 21	110	58.0	7 / 7	132	67.9	0.83	0.85
Thallium	9 / 21	1.90	1.15	2 / 7	1.50	1.10	1.27	1.05
Zinc	21 / 21	343	185	7 / 7	388	203	0.88	0.91
Organics (UG/KG)								
2-Methylnaphthalene	15 / 21	110	--	5 / 7	52.0	--	2.12	--
3- and 4-Methylphenol	3 / 7	7,800	1,401	0 / 2	--	283	--	4.95
Acenaphthene	11 / 21	90.0	--	3 / 7	89.0	--	1.01	--
Benzaldehyde	2 / 5	680	433	1 / 2	1,400	855	0.49	0.51
Diethylphthalate	1 / 10	200	--	2 / 5	260	228	0.77	--
Fluorene	13 / 21	35.0	--	3 / 7	22.0	--	1.59	--
2-Butanone	1 / 11	12.0	11.6	1 / 5	5.00	--	2.40	--
Methylene chloride	1 / 11	32.0	9.45	0 / 5	--	6.79	--	1.39

TABLE 8-41
Selected Groundwater Data - Site 5
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Chemical	Downgradient Wells			Upgradient Wells			Ratio of Maximums	Ratio of Means
	Frequency of	Maximum	Mean	Frequency of	Maximum	Mean		
Inorganics (UG/L)								
Mercury	0 / 12	--	0.081	0 / 2	--	0.075	--	1.08
Dissolved Metals (UG/L)								
Mercury	0 / 11	--	0.12	1 / 2	1.20	0.63	--	0.19

TABLE 8-42
Comparison of Site 5 Sediment Concentrations With Equilibrium Partitioning-Based Sediment Values
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Chemical	Frequency of Detection	Maximum Concentration Detected	Arithmetic Mean	Total Organic Carbon (%)	TOC-Adjusted Screening Value	Reference	Maximum Ratio	Mean Ratio
Semivolatile Organic Compounds (UG/KG)								
Fluorene	13 / 21	35.0	147	4.00	2,160	USEPA 1996b	0.02	0.07
Volatile Organic Compounds (UG/KG)								
2-Butanone	1 / 11	12.0	11.6	4.00	1,080	Jones et al. 1997	0.01	0.01
Methylene chloride	1 / 11	32.0	9.45	4.00	1,480	Jones et al. 1997	0.02	0.01

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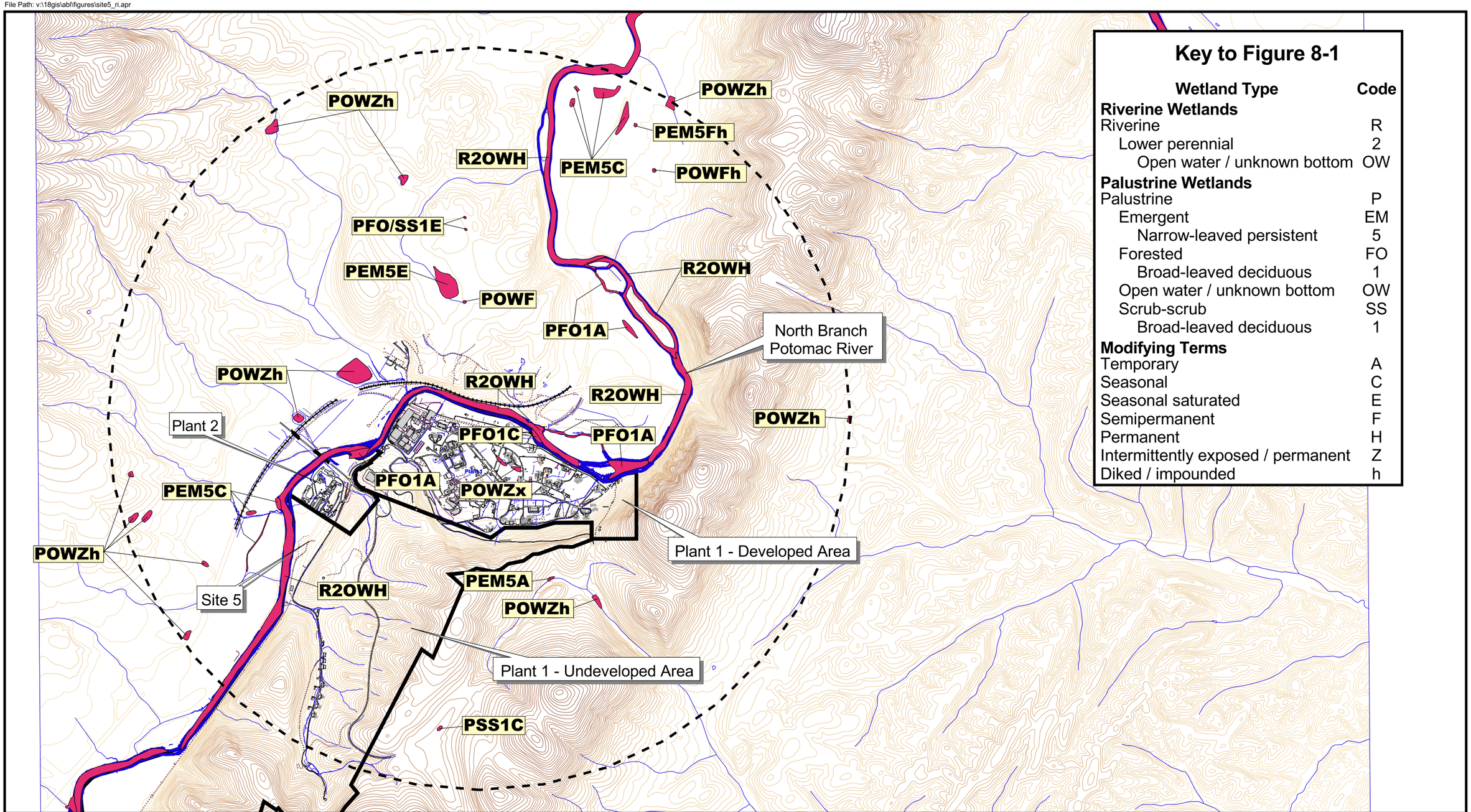

Figure 8-1
Wetland Areas
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

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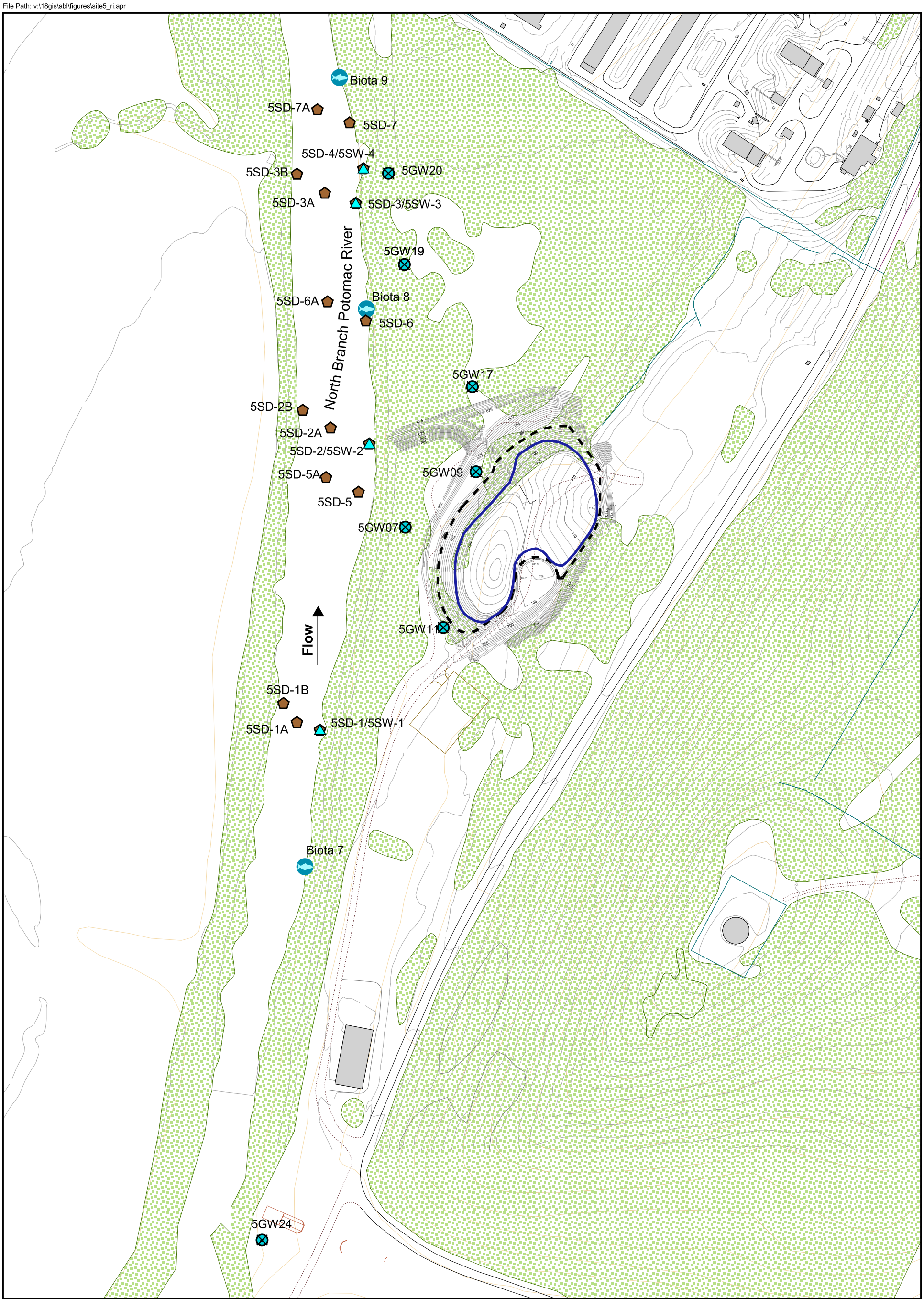

LEGEND

- Monitoring Well Location
- Surface Water Sample Location
- Sediment Sample Location
- Biota Location
- Edge of Waste
- Edge of Landfill Cap
- Vegetation

N

100 0 100 200 Feet

Figure 8-2
Monitoring Well, Biota, Surface Water, and Sediment Sampling Locations
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

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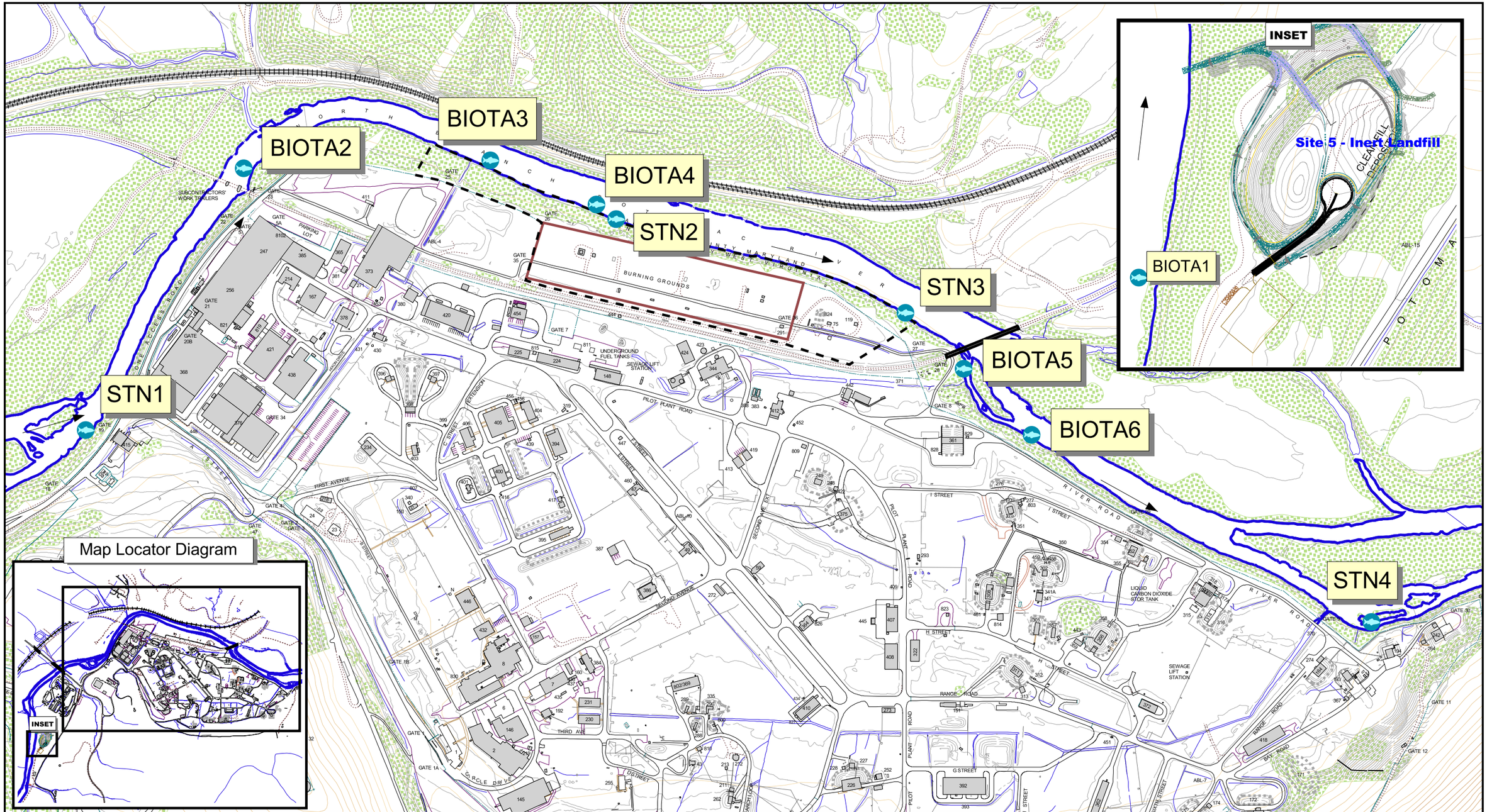

LEGEND

- Biota 1-6 (July 1998; June 2000; June 2002)
- Stn 1-4 (July 1994)
- Boundary of Burning Grounds
- Boundary of IR Site 1
- Flow Direction

N

225 0 225 450 Feet

Figure 8-3
Location of Site 1 and
Locations of Biota Sampling
in the North Branch Potomac River
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

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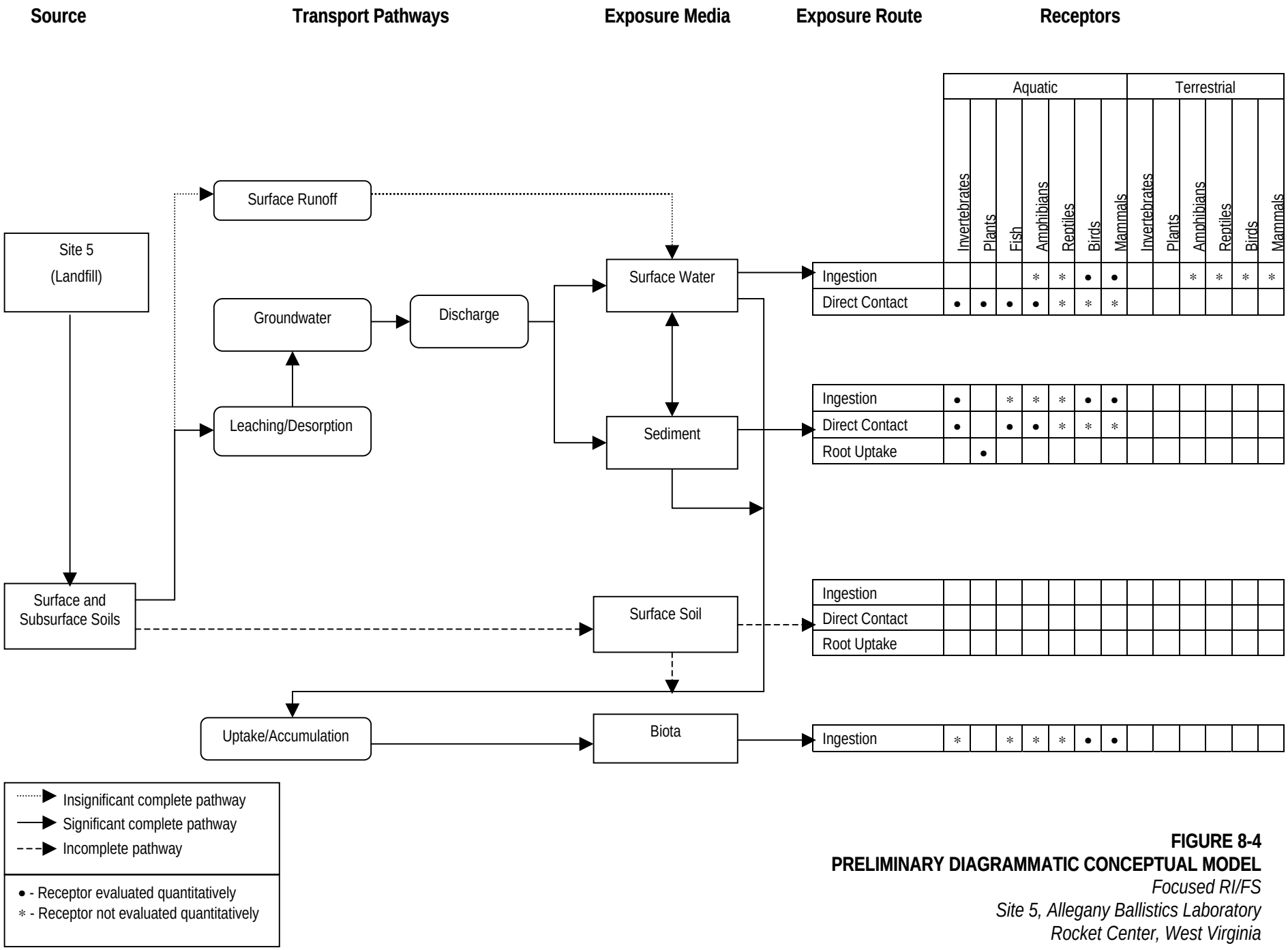

FIGURE 8-4
PRELIMINARY DIAGRAMMATIC CONCEPTUAL MODEL
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

SECTION 9

Summary and Conclusions of Focused RI

This Focused RI was prepared to evaluate geologic and hydrogeologic regimes, nature and extent of contamination, and potential risks posed to human health and the environment by Site 5 groundwater, surface water, and sediment. Data collected for the Focused RI during the August 2000, June 2001, and February 2002 LTM events were used to support an HHRA and an ERA. These data are considered to be most appropriate because they were collected subsequent to landfill cap installation.

Site 5 groundwater, surface water, and sediment constituent levels were evaluated in a baseline HHRA using current and future residential land use scenarios. An ERA was also conducted to characterize the potential risks posed by sediment and surface water constituents to the fauna and flora in the adjacent North Branch Potomac River.

The HHRA concluded that the following three constituents are present in Site 5 alluvial and bedrock groundwater at concentrations that exceed USEPA risk thresholds:

- TCE
- Iron
- Manganese

The following receptors have total calculated RME non-carcinogenic hazards or carcinogenic risks that exceed USEPA's target levels:

- A future adult resident, child resident, age-adjusted resident, and construction worker exposed to alluvial groundwater; and
- A future adult resident, child resident, and age-adjusted resident exposed to bedrock groundwater.

The alluvial TCE plume is crescent-shaped, initially migrating approximately 400 feet northward from the landfill before adopting a more westerly flow direction and approaching or discharging to the North Branch Potomac River in the vicinity of well 5GW20. Based on historical data, the concentrations of TCE in the alluvial aquifer appear to be relatively stable. TCE has consistently been detected in the same monitoring wells and the concentrations of TCE in these wells have varied within a fairly narrow range. The maximum observed concentration of TCE during monitoring events has been 150 µg/L.

TCE concentrations in the bedrock aquifer are relatively low (maximum of 19 µg/L) and have only been consistently detected (at concentrations near or just above the MCL) in two wells along the western boundary of the landfill. This information suggests TCE is not areally extensive in the bedrock aquifer.

Although iron and manganese are identified as COCs in Site 5 groundwater, the majority of the iron and manganese concentrations above risk criteria occur in groundwater immediately adjacent to the landfill, and decline to concentrations below risk criteria downgradient of the landfill. Landfill leachate typically causes reducing conditions that can

mobilize these inorganics and elevate their concentrations in groundwater. Because the Site 5 landfill has been capped, thereby minimizing infiltration and leachate generation, the dissolved iron and manganese concentrations are expected to decrease over time to levels more representative of natural conditions, such as those downgradient of the landfill.

Iron and manganese concentrations in samples from the bedrock aquifer were much lower than those in the alluvial aquifer, which is attributable to the higher turbidity of the alluvium. Groundwater samples from only one bedrock well consistently exceeded the tap water RBC for iron during the LTM program. Similarly, only one bedrock well consistently showed exceedences for the tap water RBC for manganese.

There were no unacceptable risks from exposure to surface water and sediment adjacent to Site 5 identified in the HHRA or ERA. However, during the 5-year ROD review (CH2M HILL, September 2003), a potential negative influence on ecological receptors in the sediment of the river adjacent to Site 1 (downstream of Site 5) was observed. Because no unacceptable potential risks to ecological receptors were identified at Site 5, it is unlikely that Site 5 is contributing to the negative ecological influence at Site 1.

Based on the risk drivers identified for Site 5 groundwater during the Focused RI, a Focused FS was conducted to evaluate various remedial alternatives to address those risk drivers. In addition, other regulatory criteria (e.g., ARARs, MCL exceedences, etc.) were considered during development and evaluation of remedial alternatives. The remainder of this report presents the results of the Focused FS.

SECTION 10

RAOs, ARARs, and PRGs

This section documents the first step of the Focused FS process for Site 5: the development of general and site-specific remedial action objectives (RAOs) and identification of applicable or relevant and appropriate requirements (ARARs). A list of federal and state ARARs is provided in Appendix H. Based on the findings of the Focused RI, groundwater is the only medium of concern for Site 5, and this medium represents a potential exposure risk only to humans. For this reason, groundwater is the only medium addressed in this Focused FS.

General RAOs are defined by the NCP and CERCLA (as amended by the Superfund Amendments and Reauthorization Act of 1986, or SARA), and are applicable to all CERCLA sites. CERCLA defines the statutory requirements for developing remedies.

Site-specific objectives relate to specific contaminated media (such as groundwater) and to potential exposure routes. Site-specific objectives, which require an understanding of the contaminants and the physical properties in their respective media, are based on an evaluation of the potential risks to public health and to the environment and on the ARARs.

10.1 NCP and CERCLA Objectives

The NCP requires that the selected remedy meet the following objectives:

- Each remedial action selected shall be protective of human health and the environment (40 CFR 300.430 (f)(1)(ii)(A)).
- Onsite remedial actions that are selected must attain those ARARs that are identified at the time of the record of decision signature (40 CFR 300.430(f)(1)(ii)(B)).
- Each remedial action selected shall be cost-effective, provided that it first satisfies the threshold criteria set forth in 40 CFR 300.430 (f)(1)(ii)(A) and (B). A remedy shall be cost-effective if its costs are proportional to its overall effectiveness (40 CFR 300.430 (f)(1)(ii)(D)).
- Each remedial action shall use permanent solutions and alternative treatment technologies or resource-recovery technology to the maximum extent practicable (40 CFR 300.430 (f)(1)(ii)(E)).

The statutory scope of CERCLA was amended by SARA to include the following general objectives for remedial action at all CERCLA sites:

- Remedial actions "shall attain a degree of cleanup of hazardous substances, pollutants, and contaminants released into the environment and of control of further releases at a minimum which assures protection of human health and the environment" (Section 121(d)).
- Remedial actions "in which treatment that permanently and significantly reduces the volume, toxicity, or mobility of the hazardous substances, pollutants, and contaminants

is a principal element" (Section 121(b)) are preferred. If the treatment or recovery technologies selected are not a permanent solution, an explanation must be published.

- The least-favored remedial actions are those that include "offsite transport and disposal of hazardous substances or contaminated materials without treatment where practicable treatment technologies are available" (Section 121(b)).
- The selected remedy must comply with or attain the level of any "standard, requirement, criteria, or limitation under any federal environmental law . . . or any promulgated standard, requirement, criteria, or limitation under a State environmental or facility siting law that is more stringent than any federal standard, requirement, criteria, or limitation" (Section 121(d)(2)(A)).

10.2 Development of Site-Specific Remedial Action Objectives

Site-specific RAOs are based on the exposure setting for which protection would be provided (e.g., protection from ingestion of, or direct contact with, contaminated groundwater). The potential exposure routes and risks for the site are identified in the risk assessments (Section 7 and 8).

10.2.1 Identification of Environmental Media

The human health and ecological risk assessments conducted during the Focused RI identified groundwater as the only contaminated medium of concern for Site 5.

10.2.2 Site-Specific Remedial Action Objectives

Both the level of contamination and the potential exposure routes are considered when developing RAOs for protecting public health and the environment. The future protection of environmental resources and the means of minimizing long-term disruption to existing facility operations also are considered. The site-specific RAOs for groundwater are:

- Prevent or minimize exposure of potential future onsite residents to contaminated groundwater originating from Site 5 at concentrations exceeding MCLs or, in the absence of MCLs, an excess lifetime cancer risk (ELCR) of 1×10^{-4} or an HI = 1.
- Prevent or minimize river media from becoming impacted by the Site 5 groundwater COCs such that resulting concentrations present an unacceptable risk to human health or the environment.
- Return groundwater beyond the landfill boundaries to MCLs.

Using these RAOs for Site 5 groundwater, risk-based preliminary remediation goals (PRGs) were developed. The following subsection describes the PRG development process for Site 5.

10.2.3 Development of Risk-Based Preliminary Remediation Goals

The first step in setting cleanup goals is to establish PRGs for each medium (in this case, only groundwater). PRGs are established from MCLs (which are ARARs for groundwater) and human health risk-based concentrations based on exposure pathways identified in the baseline risk assessment. It should be noted that risk-based PRGs are "to-be-considered"

criteria, not ARARs. Additional ARARs, such as impacts on surface water and air quality, are also considered in the determination of PRGs.

Human health risk-based PRGs were calculated for constituents under residential scenarios with carcinogenic risks exceeding 10^{-4} or noncarcinogenic hazards exceeding 1. Risk-based PRGs were not calculated for the construction worker scenario because the residential PRGs are more conservative than construction worker PRGs, and are therefore protective of the construction worker.

Although the site is currently used for mainly industrial purposes, and anticipated future use of the site is the same, risk-based PRGs were developed for potential future residential receptors. Risk-based groundwater PRGs were calculated for the child, adult, and lifetime resident, because these receptors showed potential risks that exceeded the criteria discussed above. The exposure scenarios considered were exposure to groundwater through ingestion (child and adult), dermal contact (child only), and inhalation of VOCs while showering (adult only).

The risk-based PRGs were calculated for carcinogenic constituents based on cancer risks of 10^{-6}, 10^{-5}, and 10^{-4}, and for noncarcinogenic constituents based on HI of 0.1, 0.5, and 1. Then, the proposed PRGs were calculated based on the number of carcinogenic constituents (so that the overall risk did not exceed $5x10^{-5}$) and the number of noncarcinogenic constituents that affect the same target organ (so that the overall HI to a target organ did not exceed 1).

Appendix I provides the equations and exposure parameters used to calculate the risk-based PRGs, and the resulting risk-based PRGs. None of the constituents have the same target organ/target effect; therefore, the recommended noncarcinogenic risk-based PRGs can be based on a target HI of 1.0 (Appendix I, Table I-4).

The exposure parameters identified in the HHRA were used to calculate the risk-based PRGs for the residential receptors. However, the dermal exposure calculations, including dermal exposure per event calculation and oral to dermal adjustment of toxicity factors, were updated following the more recent USEPA *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual, Part E, Supplemental Guidance for Dermal Risk Assessment* (USEPA, 2001).

Table 10-1 presents the PRGs for Site 5 groundwater. The constituents that are the main risk drivers at Site 5, contributing to a cancer risk above 10^{-4} or a noncancer hazard above 1, are included on the table. These constituents are TCE, iron, and manganese. The proposed PRG is the Safe Drinking Water Act MCL for TCE and the calculated risk-based PRG for iron and manganese. The human health risk-based concentrations shown on the table are calculated in Appendix I. As shown in Table 10-1, the proposed PRGs for TCE, iron, and manganese are 5.0 µg/L, 4,000 µg/L, and 260 µg/L, respectively.

10.2.4 Applicable or Relevant and Appropriate Requirements

As required by Section 121 of CERCLA, remedial actions carried out under Section 104 or secured under Section 106 must attain the levels of standards of control for hazardous substances, pollutants, or contaminants specified by the ARARs of federal and state environmental laws and state facility-siting laws, unless waivers are obtained. According to

USEPA guidance, remedial actions also must be based on non-promulgated "to-be-considered" criteria or guidelines if the ARARs do not address a particular situation.

ARARs are distinguished by the EPA as either being applicable to a situation or relevant and appropriate to it. These distinctions are critical to understanding the constraints imposed on remedial alternatives by environmental regulations other than CERCLA. The definitions of ARARs below are from USEPA guidance (USEPA, 1988).

"Applicable requirements" are standards and other environmental protection requirements of federal or state law dealing with a hazardous substance, pollutant, or contaminant and its remedial action. For example, the Clean Water Act (CWA) is "applicable" to a response action for discharging treated effluent. Also, the Corrective Action Management Unit (CAMU) regulations are "applicable" to actions requiring excavation and onsite placement of soil from the site.

"Relevant and appropriate requirements" are standards and environmental protection criteria of federal or state law that, although not "applicable" to a hazardous substance or remedial action, address situations sufficiently similar to those at the CERCLA site that their use is suitable. For example, although Resource Conservation and Recovery Act of 1976 (RCRA) regulations are not applicable to closing a site containing hazardous waste that was disposed of before 1980, the regulations may be relevant and appropriate.

A requirement may be "relevant" to a particular situation but not "appropriate" because of differences in the duration of the regulated activity or the physical characteristics of the affected media. For example, some of the requirements for designing and operating a waste pile that are found in 40 CFR 264.251, such as using a liner of sufficient strength and thickness to prevent failure caused by pressure gradients, might be considered relevant and appropriate, although the requirement to install a liner to cover all surrounding earth in potential contact with the waste might not be appropriate if the earth already is contaminated, and the eventual remedy is to remove all the contaminated earth.

A requirement that is relevant and appropriate must be met as if it were applicable. Relevant and appropriate requirements that are more stringent than applicable requirements take precedence. However, more discretion is allowed in determining relevant and appropriate requirements than in determining applicable requirements.

Another factor in determining which response or remedial requirements must be met is whether the requirement is substantive or administrative. Onsite CERCLA response actions must meet substantive requirements but not administrative requirements. Substantive requirements are those dealing directly with actions or with conditions in the environment. Administrative requirements implement the substantive requirements by prescribing procedures such as fees, permitting, and inspection that make substantive requirements effective. This distinction applies to onsite actions only; offsite response actions are subject to all applicable standards and regulations, including administrative requirements such as permits.

10.2.5 Other Criteria or Guidelines To Be Considered

Many federal and state programs have criteria, advisories, guidelines, and proposed standards that provide recommended procedures if no ARARs exist or if existing ARARs

are inadequate. In such situations, the "to-be-considered" criteria or guidelines should be used to set remedial action levels. Examples of criteria to be considered are reference doses and potency factors for ingestion of noncarcinogenic and carcinogenic compounds used in the risk assessment.

10.2.6 Determination of ARARs

There are three classifications of ARARs: chemical-specific, location-specific, and action-specific. Potential chemical-specific, location-specific, and action-specific federal ARARs for Site 5 groundwater are summarized in Appendix H. The tables summarize the potential ARARs by classification and the "to-be-considered" criteria are included as appropriate for each classification. Tables developed by the WVDEP and Maryland Department of the Environment (MDE) summarizing their state ARARs also are presented in Appendix H.

The remedial action alternatives developed in sections of this report were analyzed for compliance with federal and state ARARs. The analysis involved identifying potential requirements for each of the alternatives, evaluating their applicability or relevance, and determining if the remedial alternatives can achieve the ARARs. Results of that analysis are presented in Section 5 of this report. Any remedial action at the site must meet standards as defined by the ARARs of the USEPA, MDE, and WVDEP because Site 5 is located on the border of these two states and the North Branch Potomac River is owned by the state of Maryland. If the ARARs do not address a particular situation, remedial actions must be based on the "to-be-considered" criteria or guidelines.

10.2.6.1 Chemical-Specific ARARs

Chemical-specific ARARs set human- or ecological-health-based concentration limits in various environmental media for specific hazardous substances, pollutants, or contaminants. Examples of federal chemical-specific ARARs include RCRA toxicity characteristics, SDWA MCLs, and ambient water quality criteria. Chemical-specific ARARs for contaminated groundwater at Site 5 are presented in Appendix H.

10.2.6.2 Location-Specific ARARs

Location-specific ARARs are design requirements or activity restrictions that are based on the geographic position of a site. An example is RCRA location requirements that set USEPA policy for carrying out provisions of Executive Order 11988 (Flood Plain Management) and Executive Order 11990 (Protection of Wetlands). Location-specific ARARs for Site 5 are presented in Appendix H.

10.2.6.3 Action-Specific ARARs

Action-specific ARARs set performance, design, or other standards for particular activities in managing hazardous substances or pollutants. For example, the design requirements for landfilling hazardous waste, established in RCRA Section 264.301, are action-specific. RCRA contains the greatest number of action-specific ARARs because it regulates hazardous waste management. Action-specific ARARs for Site 5 are presented in Appendix H.

TABLE 10-1
Preliminary Remediation Goals for Groundwater
Final Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

	Concentration (μg/L)					
	Maximum Concentration[b]	EPA Safe Drinking Water Act	Risk-Based Concentrations—Human Health[c]			
Constituent[a]	μg/L	MCL	Carcinogenic		Noncarcinogenic	
Volatile Organic Compound			1E-06	1E-04	0.1	1
Trichloroethene	150	**5.0**	0.15	15	0.37	3.7
Inorganic						
Iron	16,800 (dissolved)	NA	NA	NA	400	**4,000**
Manganese	8,030 (dissolved)	NA	NA	NA	26	**260**

MCL—Maximum contaminant level.
NA—No standard available or not applicable.

Shading indicates recommended PRG. See text for rationale for recommended PRG.
[a] Constituents are selected on the basis of the risk assessment conclusions.
[b] Excludes well 5GW01, which is upgradient of the site.
[c] Risk-based concentrations based on exposure to the future child resident for noncarcinogenic RBCs, and the future age-adjusted resident for carcinogenic risk-based concentrations via a combined ingestion, dermal (child only), and inhalation (adult only) scenario. Risk-based concentrations are calculated in Appendix I.

SECTION 11

Development and Screening of Remedial Technologies

This section discusses the general response actions developed to address the RAOs outlined in the previous section. Potential remedial technologies and specific process options, which underwent a primary screening to determine their suitability as part of a remedial alternative, are identified and described for each response action.

11.1 General Response Actions

General response actions are broad classes of responses or remedies developed to meet the site-specific RAOs defined for Site 5 in Section 10. Each action is intended to address specific constituents and the possible migration pathways and exposure routes in groundwater. Although an action may be capable of meeting an objective, combinations of actions may be more cost-effective in meeting all the objectives.

The general response actions listed below have been identified as being potentially applicable for Site 5 groundwater:

- No action
- Institutional controls
- Containment
- Collection
- In-Situ Treatment
- Ex-Situ Treatment and Discharge (combined response action)

The *no action* response is included in the study because the NCP requires that a no-action alternative be developed as a baseline for evaluating the remedial alternatives.

The *institutional controls* response action is a category of alternatives that can be used singly or as part of another response action. Institutional controls include activities such as restricting groundwater use through land-use or deed restrictions, access restrictions, and groundwater monitoring.

Containment response actions are technologies that prevent the migration of contaminated groundwater. Containment technologies include vertical barriers such as slurry walls or sheet piling, and extraction wells used to create a hydraulic barrier.

Collection response actions are methods of removing contaminated groundwater from the water-bearing unit(s) of concern. Technologies include groundwater extraction wells or trenches. Groundwater collection could be employed in conjunction with other response actions such as treatment and discharge to better attain the RAOs.

In-Situ Treatment response actions are *in-situ* methods of reducing the toxicity, mobility, or volume of contaminants in groundwater. Treatment technologies include biological, chemical, and physical processes.

Ex-Situ Treatment response actions are treatment methods for groundwater that has been extracted. The required treatment is dependent upon the discharge location.

Discharge response actions include groundwater re-injection, discharge to a sewer, or discharge to a surface water body.

11.2 Identification and Screening of Remedial Technologies and Process Options

The next step in the FS process is to identify remedial technologies and process options for each general response action. *Remedial technologies* are general categories of technologies such as chemical treatment, thermal destruction, or immobilization. *Process options* are specific processes within each technology type. For example, the chemical treatment remedial technology includes process options such as precipitation, ion exchange, and oxidation/reduction.

Technologies and process options that potentially apply to Site 5 groundwater were screened initially on the basis of their compatibility with site-specific characteristics. The focus is on an evaluation of remedial action alternatives for TCE, as this is the most wide-spread COC and the only constituent exceeding an MCL. Iron and manganese are also considered in the evaluation of the remedial alternatives.

Site characteristics that generally influence primary screening are the contaminant types, quantities, concentrations, and the physical site conditions. The primary screening of remedial technologies and process options for groundwater are shown in Table 11-1.

Some technologies and process options presented in Table 11-1 were applicable for the alluvial aquifer but not for the bedrock aquifer. These were retained for further consideration if they could be used in combination with other technologies and process options to meet the site-specific RAOs.

The remedial technologies and process options that were suitable on the basis of the primary screening were evaluated in greater detail to eliminate non-viable technologies and process options and to simplify the development of remedial alternatives. The secondary technology and process option screening is based on effectiveness, implementability, and relative cost as applied only to the general response actions they are intended to satisfy and not to the site as a whole. Specific remedial technologies or process options were evaluated on the basis of their potential performance relative to other remedial technologies and process options within the same general response action.

In the screening process, *effectiveness* pertains to the following:

- The capability of the technology to attain RAOs for groundwater
- The capability of a remedial technology to handle the estimated areas or volumes of groundwater and to prevent or minimize the release of hazardous substances to potential receptors
- The degree of protection afforded to human health and the environment during construction and implementation of the remedial technology
- The reliability and performance of the technology with respect to the site conditions

Implementability pertains to the following:

- The availability and capacity of treatment, storage, and disposal services
- The constructability of the remedial technology under facility conditions
- The time needed to implement the remedial technology, to achieve beneficial results, and to satisfy the RAOs

Relative cost screening considers the general capital and operation and maintenance (O&M) costs associated with the process options. During the screening phase, detailed, site-specific cost estimates were not developed. The relative cost of process options was considered only if the cost of an option was believed to be significantly higher than the cost for other process options comparably effective or implementable.

Table 11-2 presents the secondary screening of the groundwater technologies and process options that were retained after the preliminary screening. Where possible, a single process option was selected as representative of a general response action. In some cases, more than one process option was selected because the options could not be differentiated in terms of effectiveness, implementability, or relative cost. The following sections discuss the remedial technologies and process options that passed the effectiveness, implementability, and cost screening for each general response action.

11.2.1 No Action

The no-action response is required by the NCP and was retained to provide a basis for comparison with the other actions. This alternative, however, does not reduce COC migration or concentrations and does not meet the RAOs for Site 5 groundwater.

11.2.2 Institutional Control Actions

The institutional controls (ICs) that are retained through the alternatives screening process comprise administrative and/or engineering measures specific to Site 5. IC actions do not reduce groundwater contaminant migration or concentrations, but when combined with other remedial alternative(s), they can reduce the potential for exposure.

A general IC plan has previously been developed for ABL that lists access restrictions and general procedures for implementing restrictions. This document, the *Final Construction, Excavation, and Groundwater Use Restriction Plan for Installation Restoration Program Sites at the*

ABL (CH2M HILL, 2002a), includes restrictions for Site 5. If necessary, additional instructions specific to Site 5 will be defined in the remedial design.

Groundwater monitoring on a periodic basis would provide data to determine when RAOs are met and institutional controls are no longer needed. This type of monitoring is currently conducted at the site as part of the remedy selected for the landfill contents, and is further discussed in Section 11.3.

11.2.3 Containment

The objectives of containment options for groundwater are to prevent or retard the movement of contaminated groundwater or to prevent the flow of clean, upgradient groundwater through areas on the site where contamination is present. Containment options are not aimed at reducing the volume or toxicity of contamination.

Although the containment options are technically feasible, the sheet piling was rejected during the primary screening process (see Table 11-1) because of the high cost to implement, especially for the relatively low levels of contamination over a large area at the site, and because the option does not meet all the RAOs.

The slurry wall was rejected in the primary screening process due to the lack of evidence supporting the efficacy of a slurry wall to hydrologically isolate the landfill from groundwater flow. Based on previous evaluations, the waste appears to be approximately 15 feet above the water table.

11.2.4 Collection

Extraction wells can be used to collect groundwater from the alluvial and bedrock aquifers. Wells could be placed within and downgradient of the contaminant plume to recover groundwater for treatment and/or disposal and to avoid spreading contaminants to downgradient areas. The wells would be pumped until contaminant concentrations in the aquifer are reduced to the PRGs listed in Table 10-1.

11.2.5 In-Situ Treatment

In-situ treatment process options that carried through the evaluation process comprise MNA, enhanced reductive dechlorination (ERD), and metal-enhanced abiotic degradation.

11.2.5.1 Monitored Natural Attenuation

MNA was retained as a remedial technology for groundwater. MNA is an in-situ technology whereby contaminants are attenuated by naturally occurring processes including degradation, volatilization, geochemical reactions, and dispersion. While existing data suggest natural biodegradation may not be a viable stand-alone option for Site 5 groundwater COCs, the collective natural attenuation processes may be suitable when combined with other technologies, especially because of the relatively low concentration of groundwater contaminants. Analytical results from surface water and sediment samples collected from the North Branch Potomac River indicate the river has not been impacted by contaminated groundwater at Site 5. According to the historical concentrations in the alluvial and bedrock aquifers, VOCs originating from Site 5 are attenuated by natural processes prior to reaching the river or are present in the river below analytical detection

limits. A component of the natural attenuation process option is groundwater, surface water, and sediment monitoring to ensure that COC concentrations decline in groundwater and remain below potential risk levels in the North Branch Potomac River.

USEPA guidance allows MNA to be selected as a remedy for sites, provided that source control has been implemented, public health and the environment are protected, and there is sufficient evidence that the groundwater COCs will naturally attenuate to the cleanup goals in a reasonable time frame compared to other remedial alternatives.

Screening assessments of natural attenuation through biological processes in the Site 5 alluvial aquifer were performed using data collected during August 2000, April 2001, February 2002, and October 2002 sampling events (Appendix J). The inclusion of October 2002 data allows the evaluation to encompass four monitoring events.

The evaluation of MNA concluded that there was limited or inadequate evidence for biodegradation of chlorinated hydrocarbons in Site 5 groundwater. Even though natural biodegradation of chlorinated hydrocarbons is unlikely at Site 5, other mechanisms encompassed by MNA, such as dispersion and dilution, may be effective at Site 5. Therefore, MNA may be applicable, in combination with other technologies, for remediation of TCE in groundwater.

11.2.5.2 Enhanced Reductive Dechlorination (Enhanced Biodegradation)

ERD is a process that creates a strongly reducing environment to accelerate the naturally occurring reductive dechlorination (RD) of chlorinated VOCs. The reducing environment is created by injection of an organic substrate such as lactate, vegetable oil, soybean oil or other low cost, nontoxic organics that can be injected into the subsurface. The organics serve as a food source and electron donor for microbes that in turn use the available electron acceptors (oxygen, nitrate, ferric iron, sulfate, carbon dioxide), resulting in reducing conditions favorable to biological RD. This technology alternative was retained for further consideration.

11.2.5.3 Metal-Enhanced Abiotic Degradation

Recent experimental work in the laboratory and full-scale systems in the field have shown that a variety of chlorinated solvents can be degraded in water in the presence of zero-valent iron particles and that abiotic RD occurs. Chlorinated solvents can be converted to the end-products ethene, ethane, methane, and chloride ions. This technology, called metal-enhanced abiotic degradation, has been patented in various forms of application by several private companies. This is an in-situ technology that is implemented by constructing a reactor below the groundwater table, and filling the reactor with iron. This technology alternative was retained for further consideration.

11.2.6 Ex-Situ Treatment and Discharge

The following discussion relates to the evaluation of general response options that would involve a combination of groundwater collection (previously discussed in Section 11.2.4), possible ex-situ treatment, and discharge.

11.2.6.1 Ex-Situ Treatment

The only ex-situ treatment process option that was not eliminated during the evaluation process was air stripping (Tables 11-1 and 11-2). The technology evaluation considered the results of the evaluation of permit standards for discharge to surface water discussed below.

Air Stripping. Air stripping occurs when a gas, such as air, is introduced into a water containing volatile constituents. Air introduction can occur by exposure of the groundwater contaminants to the atmosphere, or by mechanical means with the use of a blower. Air stripping causes VOCs present in the water to transfer into the air stream. Depending on state regulations, the contaminated air stream is captured and treated or released to the atmosphere. The treated water then could be discharged.

Discharge. After extraction, and potentially treatment to remove VOCs, groundwater will require discharge. The only discharge option that was retained after the secondary screening (Table 11-2) involves discharge to surface water; extracted groundwater would be discharged to the North Branch Potomac River under this scenario. Downstream from Site 5, low concentrations of TCE are currently entering the North Branch Potomac River from permitted discharge locations at ABL. The impact of any discharge from Site 5 will need to be considered in parallel with these existing discharges. Evaluation of remedial technologies for groundwater treatment is dependent on the permit standards for discharge to surface water.

This type of discharge to surface water must comply with West Virginia National Pollutant Discharge Elimination System (NPDES) requirements. The State of Maryland has the right to review discharge limitations imposed by West Virginia and, further, may impose more stringent limitations as allowable under the authority of current Maryland NPDES policies and regulations. Final discharge limits would be developed and approved by the USEPA, MDE, and WVDEP during pre-design work.

Preliminary Groundwater Treatment Criteria. Based on previous discussions with the EPA and the states of Maryland and West Virginia, discharges to the North Branch Potomac River from Site 5 will be regulated by the State of West Virginia based upon the water quality standards listed in Appendix K of the Legislative Rules, West Virginia Water Quality Resources Board, Series I, Requirements Governing Water Quality Standards (1985) or the federal water quality standards, whichever are more protective. The federal ambient water quality criteria (FAWQC) (chronic), EPA Region III RBC table, and Biological Technical Assistance Group (BTAG) screening levels are to be consulted, if appropriate, when developing discharge requirements. In accordance with the Clean Water Act, state law requires that the industry-based best available technology (BAT) limitations promulgated in 40 CFR 414.101 be imposed when these are more stringent than limitations derived from the West Virginia water quality standards.

The State of West Virginia Office of Water Resources has developed a toxic pollutant control strategy, the purpose of which is to determine allowable surface water discharge limits. The toxic pollutant control strategy conservatively considers the assimilative capacity of the receiving stream to calculate discharge limits. The toxic pollutant control strategy was used to estimate preliminary surface water discharge limits based on the estimated flow rate of the influent waste stream. Further explanation of the governing standards and an example estimation of discharge limits is presented in Appendix K. Flow rates will vary depending

on actual design and field conditions. For calculation purposes, the estimated flow rate for alluvial aquifer extraction is 26 gpm (see Section 11.3.5.2). For virtually any flow rate that would be anticipated from any extraction system design for Site 5, the BAT average monthly concentration (BAT AMC) effluent limit for TCE would be lower than a calculated AMC (based on the West Virginia Toxic Pollutant Control Strategy); therefore, the BAT effluent limitation governs for average monthly discharge.

Based on the toxic pollutant control strategy, TCE is the only Site 5 groundwater constituent that may require treatment prior to surface water discharge. The maximum detected concentration of TCE (150 µg/L) is higher than the preliminary discharge limit of 26 µg/L (BAT AMC). However, the TCE concentration detected in the majority of the alluvial and bedrock wells is below this preliminary discharge limit. Depending on the extraction scenario employed, it is likely that the combined TCE concentration from the extraction wells will be below the discharge limit, and minimal treatment or no treatment likely will be required prior to surface water discharge.

11.3 Development of Remedial Alternatives

The next step in the feasibility study process is to group process options that remain after the secondary evaluation into remedial action alternatives to address groundwater contamination in both the alluvial and bedrock aquifers.

Remedial alternatives have been developed in an effort to present a wide range of remedial actions in terms of both cost-effectiveness in protecting human health and the environment, and level of difficulty in implementation. These alternatives have been developed to meet the RAOs defined in Section 10, which focus on reducing potential human exposure to contaminants, preventing any negative impact on river media, and remediating the groundwater to cleanup goals within a reasonable time frame. Groundwater remedial alternatives were developed for Site 5 on the basis of the identification and screening of technology types and process options previously conducted in this section. The remedial alternatives identified for further evaluation are as follows:

- Alternative 1—No Action
- Alternative 2—Enhanced Reductive Dechlorination
- Alternative 3—Permeable Reactive Barrier
- Alternative 4— Groundwater Extraction and Treatment

Table 11-3 presents a matrix of the retained technologies and the remedial alternatives. The major components of each remedial alternative are defined in the following subsections.

11.3.1 Alternative 1—No Action

The no-action alternative is required by the NCP and serves as the baseline alternative. All other remedial action alternatives are judged against the no-action alternative. Under this alternative, no controls or remedial technologies will be implemented. CERCLA (Section 121(c)), as amended by SARA (USEPA, 1986), requires that the site be reviewed every 5 years because contamination would remain onsite.

11.3.2 Alternative 2 — Enhanced Reductive Dechlorination

Under this alternative, the existing natural attenuation processes would be augmented by the injection of an organic substrate to increase the rate of biological RD in the alluvial aquifer. The objective is to reduce the time until cleanup goals are achieved in the groundwater. The less concentrated and less extensive bedrock contamination would be allowed to naturally attenuate under this alternative.

This alternative consists of:

- Groundwater use restrictions
- ERD in the alluvial aquifer
- Monitored Natural Attenuation
- Groundwater and river monitoring

11.3.2.1 Groundwater Use Restrictions

Groundwater use restrictions (via an IC plan), which prevent use of untreated, contaminated groundwater for potable water will be in place until groundwater monitoring indicates that remediation goals have been met.

11.3.2.2 Enhanced Reductive Dechlorination (ERD)

The target area for ERD would be selected to cost effectively minimize the time until cleanup goals are achieved. For evaluation purposes, the tentative location for targeted treatment is the area downgradient of the landfill where samples show TCE concentrations exceeding 50 µg/L (Figure 11-3). This substrate injection area covers about 65,000 square feet. The substrate would be injected from about 10 feet to 25 feet below ground surface (bgs), the saturated zone of the alluvial aquifer. A pilot test would be performed to determine the effectiveness of ERD and the optimal spacing for injection locations. It is assumed that injection wells are required due to subsurface conditions that preclude use of direct-push methods.

Injection wells are assumed to require 30-foot centers (15-foot radius of influence), resulting in a total of 73 wells across the treatment area. Following installation of the injection wells, a substrate would be injected to enhance biological activity and create reducing conditions in the subsurface. Under these conditions TCE would begin to act as an electron acceptor and be reductively dechlorinated. Potential substrates that can be used for this alternative include, but are not limited to, the following:

- Molasses
- Vegetable oil
- Hydrogen releasing compounds
- Lactic acid
- Alcohol

In each case, the substrate is metabolized by naturally occurring microorganisms, resulting in the creation of anaerobic aquifer conditions and the production of hydrogen. Naturally occurring microorganisms, capable of RD, then use the hydrogen to progressively remove chlorine atoms from the chlorinated hydrocarbons (e.g., degradation of TCE to DCE to vinyl chloride to ethene).

While the degradation rates of TCE are highest under anaerobic conditions, vinyl chloride and ethene will degrade faster under aerobic conditions. Therefore, optimal locations for substrate addition should provide unenhanced downgradient areas for aerobic biodegradation of vinyl chloride and ethene.

11.3.2.3 Monitored Natural Attenuation

The groundwater contamination in locations not augmented by the injected substrate (i.e. in the alluvial aquifer outside of the area of influenced by the injections and in the bedrock aquifer) will be allowed to attenuate naturally, primarily through processes of diffusion, geochemical reactions, volatilization, advection, adsorption, and dispersion in the alluvial and bedrock aquifers.

The results of groundwater sampling performed under this alternative would be evaluated to determine if the combined natural attenuation mechanisms, including biodegradation enhanced by the injected substrate, are occurring at a rate sufficient to meet RAOs for the site within a reasonable timeframe.

11.3.2.4 Groundwater and River Monitoring

Under this alternative, groundwater, surface water and sediment within the North Branch Potomac River adjacent to the site would be sampled periodically. This sampling would be conducted to evaluate whether groundwater contaminant concentrations decrease over time. Monitoring currently conducted at the site as part of long-term monitoring activities will provide sufficient data for this purpose. The procedures for conducting groundwater sampling at the site are documented in the *Post-Closure Operation and Maintenance Plan and Long-Term Monitoring Plan, Site 5 – Inert Landfill* (CH2M HILL, 1998a). It is assumed that monitoring would continue on its current tri-quarterly schedule to monitor groundwater and river quality until remediation is complete. For costing purposes, it was assumed that one groundwater sample from 15 wells at the site and four surface water and sediment samples from the North Branch Potomac River will be collected during each sampling event and analyzed for LC or TCL VOCs, TAL dissolved inorganics, natural attenuation parameters (only for groundwater samples), and other analytes as required in the Long-Term Monitoring Plan (CH2M HILL, 1998a). It is assumed that no new monitoring wells will be required. It is possible that the number of wells sampled and/or the analytical protocol could be modified with time to optimize the monitoring program and increase cost efficiency.

11.3.3 Alternative 3—Permeable Reactive Barrier

The main feature of this alternative is installation of a passive permeable reactive barrier (PRB) in the contaminated portion of the alluvial aquifer with simultaneous MNA in the bedrock aquifer. The components of this alternative are:

- Groundwater use restrictions
- Permeable reactive barrier
- Monitored natural attenuation
- Groundwater and river monitoring

11.3.3.1 Groundwater Use Restrictions

Institutional controls to prevent exposure to contaminated groundwater at the site would be the same as those included in Alternative 2. These would remain in effect until groundwater PRGs are met and potential risks from groundwater are shown to be reduced to acceptable levels.

11.3.3.2 Permeable Reactive Barrier

The PRB would consist of reactive material placed in the subsurface to intercept the most highly contaminated portion of the plume. The contaminated groundwater moves through it as it flows under its natural gradient, and the TCE reductively dechlorinates to ethene and carbon dioxide. This process is referred to as metal ERD (MERD). The MERD via a PRB was developed in 1994 and is marketed as proprietary technology by EnviroMetal Technologies Inc. (ETI) of Canada.

Iron metal, variously designated as Fe(0) or zero-valent iron, is the most common reactive media in the majority of field-scale and commercial implementations. Scrap iron for this purpose can be obtained in a granular form in the large quantities needed. This material has the ability to reductively dehalogenate hydrocarbon compounds. The reductive dehalogenation of TCE and subsequent daughter products occurs due to electron transfers from the iron to the halocarbon at the iron surface. This results in the halogen ions (e.g., Cl^-) being replaced by hydrogen species, ultimately yielding ethene or ethane that can be mineralized via biodegradation.

The PRB should be placed in a location that is selected to cost effectively minimize the time until cleanup goals are achieved. The tentative location for evaluation purposes is about midway between the landfill and the river in the most concentrated portion of the plume and orientated perpendicular to groundwater flow (Figure 11-4). The purpose of this particular placement is to maximize the rate of remediation of the overall plume because this technology relies on natural gradients for transmission of the contaminated groundwater to the barrier. The PRB would be about 200 feet long and constructed from 10 to 25 feet below ground surface, placing it in the alluvial aquifer.

The required thickness of the PRB is dependent on the influent concentrations, degradation rates, and groundwater flow velocity. TCE, the only VOC COC in Site 5 groundwater, requires a residence time within the PRB of approximately 0.75 day. The thickness of the PRB is calculated to provide the required residence time. An iron PRB with a flow-through thickness of about 1 foot would theoretically provide the required degradation. The required flow-through thickness of the PRB is 2 feet at the site, so sand would be used as a bulking agent and mixed with granular iron. For a PRB measuring 200 feet long with a saturated height of 15 feet, 3,000 cubic feet of granular iron would be required. The typical in-situ density of granular iron is 0.075 tons/ft^3. A total of 225 tons of granular iron would therefore be required. The costs for off-site disposal of excavated soil is included in the cost estimate for Alternative 3 (Appendix L).

Implementation of the PRB consists of several phases, including a treatability study followed by full-scale implementation. The treatability study is designed to evaluate the efficiency of the PRB technology, under simulated groundwater flow conditions, through laboratory tests using representative groundwater samples taken from the site and

commercial granular iron material. The treatability study would confirm whether site VOCs are degraded by the process, evaluate possible undesirable geochemical reactions, such as the formation of metal precipitates, and evaluate the rates of VOC degradation. These rates are then used to determine the required residence time in the reactive material. The size of the treatment zone is then determined using the calculated residence time and groundwater flow rate.

11.3.3.3 Monitored Natural Attenuation

MNA would be used as a component of this alternative to remediate the less contaminated groundwater in the alluvial aquifer downgradient and sidegradient of the PRB. In addition, MNA would be relied upon for remediation of the bedrock aquifer. MNA activities at the site would be the same as those included in Alternative 2 until RAOs are met.

11.3.3.4 Groundwater and River Monitoring

Monitoring would be conducted in a similar manner as described in Section 11.3.2.4 for Alternative 2 until remediation is complete and RAOs are met.

11.3.4 Alternative 4—Groundwater Extraction and Treatment

The main feature of this alternative is installation of extraction wells in the alluvial aquifer northwest of the landfill. TCE in the extracted groundwater would be treated by air stripping prior to discharge to the North Branch Potomac River.

The components of this alternative include:

- Groundwater use restrictions
- Groundwater extraction and treatment
- Groundwater and river monitoring

11.3.4.1 Groundwater Use Restrictions

Groundwater use restrictions would need to be in place until the groundwater extraction system reduces groundwater concentrations to the cleanup goals. The existing IC plan for ABL provides for these restrictions and would be revised, if necessary, as described in Alternative 2.

11.3.4.2 Groundwater Extraction and Treatment

The groundwater extraction wells would be placed in locations selected to cost effectively minimize the time until cleanup goals are achieved. Tentative locations for extraction wells are shown on Figure 11-4. These tentative locations serve only to provide a means of comparatively evaluating remedial alternatives, as they are based on preliminary review of existing data and screening-level modeling. More detailed analysis and advanced modeling would be required to optimize the orientation and number of extraction wells.

Groundwater Extraction Wells. To assess the viability of this alternative, the feasibility of groundwater extraction from the alluvial aquifer within the contaminant plume was evaluated using an analytical model based on the Theis equation (Fetter, 1988):

$$s = \frac{Q}{4\pi T} W(u) \qquad (1)$$

Where: s	=	Drawdown (ft)
Q	=	Pumping rate (ft^3/day)
T	=	Aquifer transmissivity (ft^2/day)
W(u)	=	well function
U	=	$r^2S/4Tt$
r	=	well radius (ft)
S	=	Aquifer storativity
t	=	time since pumping began (day)

By rearranging equation (1) and solving for Q, an estimate of the feasibility of pumping from the alluvial aquifer at Site 5 was made. Calculation of the approximate sustainable pumping rate for an alluvial extraction well was done using the average transmissivity determined from the Site 5 slug tests (i.e., 78.5 ft^2/day), a storage coefficient similar to those determined for the Site 1 alluvial aquifer (i.e., 0.008), an estimated pumping time of 360 days, and a drawdown limited to half the saturated thickness of the alluvium. Solving equation (1) for Q resulted in an estimated extraction rate of approximately 2 gpm (400 ft^3/day).

Based on an extraction rate of 2 gpm per well, an estimate of the number of extraction wells required to capture the contaminant plume in the Site 5 alluvial aquifer was made. The estimate was based on a method developed by Javandel and Tsang (1986), whereby a series of equations is used to estimate the optimal distance between a number of linearly arranged extraction wells and the lateral extent of the resulting capture zone. The contaminant plume in the alluvium is estimated to extend from approximately 100 feet southwest of well 5GW09 to 50 feet south of well 5GW21 (i.e., 800 feet), as shown in Figure 11-2.

Using an extraction rate of 2 gpm per well, the Javandel and Tsang method indicated that the extraction wells should be spaced approximately 100 feet apart to capture the most contaminated portion of the contaminant plume. Figure 11-4 shows the proposed location of the alluvial extraction wells, which includes five wells in the most concentrated portion of the plume to increase the rate of remediation. The extraction wells would be screened from 10 feet to 25 feet bgs, the saturated zone of the alluvial aquifer. For costing purposes, 4-inch diameter Schedule 40 PVC wells were assumed.

The bedrock contamination located west of the landfill is expected to also be captured by the alluvial extraction wells placed in that area of the plume. It is expected that the alluvial wells would lower the head in the alluvium sufficiently to induce an upward gradient from the bedrock to the alluvium and result in collection of the less contaminated bedrock plume.

Groundwater Treatment and Discharge. Because of the low constituent concentrations observed in the alluvial aquifer at Site 5 during previous investigations, the preliminary assessment is that extracted groundwater would require minimal treatment to meet surface water discharge limits. Based on the preliminary surface water discharge limits developed

in the previous section, TCE is the only Site 5 constituent that may require treatment prior to discharge. It is likely that no inorganic constituents would require treatment because the estimated inorganic concentrations in extracted groundwater are expected to be below the preliminary discharge limits.

Extracted groundwater would be discharged to the existing rip-rap channel (see Figure 11-4), which would require some reinforcement along the riverfront. The rip-rap channel would provide for turbulence and aeration of the groundwater prior to discharge to the North Branch Potomac River. The channel could be modified, if necessary, in order to act as a cascade aerator to maximize aeration and volatilization of VOCs. Cascade aerators generally have removal efficiencies in the range of 50 to 80 percent, depending on many factors such as the length of the aerator and baffle material. Therefore, the aeration channel should provide, at a minimum, a 50 to 80 percent safety factor to ensure the discharge limits are not exceeded. The existing grade is sufficiently sloped to promote good drainage to the river from the channel. The discharge piping would be fitted with a spray nozzle to maximize volatilization of VOCs as groundwater is discharged from the pipe to the channel.

11.3.4.3 Groundwater and River Monitoring

Monitoring would be conducted in a similar manner as described in Section 11.3.2.4 for Alternative 2 until remediation is complete and RAOs are met.

TABLE 11-1
Primary Screening of Remedial Technologies for Groundwater
Final Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

General Response Action	Remedial Action or Technology	Process Options	Description	Screening Action		Screening Comments
				Retain	Reject	
No Action	None	Not applicable	No action	X		Retain as baseline alternative.
Institutional Control Actions	Administrative restrictions	Deed or groundwater use restrictions	Deeds for property in area would include groundwater use restrictions.	X		Potentially applicable.
	Monitoring	Groundwater monitoring	Collection and analysis of groundwater samples to monitor extent and migration of groundwater contamination.	X		Technically feasible.
Containment	Vertical barriers	Sheet piling	Metal sheeting mechanically driven into ground, forming a hydraulic barrier around areas of contamination.		X	Potentially applicable for alluvial aquifer. Not technically feasible for bedrock aquifer. Standard sheeting is not impermeable. May need to inject polymer into sheeting interlocks to prevent excessive leakage.
		Slurry wall	Trench around areas of contamination filled with a low-permeability soil-bentonite or cement-bentonite slurry material.		X	Potentially applicable for alluvial aquifer. Not technically feasible for bedrock aquifer. Slurry wall will not hydrologically isolate the waste. See Section 11.2.3 for more information.
Collection	Extraction	Extraction wells	Series of wells to extract contaminated groundwater.	X		Potentially applicable for both aquifers.

TABLE 11-1
Primary Screening of Remedial Technologies for Groundwater
Final Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

General Response Action	Remedial Action or Technology	Process Options	Description	Screening Action		Screening Comments
				Retain	Reject	
Collection (cont.)	Extraction (cont.)	Extraction trenches	Perforated pipe in trenches backfilled with porous media to collect groundwater	X		Potentially applicable for alluvial aquifer. Not appropriate for construction within bedrock aquifer because of excessive cost of rock excavation, so must be combined with another technology.
In-Situ Treatment	Biological treatment	Aerobic	Organics degraded by microorganisms in an aerobic environment.		X	Potentially applicable in combination with other technologies. However, chlorinated organics are degraded very slowly in aerobic environments.
		Anaerobic	Organics degraded by microorganisms in an anaerobic environment.	X		Potentially applicable for alluvial aquifer. Not technically feasible for bedrock aquifer because of difficulty in obtaining the necessary distribution of substrate to promote RD, so must be combined with another technology.
		Phytoremediation	Organics are stabilized or degraded by plants through processes including enhanced rhizosphere biodegradation, hydraulic control, phytodegradation, and phytovolatilization.		X	Not technically feasible because plant roots cannot penetrate groundwater beneath the landfill. Groundwater is too deep for contact with plant roots.

TABLE 11-1
Primary Screening of Remedial Technologies for Groundwater
Final Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

General Response Action	Remedial Action or Technology	Process Options	Description	Screening Action		Screening Comments
				Retain	Reject	
In-Situ Treatment (cont.)	Physical/chemical treatment	Monitored Natural Attenuation	Contaminants are allowed to attenuate through natural processes including biological degradation, volatilization, advection, dilution, and geochemical reactions.	X		Potentially applicable for both alluvial and bedrock aquifer.
		Chemical oxidation	Chemical oxidation through injection of oxidants such as hydrogen peroxide or permanganate throughout plume.	X		Potentially applicable for alluvial aquifer. Not applic-able for bedrock aquifer because of difficulty in obtaining contact between oxidant and VOCs, so must be combined with another technology.
		Metal-enhanced abiotic degradation in permeable reactive wall or injected throughout plume.	Halogenated organics degraded in-situ by an iron reactor.	X		Potentially applicable for the alluvial aquifer. Not applicable for the bedrock aquifer, so must be combined with another technology.

TABLE 11-1
Primary Screening of Remedial Technologies for Groundwater
Final Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

General Response Action	Remedial Action or Technology	Process Options	Description	Screening Action		Screening Comments
				Retain	Reject	
In-Situ Treatment (cont.)	Physical/chemical treatment (cont.)	Air sparging	Air is injected into the aquifer to maximize contaminant volatilization to the vapor phase.	X		Potentially applicable in alluvial aquifer if a zone of uniform density and permeability is installed perpendicular to groundwater flow to serve as an injection point for air. Not technically feasible in bedrock aquifer because it is difficult to assure that air at a sufficient rate would be supplied to all bedrock fractures with COCs > remedial goals, so must be combined with another technology.
		Bioventing	Injection of pressurized air into aquifer, resulting in biological oxidation as well as volatilization of organics.		X	Air flow through soil is sensitive to changes in soil density and permeability. The primary COC is TCE, which is not sufficiently aerobically degradable. In addition, option is not technically feasible in heterogeneous soil existing in alluvium at Site 5.
		In-well aeration	Air, extracted from a well, creates a water column in the well. Air is injected into the water column, stripping out VOCs in the well.		X	Not technically feasible in aquifers with thin saturated thickness or with variable permeabilities such as at Site 5, or in bedrock.

TABLE 11-1
Primary Screening of Remedial Technologies for Groundwater
Final Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

General Response Action	Remedial Action or Technology	Process Options	Description	Screening Action		Screening Comments
				Retain	Reject	
Ex-Situ Treatment	Physical/chemical treatment	Air stripping	Contaminants are exposed to air amid turbulence to maximize volatilization to vapor phase.	X		Potentially applicable.
		Carbon adsorption	Contaminants adsorbed onto activated carbon by passing contaminated groundwater through carbon column.	X		Potentially applicable.
		Filtration	Contaminated groundwater passed through a filtration system to reduce solids content.	X		Potentially applicable for pretreatment of suspended solids. Not applicable for removal of organics.
		Sedimentation	Suspended solids separated from contaminated water by gravity in a sedimentation tank or basin.	X		Potentially applicable for pretreatment of suspended solids. Not applicable for removal of volatile organics.
		Reverse osmosis	Forced passage of water through a membrane, leaving contaminants behind.	X		Potentially applicable for inorganics. Not applicable for the removal of organics.
		Ion exchange	Contaminated water passed through a resin bed where ions exchange between resin and water.	X		Potentially applicable for inorganics. Not applicable for the removal of organics.
		Chemical precipitation	pH of contaminated ground-water is raised, facilitating precipitation of dissolved solids. Resulting sludge is removed from waste stream.	X		Potentially applicable as a pretreatment step for removal of elevated concentrations of iron, manganese, and carbonates.

TABLE 11-1
Primary Screening of Remedial Technologies for Groundwater
Final Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

General Response Action	Remedial Action or Technology	Process Options	Description	Screening Action		Screening Comments
				Retain	Reject	
Ex-Situ Treatment (cont.)	Physical/chemical treatment (cont.)	Chemical oxidation/UV oxidation	Contaminated water mixed with an oxidant such as hydrogen peroxide to destroy organic compounds.	X		Potentially applicable for organics. Not applicable for inorganics.
		Evaporation	Contaminated water evaporated to produce a contaminant brine.		X	Not feasible due to large amount of water requiring treatment.
Discharge	Discharge of treated groundwater	Surface water	Groundwater discharged to North Branch Potomac River.	X		Potentially applicable; groundwater may require treatment before discharge.
		Existing onsite treatment plant	Groundwater discharged to existing onsite treatment plant.		X	Treatment plant lacks additional capacity, and is located a significant distance from Site 5.
		POTW	Groundwater discharged into municipal sewer system.		X	There are no sewer lines in the vicinity of Site 5.
		Injection well	Groundwater reinjected into the aquifer via an injection well.	X		Potentially applicable; groundwater will likely require treatment to SDWA MCLs before reinjection.
		Infiltration bank	Groundwater discharged to groundwater infiltration bank or trench.		X	Difficult to implement due to significant soil heterogeneity and low hydraulic conductivity.

TABLE 11-2
Secondary Screening of Remedial Process Options for Groundwater
Final Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

General Response Action	Remedial Action or Technology	Process Options	Effectiveness	Implementability	Relative Cost	Evaluation Action		Screening Comments
						Retain	Reject	
No Action	None	Not applicable	Does not protect human health or the environment. Does not satisfy RAOs.	Easily implemented.	None	X		Retain as baseline alternative.
Institutional Control Actions	Administrative restrictions	Deed or groundwater use restrictions	Effectiveness depends on continued future implementation regardless of property use or ownership. Does not reduce contaminant levels.	Easily implemented on ABL property.	Low	X		Will likely be used with other remedial alternative(s) until RAOs are met.
	Monitoring	Groundwater Monitoring	Effective in tracking contaminant migration and reduction. Does not satisfy RAOs.	Easily implemented. Existing monitoring wells may be used for a groundwater monitoring program.	Low capital, low O&M	X		Will likely be used with other remedial alternative(s) until RAOs are met.
Collection	Extraction	Extraction wells	Effective for transmissive aquifers. Effective in preventing offsite contaminant migration and in remediating aquifer to cleanup levels in the absence of DNAPLs.	Easily implemented.	Moderate capital, moderate O&M	X		Retained as an option because of lack of other means to perform many feasible treatment options without extraction.

TABLE 11-2
Secondary Screening of Remedial Process Options for Groundwater
Final Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

General Response Action	Remedial Action or Technology	Process Options	Effectiveness	Implementability	Relative Cost	Evaluation Action		Screening Comments
						Retain	Reject	
Collection (cont.)	Extraction (cont.)	Extraction trenches	Effective for shallow groundwater, such as in an alluvial aquifer.	More difficult to implement than extraction wells. Trenches commonly become clogged with metal oxide precipitates.	Moderate capital, moderate O&M		X	High groundwater solids content would most likely cause fouling.
In-Situ Treatment	Biological Treatment	Anaerobic	VOCs can be degraded effectively by micro-organisms in an anaerobic environment created through the addition of an organic substrate.	Implementable, though will likely require bench and/or pilot scale testing.	Moderate capital, low O&M	X		Has been effectively implemented for TCE biological degradation under similar conditions.
		Monitored Natural Attenuation	Most likely effective in remediation of alluvial and bedrock aquifers during assumed 30 year project life. Landfill cap will contain contaminant source, allowing for natural attenuation to remediate groundwater contamination.	Easily implemented.	Low capital, low O&M costs	X		Technically feasible for both aquifers. Even though natural reductive dechlorination is unlikely given the aquifer conditions (Appendix J), other MNA mechanisms, such as dispersion and dilution, render this option potentially effective in conjunction with other remedial options.

TABLE 11-2
Secondary Screening of Remedial Process Options for Groundwater
Final Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

General Response Action	Remedial Action or Technology	Process Options	Effectiveness	Implementability	Relative Cost	Evaluation Action		Screening Comments
						Retain	Reject	
In-Situ Treatment (cont.)	Biological Treatment (cont.)	Chemical oxidation	Although oxidation can be effective, it typically requires multiple injections of oxidant before significant VOC destruction occurs. Poor effectiveness in heterogeneous aquifers where adequate oxidant distribution is difficult.	Implementable in alluvial aquifer only. Will require pilot-scale testing.	High capital cost		X	Rejected because adequate distribution of oxidant will be difficult to obtain and it has very high cost.
		Metal enhanced abiotic degradation	Effective in remediating VOCs to MCLs.	Implementable in alluvial aquifer only. Will require pilot-scale testing.	Moderate capital, low O&M	X		Technically feasible for remediating VOCs to MCLs. Likely will have to be combined with other remedial alternative(s) to meet RAOs.
		Air sparging	Air sparging can result in channeling of air bubbles (especially in heterogeneous aquifers) and may not be effective in removing VOCs to MCLs unless sparge curtain is placed in an engineered backfill, which greatly increases cost.	Easily implemented in alluvial aquifer (unless engineered backfill is required). Not implementable in bedrock aquifer because it is difficult to assure that air at a sufficient rate would be supplied to all bedrock fractures with COCs > remedial goals.	Moderate capital, moderate O&M		X	Rejected because other technologies for organics removal are more cost effective.

TABLE 11-2
Secondary Screening of Remedial Process Options for Groundwater
Final Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

General Response Action	Remedial Action or Technology	Process Options	Effectiveness	Implementability	Relative Cost	Evaluation Action		Screening Comments
						Retain	Reject	
Ex-Situ Treatment	Physical/chemical treatment	Air stripping	Effective in remediating VOCs in extracted groundwater to below MCLs or to surface water discharge limits.	Easily implemented.	Low capital, moderate O&M	X		Technically feasible for remediating VOCs in extracted groundwater to meet cleanup levels.
		Carbon adsorption	Effective in remediating most extracted groundwater contaminants to below MCLs or to surface water discharge limits.	Easily implemented. May require pretreatment for solids removal and to prevent biological fouling.	Moderate capital, moderate O&M		X	Technically feasible for remediating most extracted groundwater contaminants to below MCLs. However, is considerably more expensive than other treatment alternatives.
		Filtration	Effective in reducing solids content of extracted groundwater.	Easily implemented. Associated residual may require treatment/disposal as a hazardous waste.	Low capital, moderate O&M		X	Solids are not anticipated to require treatment prior to discharge.
		Sedimentation	Effective in reducing solids content of extracted groundwater.	Easily implemented. Associated sludge may require treatment/disposal as a hazardous waste.	Moderate capital, high O&M		X	Solids are not anticipated to require treatment prior to discharge. Also rejected because other technologies for inorganics removal are most cost effective.

TABLE 11-2
Secondary Screening of Remedial Process Options for Groundwater
Final Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

General Response Action	Remedial Action or Technology	Process Options	Effectiveness	Implementability	Relative Cost	Evaluation Action		Screening Comments
						Retain	Reject	
Ex-Situ Treatment (cont.)	Physical/chemical treatment (cont.)	Chemical precipitation	Effective in removing iron, manganese, and carbonates from influent waste stream.	Easily implemented. Requires sludge processing equipment. Sludge may require treatment and disposal as a hazardous waste.	Moderate capital, high O&M		X	Iron and manganese do not require treatment to meet the likely NPDES discharge limits. Also it does not address VOCs.
		Reverse Osmosis	Effective in removing inorganics to low levels in extracted groundwater	Easily implemented. However, brine will require treatment and/or disposal.	High capital and O&M		X	Iron and manganese do not require treatment to meet the likely NPDES discharge limits. Although it is effective in removing some VOCs, reverse osmosis is not as effective at removing lighter-weight VOCs such as TCE.
		Ion exchange	Effective in removing inorganics to low levels in extracted groundwater.	Easily implemented. Brine backwash will require treatment.	Moderate capital and O&M		X	Iron and manganese do not require treatment to meet the likely NPDES discharge limits. Also it does not address VOCs.

TABLE 11-2
Secondary Screening of Remedial Process Options for Groundwater
Final Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

General Response Action	Remedial Action or Technology	Process Options	Effectiveness	Implementability	Relative Cost	Evaluation Action		Screening Comments
						Retain	Reject	
Ex-Situ Treatment (cont.)	Physical/chemical treatment (cont.)	Chemical oxidation/ UV oxidation	Effective in remediating most extracted ground-water contaminants to cleanup levels. Presence of saturated organics, such as the alkanes (DCA, TCA), requires UV/reduction with the use of an iodine catalyst to expedite the reaction.	Easily implemented. No off-gas or process byproducts are produced.	High capital, high O&M		X	Rejected because other technologies for organics removal are more cost effective.
Discharge	Discharge of treated groundwater	Surface water	Effective and reliable.	Easily implemented. Groundwater would be discharged to the North Branch Potomac River. Federal and state surface water discharge limits must be met.	Low capital, low O&M	X		Retained as a discharge option.
		Injection well	Effective and reliable. If groundwater contains significant concen-trations of dissolved iron, manganese, and carbonates, well screen and soil may become clogged.	Not acceptable to WVDEP government if used solely as disposal method. Injected water quality generally must meet MCLs.	Moderate capital, moderate O&M		X	Implementation would be difficult relative to other options.

TABLE 11-3
Assembly of Remedial Alternatives
Final Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Technology/ Process Option	Alternative 1 No Action	Alternative 2 Enhanced Reductive Dechlorination	Alternative 3 Permeable Reactive Barrier	Alternative 4 Groundwater Extraction and Treatment
No Action	X			
Administrative Restrictions on Groundwater Use		X	X	X
Groundwater and River Monitoring		X	X	X
Groundwater Extraction Wells				X
Monitored Natural Attenuation		X	X	
In-Situ Enhanced Reductive Dechlorination		X		
In-Situ Metal Enhanced Reductive Dechlorination			X	
Ex-Situ Air Stripping Treatment				X
Discharge to Surface Water				X

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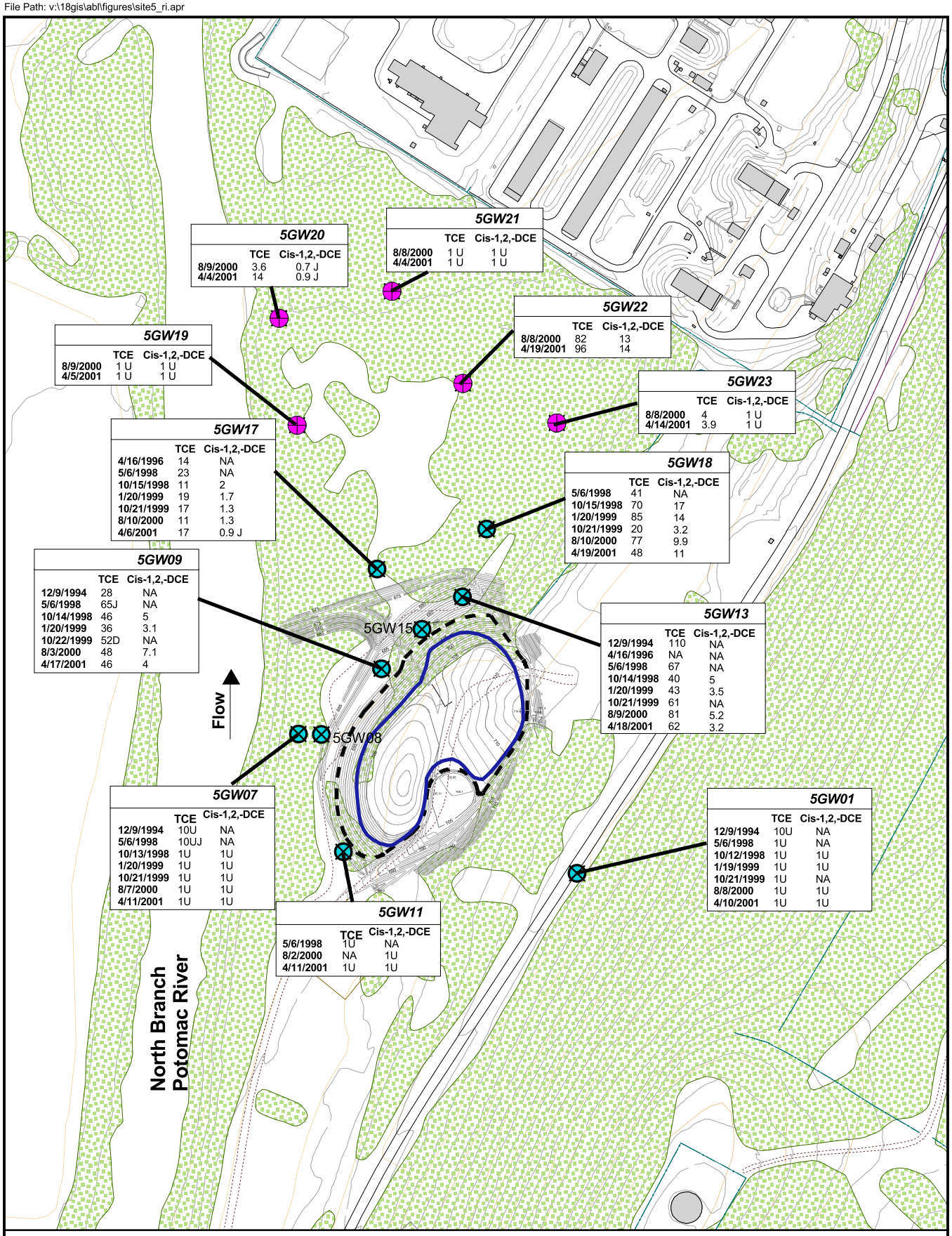

LEGEND

- New Monitoring Well - Alluvial
- Existing Monitoring Well - Alluvial
- Edge of Waste
- Vegetation
- Edge of Landfill Cap

N

125 0 125 250 Feet

Figure 11-1
Historical Concentrations of TCE and Cis -1, 2, -DCE in Alluvial Aquifer
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

CH2MHILL

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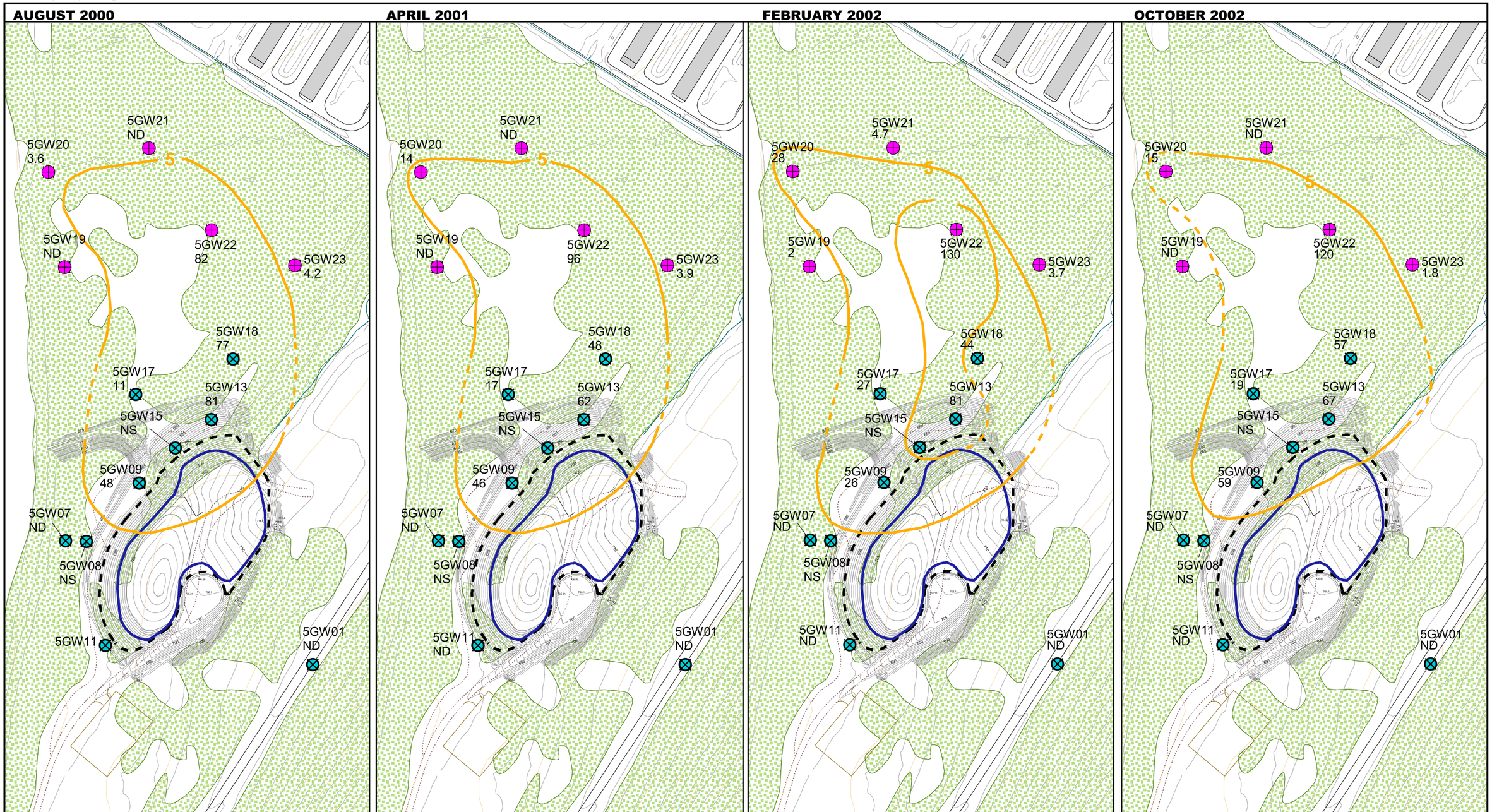

LEGEND

- Existing Monitoring Well - Alluvial
- New Monitoring Well - Alluvial
- Edge of Waste
- Edge of Landfill Cap
- Vegetation
- TCE Isoconcentration (5 ug/L)

Concentrations of TCE in ug/L

ND = Not Detected

NS = Not Sampled

N

0 200 400 Feet

Figure 11-2
TCE Alluvial Groundwater Plume

Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

CH2MHILL

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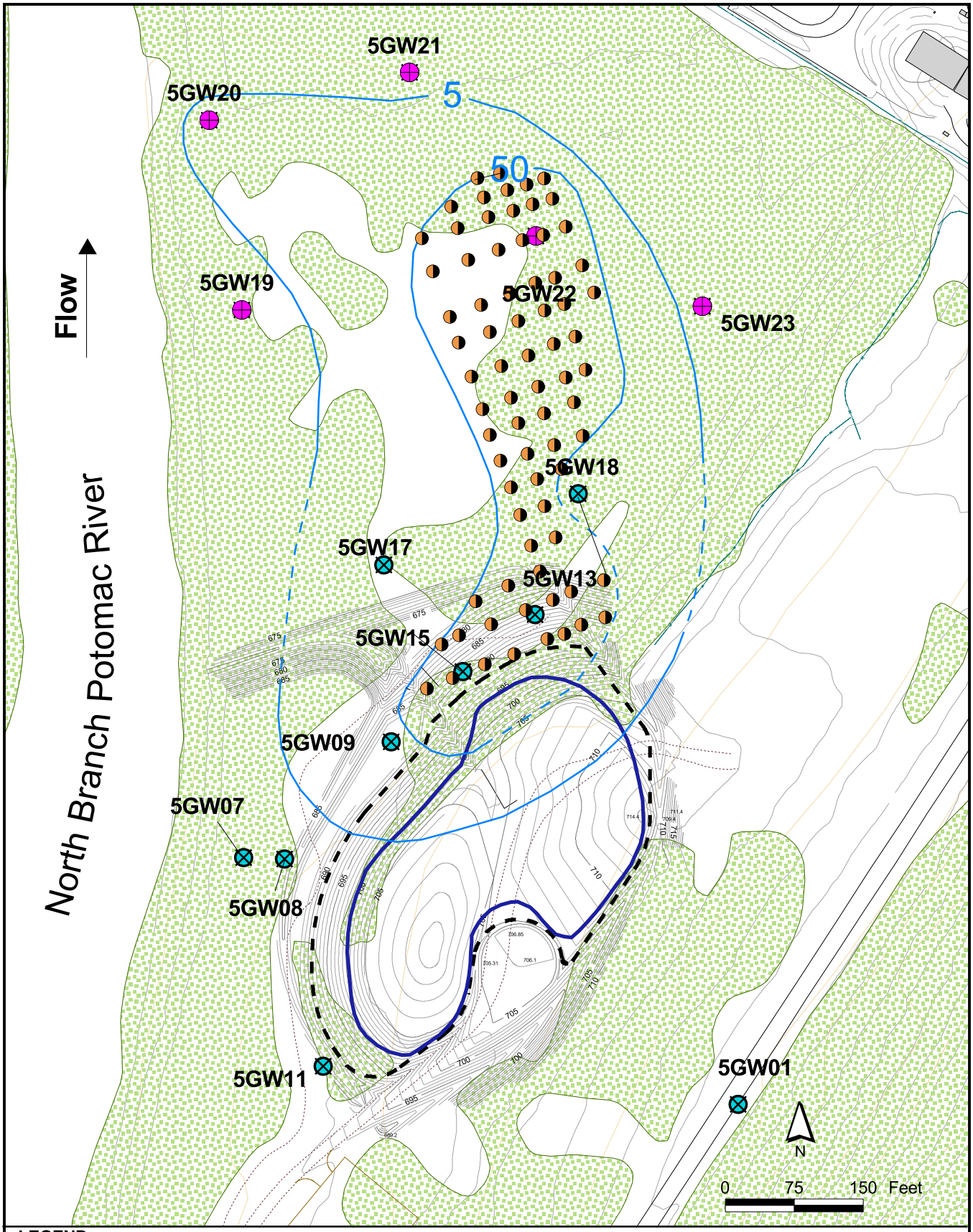

LEGEND

- Existing Alluvial Monitoring Well
- Alluvial Monitoring Well Installed During Focused RI
- Edge of Waste
- Edge of Landfill Cap
- Vegetation
- Injection Points

NS = Not Sampled
ND = Not Detected
50 ug/L Isoconcentration line for TCE; dashed where inferred

Figure 11-3
Alternative 2
Enhanced Reductive Dechlorination
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

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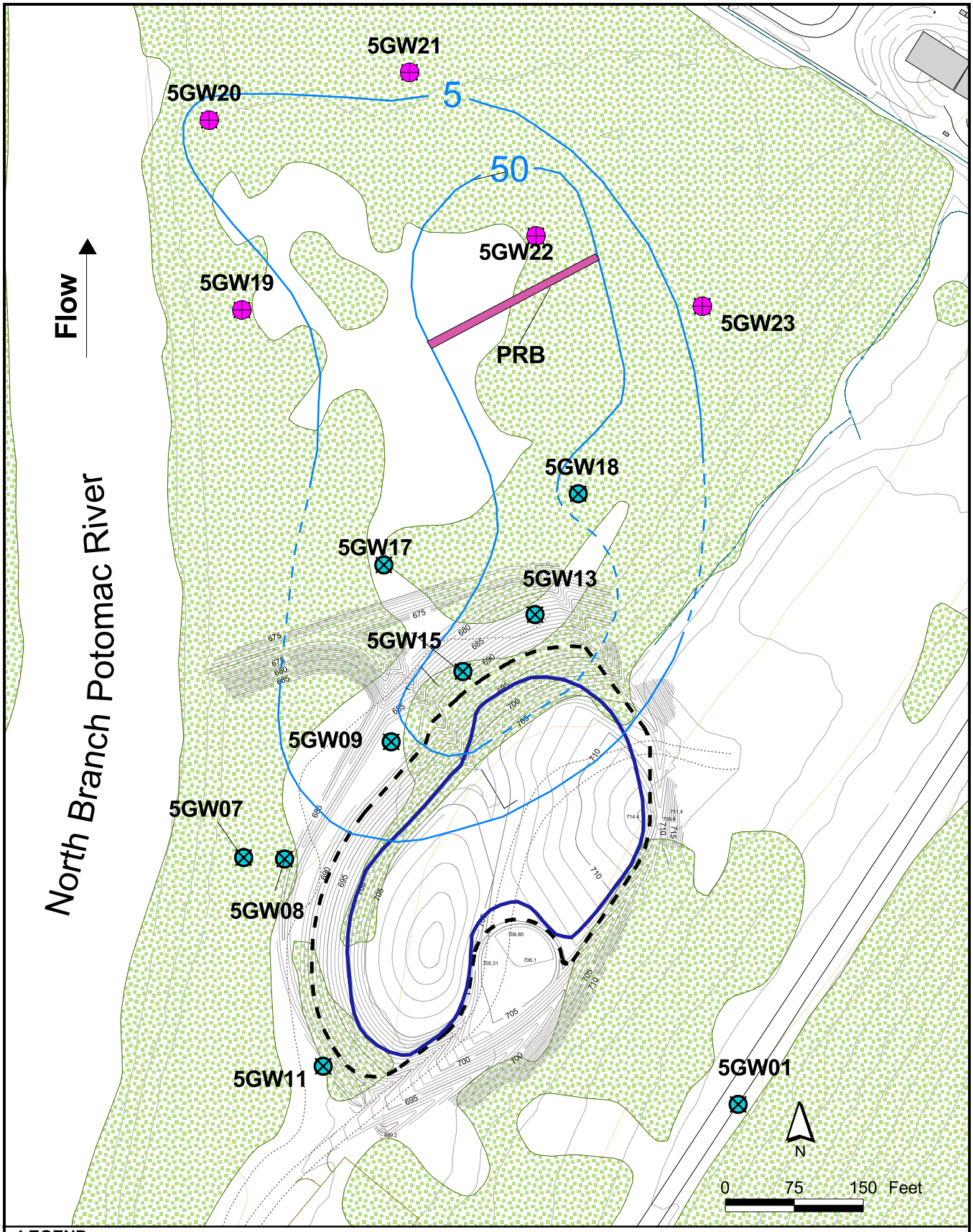
File Path: v:\18gis\abl\figures\site5_FS.apr



LEGEND

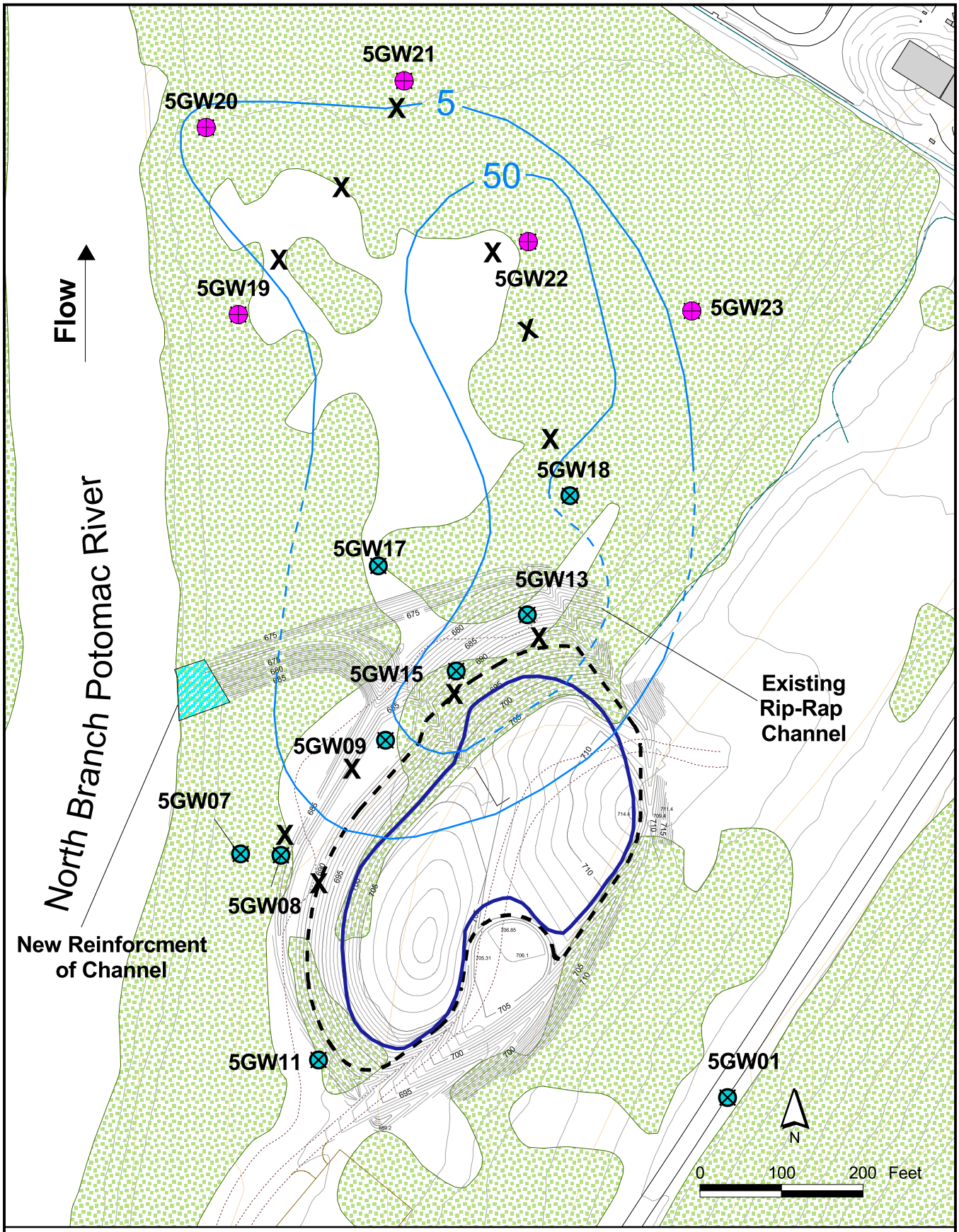
- Existing Alluvial Monitoring Well
- Alluvial Monitoring Well Installed During Focused RI
- Edge of Waste
- Edge of Landfill Cap
- Vegetation

NS = Not Sampled
ND = Not Detected
50 ug/L Isoconcentration line for TCE; dashed where inferred

Figure 11-4
Alternative 3
Permeable Reactive Barrier
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

CH2MHILL

File Path: v:\18gis\abl\figures\site5_fs.apr



LEGEND

- Existing Monitoring Well - Alluvial
- Focused RI Monitoring Well - Alluvial
- Edge of Waste
- Edge of Landfill Cap
- Vegetation
- X Proposed Alluvial Extraction Well
- 50 ug/L Isoconcentration line for TCE; dashed where inferred

Figure 11-5
Alternative 4
Groundwater Extraction and Treatment
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

CH2MHILL

SECTION 12

Detailed Analysis of Remedial Alternatives

The remedial alternatives developed in Section 11 are further evaluated in this section. The detailed evaluation is performed first and is followed by a comparative evaluation. Additional screening of remedial alternatives was not necessary because of the limited number of technologies remaining following the technology screening in Section 11.

Each alternative was developed to address potential threats to human health and the environment posed by contaminated groundwater. The NCP requires the remedial alternatives be evaluated against the nine criteria listed below.

- Protection of human health and the environment
- Compliance with ARARs
- Long-term effectiveness and permanence
- Reduction of toxicity, mobility, and volume through treatment
- Short-term effectiveness
- Implementability
- Cost
- State acceptance
- Community acceptance

The first seven criteria are addressed in this Focused FS. The last two criteria will be addressed in the ROD.

12.1 Evaluation Criteria

The detailed alternative analysis is performed to develop the rationale for selecting a remedy. The following paragraphs define each of the nine criteria.

12.1.1 Overall Protection of Human Health and the Environment

This evaluation criterion is an assessment of whether each alternative achieves and maintains adequate protection of human health and the environment. The overall appraisal of protection draws on the assessments conducted under other evaluation criteria, especially long-term effectiveness and permanence, short-term effectiveness, and compliance with ARARs. Another consideration is the statutory preference for onsite remedial actions.

12.1.2 Compliance with ARARs

This evaluation criterion is used to determine whether an alternative would meet all federal, state, and local ARARs that have been previously identified. Significant ARARs are identified for each alternative, and descriptions on how they are met would be given. A discussion of the compliance of each alternative with chemical-, location-, and action-specific ARARs is included.

12.1.3 Long-Term Effectiveness and Permanence

Under this criterion, the results of a remedial alternative are evaluated in terms of the risk remaining at the site after response objectives have been met. The primary focus of this evaluation is the extent and effectiveness of the actions or controls that may be required to manage the risk posed by treatment residuals or untreated wastes. Factors to be considered and addressed are magnitude of residual risk, adequacy of controls, and reliability of controls. Magnitude of residual risk is the assessment of the risk remaining from untreated waste or treatment residuals after remediation. Adequacy and reliability of controls is the evaluation of the controls that can be used to manage treatment residuals or untreated wastes that remain at the facility. The evaluation may include an assessment of containment systems and institutional controls to determine whether they are sufficient to ensure that any exposure to human and environmental receptors is within protective levels.

12.1.4 Reduction of Toxicity, Mobility, and Volume Through Treatment

This evaluation criterion addresses the statutory preference for selecting remedial actions that, as their principal element, use treatment technologies that permanently remediate and significantly reduce the toxicity, mobility, or volume of the hazardous substances. This preference is satisfied when treatment is used to reduce the principal threats at a site through destruction of toxic constituents, reduction of the total mass of toxic constituents, irreversible reduction of constituent mobility, or reduction of total volume of contaminated media. When evaluating this criterion, an assessment is made as to whether remediation is used to reduce principal threats, including the extent to which toxicity, mobility, or volume are reduced either separately or in combination with one another. Factors that would be focused on include:

- Remediation processes employed by the remedy
- Amount of hazardous materials that would be remediated
- Degree of expected reduction in toxicity, mobility, or volume measured as a percentage of reduction
- Degree to which the remediation would be irreversible
- Type and quantity of treatment residuals that would remain following remediation
- Whether the alternative would satisfy the statutory preference for treatment as a principal element

12.1.5 Short-Term Effectiveness

This evaluation criterion addresses the effects on human health and the environment of the alternative during the construction and implementation phase until RAOs are met. The following factors would be addressed for each alternative:

- Protection of the community during remedial actions
- Protection of workers during remedial actions
- Environmental impacts during remedial actions
- Time until RAOs are achieved

12.1.6 Implementability

The implementability criterion addresses the technical and administrative feasibility of executing an alternative and the availability of various services and materials required during its implementation. Technical feasibility includes construction, operation, reliability of technology, ease of undertaking additional remedial action, and monitoring. Administrative feasibility refers to the activities needed to coordinate with other offices and agencies (e.g., local permits). Availability of services and materials includes availability of adequate off-facility treatment, storage capacity, and disposal services; necessary equipment and specialists; services and materials; and prospective technologies.

12.1.7 Cost

For the detailed cost analysis of alternatives, the expenditures required to complete each measure are estimated in terms of both capital and annual O&M costs. Using these values, a present-worth calculation for each alternative then can be made for comparison.

Capital costs consist of direct and indirect costs. Direct costs include the cost of construction, equipment, land and site development, treatment, transportation, and disposal. Indirect costs include engineering expenses, license or permit costs, and contingency allowances.

Annual O&M costs are the post-construction costs required to ensure the continued effectiveness of the remedial action. Components of annual O&M cost include the cost of operating labor, maintenance materials and labor, auxiliary materials and energy, residue disposal, purchased services, administration, insurance, taxes, licensing, maintenance reserve and contingency funds, rehabilitation, monitoring, and periodic site reviews.

Expenditures that occur over different time periods were analyzed using present worth, which discounts all future costs to a common base year. Present-worth analysis allows the cost of remedial action alternatives to be compared on the basis of a single figure representing the amount of money that, if invested in the base year and disbursed as needed, would be sufficient to cover all costs associated with the life of the remedial project. Assumptions associated with the present-worth calculations include a discount rate of 3.2 percent (Executive Office of the President, Office of Management and Budget (OMB) Circular No. A-94, Appendix C, revised January 2003), cost estimates in the planning years in constant dollars, and a period of performance that would vary depending on the activity, but would not exceed 30 years.

The cost estimates for this section are provided to an accuracy of +50 percent to -30 percent. The alternative cost estimates are in 2003 dollars and are based on conceptual design from information available at the time of this study. The actual cost of the project would depend on the final scope and design of the selected remedial action, the schedule of implementation, competitive market conditions, and other variables. Most of these factors are not expected to affect the relative cost differences between alternatives. The cost estimates were prepared in general conformance with *A Guide to Developing and Documenting Cost Estimates During the Feasibility Study* (USEPA, 2000c).

12.1.8 State Acceptance

This assessment evaluates the technical and administrative issues and concerns the states may have regarding each of the alternatives. This criterion is not discussed in this report, but would be addressed in the ROD once comments on the remedial investigation/ feasibility study (RI/FS) have been received.

12.1.9 Community Acceptance

This assessment evaluates the issues and concerns the public may have regarding each of the alternatives. As with state acceptance, this criterion is not discussed in this report, but would be addressed in the ROD once comments on the RI/FS and Proposed Remedial Action Plan (PRAP) have been received.

12.2 Detailed Evaluation of Remedial Alternatives

In Section 11, four remedial alternatives, including the No Action alternative, were developed with the goal of meeting the site-specific RAOs presented in Section 10. All of the remedial alternatives are suitable to be carried forward to Section 12 for detailed evaluation.

The four remedial alternatives evaluated in detail are:

- Alternative 1—No Action
- Alternative 2—Enhanced Reductive Dechlorination
- Alternative 3—Permeable Reactive Barrier
- Alternative 4— Groundwater Extraction and Treatment

Section 11 describes each alternative in detail. These alternatives are evaluated in this section on the basis of the seven criteria previously discussed. A summary of this evaluation for each alternative is presented in Table 12-1.

Each alternative is measured by its ability to meet the RAOs. The site-specific RAOs for Site 5 groundwater are to:

- Prevent or minimize exposure of potential future onsite residents to contaminated groundwater originating from Site 5 at concentrations exceeding MCLs or, in the absence of MCLs, an ELCR of 1×10^{-4} to 1×10^{-6} or a HI = 1.
- Prevent or minimize river media from becoming impacted by the Site 5 groundwater COCs such that resulting concentrations present an unacceptable risk to human health or the environment.
- Return groundwater beyond the landfill boundaries to MCLs.

One of the tools used in the comparative analysis was the batch flushing model of constituent reduction per pore volume exchange (Table 12-2). This model was applied to assess the time required for TCE concentrations to achieve the PRG of 5 µg/L. Because variations in each of the site-specific parameters from those assumed in the model can have a significant effect on the estimated time to achieve the PRG, the estimates were used only for comparative purposes between alternatives and not as accurate estimates of actual times to achieve the MCL. The model's estimated times to complete remediation are driven by the

assumption that there will be no additional releases from the landfill because the landfill has been capped. The landfill cap will likely minimize the potential for continued groundwater contamination from leaching of landfill contents, but even a small release could result in TCE levels above PRGs. Further assumptions of this model are detailed in Table 12-2.

Although TCE is the primary COC in Site 5 groundwater, iron and manganese are also present at concentrations exceeding PRGs. Iron and manganese are discussed under each of the following alternatives, but it should be noted that their concentrations may not comply with PRGs within the estimated timeframes for TCE remediation. Landfill leachate typically causes reducing conditions that can mobilize these inorganics and elevate their concentrations in groundwater. Because the Site 5 landfill has been capped, thereby minimizing infiltration and leachate generation, the dissolved iron and manganese concentrations are expected to decrease over time to levels more representative of natural conditions, such as those downgradient of the landfill. Groundwater monitoring associated with the remedial action for TCE will include iron and manganese in order to verify their concentrations return to more natural levels concurrent with the groundwater TCE remediation. In spite of the elevated iron and manganese concentrations, each of the alternatives, with the exception of Alternative 1, will achieve the site-specific RAOs listed above.

12.2.1 Alternative 1—No Action

This alternative is required under the NCP. Under this alternative, no further effort or resources would be expended to remediate contaminated groundwater at Site 5. Because contaminated media would be left on the site, a review of site conditions would be required every 5 years, as specified by the NCP. Alternative 1 serves as the baseline against which the effectiveness of other alternatives are judged.

12.2.1.1 Overall Protection of Human Health and the Environment

This alternative does not contain measures to prevent potential future onsite residents from using and contacting contaminated groundwater. The risk posed by contaminated groundwater would not be decreased because the risk of potential future exposures would continue. Alternative 1 does not address the second RAO concerning potential impacts to the river. However, the RI Report concluded that Site 5 groundwater contamination is not currently impacting the river. Residual risks are identical to those identified in the baseline risk assessment.

12.2.1.2 Compliance with ARARs

Chemical-Specific ARARs. TCE in the alluvial and bedrock aquifers will remain out of compliance with its PRG for roughly 30 years. This time was estimated based on a batch flushing model of constituent reduction per pore volume exchange (Table 12-2). As discussed previously, the time estimates are for comparative purposes only. Key assumptions of the model are stated in Table 12-2.

Location-Specific ARARs. There are no location-specific ARARs for this alternative because no remedial actions would be undertaken.

Action-Specific ARARs. There are no action-specific ARARs because no remedial actions would be undertaken in this alternative.

12.2.1.3 Long-Term Effectiveness and Permanence

The residual risk associated with groundwater contamination under this alternative would be reduced over the long term. TCE concentrations in the alluvial aquifer would diminish over an estimated 30-year period. Iron and manganese concentrations above PRGs may persist longer than 30 years because of reducing conditions in alluvial groundwater beneath the landfill. Contamination in the bedrock aquifer should be removed in a shorter period than in the alluvial aquifer due to the lower initial constituent concentrations present in the bedrock aquifer. Because contaminants are left at the site above cleanup levels, a review of site conditions would be required every 5 years.

12.2.1.4 Reduction of Toxicity, Mobility, and Volume Through Treatment

This alternative does not include treatment. The estimated 4.9 pounds of TCE dissolved in the groundwater and adsorbed to the aquifer matrix would diminish over time through natural attenuation processes. Iron and manganese concentrations would decrease as subsurface conditions become less reducing over time.

12.2.1.5 Short-Term Effectiveness

There is no construction associated with this alternative, so there are no short-term impacts on workers, the community or the environment.

12.2.1.6 Implementability

This alternative does not have a monitoring or construction component associated with it. Therefore, there are no issues concerning implementation.

12.2.1.7 Cost

Taking no action would require no capital expenditure. As part of the 5-year review process, monitoring may be required and time would be expended on preparing a report detailing the potential risks associated with the site. However, long-term monitoring is currently conducted for this site; therefore, these costs have not been included in this Focused FS.

12.2.2 Alternative 2—Enhanced Reductive Dechlorination

This alternative is described in detail in Section 11. It consists of subsurface injection of an organic substrate to enhance the rate of biological RD in the most contaminated portion of the alluvial aquifer, with reliance on MNA mechanisms to reduce contamination in less contaminated portions of the alluvial aquifer and the bedrock aquifer. This alternative also includes groundwater-use restrictions and groundwater and river monitoring during the remediation period.

12.2.2.1 Overall Protection of Human Health and the Environment

Alternative 2 is considered protective of human health and the environment. The groundwater constituents are not currently posing a risk and the groundwater use restrictions would prevent future exposure to the groundwater. The portion of the alluvial aquifer most heavily contaminated with TCE would be remediated through ERD. Also, discharge of contaminated groundwater to the river is not expected to pose a risk to human health or the environment. Long-term monitoring would verify this assumption.

Although Alternative 2 would remediate TCE concentrations in Site 5 groundwater, the injection of substrate would exacerbate reducing conditions in the subsurface, resulting in further mobilization of iron and manganese and a possible increased discharge of these constituents to the river. Although impacts on the river are not expected to be significant because of the large dilution that would occur, there is a potential for orange staining along the river bank from the oxidation of the iron as it discharges to the river.

The RAO of returning the groundwater TCE concentrations to MCLs in a reasonable time period would be met as further discussed below in Section 12.2.3.2, Chemical-Specific ARARs (see Table 11-2 and the critical assumptions below). However, the substrate injection would likely increase iron and manganese concentrations in groundwater, extending the time required for these concentrations to comply with PRGs.

The estimated time frame for TCE remediation is considered reasonable for Site 5 because the groundwater is not currently used and any future water needs by the facility can be met by wells located elsewhere at the facility or by other means.

12.2.2.2 Compliance with ARARs

As described below, Alternative 2 complies with all ARARs.

Chemical-Specific ARARs. The aquifers would remain out of compliance with chemical-specific ARARs until the ERD and natural attenuation mechanisms return groundwater to concentrations below the ARARs. Based on the rate of TCE degradation rates potentially attainable with ERD, it is estimated that chemical-specific ARARs would likely be met in the injection area of the alluvial aquifer within several years following treatment. This time frame is driven by the assumption that no additional releases from the landfill occur.

The area of lower levels of TCE in the alluvial aquifer, which lies outside of the target treatment area, and the bedrock aquifer are expected to meet ARARs within 20 years. This time was estimated based on a batch flushing model of constituent reduction per pore volume exchange (Table 12-2) and assumes that the landfill cap prevents further leaching of constituents to the groundwater. As discussed previously, the time estimates are for comparative purposes only. Key assumptions of the model are stated in Table 12-2.

Location-Specific ARARs. Location-specific ARARs for this alternative are also action-specific ARARs, as described in the following section.

Action-Specific ARARs. The main action-specific ARAR are the requirements for underground injection. The state of West Virginia regulates underground injection under Title 47 of the Code of State Rules (CSR) Series 13, Underground Injection Control. The substantive requirements of the program must be met even though NPL sites are not required to obtain permits. New injection wells can be regulated by permit or by rule under this regulation. Requirements can include adhering to well construction specifications codified in the rule, conducting monitoring of the well to ensure that no adverse affects to groundwater sources have occurred, the maintenance of operational data regarding injection flow, and the reporting of any activities conducted that are not compliant with the regulation.

Erosion and sediment controls are action-specific ARARs as well as location-specific ARARs. These controls would be used during construction of the injection wells to prevent adverse effects on the river. Therefore, the requirements of the Wild and Scenic Rivers Act (16 USC 1271 et seq. and Section 7(a)) would be met. Well construction spoils would be disposed in accordance with solid waste disposal regulations. It is anticipated that these soils would be disposed offsite as a hazardous waste.

12.2.2.3 Long-Term Effectiveness and Permanence

Magnitude of Residual Risks. TCE is expected to decline from the current maximum concentration of about 100 µg/L to the MCL of 5 µg/L over a several-year period within the substrate injection area. Outside the injection zone, natural attenuation is expected to reduce TCE to below the MCL over a longer period, as previously discussed. Iron and manganese concentrations may persist beyond the 20-year TCE-remediation timeframe because of reducing conditions in alluvial groundwater beneath the landfill. As noted above, the injection of substrate would cause further reducing conditions and result in higher iron and manganese concentrations in the groundwater. Iron and manganese concentrations would decline over time because of a decrease in leachate production from the landfill, but it would likely take many years for these concentrations to meet PRGs.

ICs would prevent human exposure to groundwater. Any risk associated with migration to the river would be reduced as TCE is removed via ERD and natural attenuation. If elevated iron and manganese concentrations caused by substrate injection migrate to the river, the impacts on the river are not expected to be significant because of dilution in the river water, although orange staining along the river bank might occur from the oxidation of the iron as it discharges to the river.

Adequacy and Reliability of Controls. The ICs are expected to be adequate and reliable particularly given the lack of a need for this groundwater as a potable source during the foreseeable future. Groundwater monitoring is adequate and can be reliably used to track groundwater quality and constituent migration. The adequacy of groundwater use restrictions is based on their continued implementation. Use restrictions, which restrict future installation or use of wells for potable water must be enforced until groundwater monitoring indicates natural processes have resulted in the groundwater RAOs being met.

Current groundwater and river monitoring activities are considered adequate and can be reliably used to track groundwater and river quality and constituent migration. An evaluation of the existing monitoring well network may be warranted for implementation of this alternative, to maximize the efficiency of the associated monitoring and analytical protocol.

Substrate injection to enhance RD applications has been shown to effectively treat chlorinated VOCs, including TCE. For implementation of this technology at Site 5, the particular substrate to be injected that would be both effective and economical would have to be selected. Pilot testing may be recommended to determine the technology's effectiveness in meeting the PRGs for Site 5 groundwater. In the event that the landfill continues to release VOCs to groundwater, re-injection of substrate would be needed at regular intervals to allow continued groundwater treatment. However, this is not considered likely at this time because the existing landfill cap will minimize infiltration of water through the landfill materials.

12.2.2.4 Reduction of Toxicity, Mobility, and Volume Through Treatment

The substrate injection and resulting ERD would significantly reduce the toxicity, mobility and volume of TCE in the groundwater by degrading the VOCs in the area of higher TCE concentrations in the alluvial aquifer. Nearly all the estimated 2.4 pounds of TCE within the 50 µg/L contour would be degraded. The majority of the remaining 2.5 pounds would naturally attenuate through biological degradation, geochemical processes, and volatilization. However, as noted above, further iron and manganese dissolution into groundwater would occur because of the substrate injection, and the potential exists for these constituents to migrate downgradient toward the river.

12.2.2.5 Short-Term Effectiveness

There would be a minimal effect on the ABL facility, and virtually no effect on the community during implementation of this alternative. Some drilling equipment would be required during the substrate injection process. However, this equipment would cause minimal disturbance to this industrial site.

As a result of substrate injection, there would be an adverse impact on groundwater quality because reducing conditions would be exacerbated, resulting in further dissolution of iron and manganese. The reducing conditions may also result in increased discharge of these inorganics to the river, depending on how far the reducing plume expands downgradient. Impacts on the river are not expected to be significant because of the large dilution that would occur. However, there is a potential for orange staining along the riverbank from the oxidation of the iron as it discharges to the river.

12.2.2.6 Implementability

Technical Feasibility. The most economical and effective substrate available would have to be determined for this site. There are several effective choices of substrate available commercially that will serve this purpose. In addition, pilot-scale testing may be recommended to determine the technology's effectiveness in meeting the PRGs for Site 5 groundwater. However, implementation at other sites has yielded satisfactory results. Therefore, it is likely that this technology can remediate the alluvial aquifer and attain the PRGs for TCE.

It should be noted that injection of substrate into the groundwater will cause a shift in pH and eH conditions and enhanced biological activity. These changes will cause an increase in the solubility of the naturally occurring iron and manganese in the area, and thus increase the iron and manganese concentrations.

Administrative Feasibility. Groundwater would likely remain contaminated for years under this alternative. Therefore, long-term administrative resources must be expended to conduct the 5-year site reviews required by the NCP. In addition, administrative resources would be required on an ongoing basis to administer the groundwater and river monitoring program.

The implementation of ICs under the existing IC plan may require coordination with ABL staff and local government agencies. An underground injection permit must be obtained and met and would require coordination time.

Availability of Services and Materials. A variety of environmental consultants are available to conduct the substrate injection and groundwater monitoring, and to assist in the establishment and implementation of ICs. Various organic substrates that have been used to enhance RD in groundwater are available commercially.

12.2.2.7 Cost

The capital cost of this alternative is approximately $593,000. This cost assumes that soil cuttings generated during the installation of extraction wells would be disposed offsite as a hazardous waste. The initial annual O&M cost is estimated to be $186,000. The cost comprises four quarterly groundwater monitoring events performed in the first 2 years after injection of the substrate. The quarterly monitoring events would be conducted to assess whether the substrate is coming into contact and having an effect on the TCE concentrations in the groundwater. This quarterly assessment will allow for the injection of additional substrate, if necessary, early in the remediation effort. For cost estimating purposes, no subsequent substrate injections are assumed. Following the first 2 years of quarterly monitoring, the frequency of subsequent monitoring would be scaled back to tri-quarterly during Years 3 through 10, equating to an annual O&M cost of $59,000. Bi-annual monitoring would be performed during Years 11 through 25, resulting in annual O&M costs of $26,000. Post-closure costs, estimated at $98,000, comprise abandonment of injection wells and preparation of a Closure Report. The present worth, assuming a 25-year project life (21 years plus an additional 4 years of monitoring), is $1,602,000. The cost estimate details are provided in Appendix L.

12.2.3 Alternative 3—Permeable Reactive Barrier

This alternative is described in detail in Section 11. It consists of installing a PRB within the most contaminated portion of the alluvial aquifer, with simultaneous natural attenuation in the remainder of the alluvial aquifer and bedrock aquifer. Groundwater use restrictions and groundwater and river monitoring would continue to be implemented as in Alternative 2 to monitor the effectiveness of the PRB and compliance with RAOs until remediation is complete.

12.2.3.1 Overall Protection of Human Health and the Environment

Alternative 3 is considered protective of human health and the environment. The groundwater constituents are not currently posing a risk and the groundwater use restrictions would prevent future exposure to the groundwater. The most heavily contaminated portion of the alluvial aquifer would be remediated as it passes through the PRB. The PRB would also result in metals removal due to the pH shift within the barrier. The discharge of constituents to the river from areas sidegradient of the hypothetical barrier is likely to be undetectable and is not expected to pose a risk to human health or the environment. Long-term monitoring would verify this assumption.

The RAO of returning TCE concentrations in groundwater to the MCL in a reasonable time period would also be met, as further discussed below in Section 12.2.3.2, Chemical-Specific ARARs. Because the landfill cap will minimize leachate production, reducing conditions beneath the landfill will decline over time, reducing the extent of iron and manganese dissolution in groundwater. It is not clear how long iron and manganese concentrations would remain above PRGs. The PRB system would not be expected to increase or decrease the mobility of iron and manganese in groundwater to an appreciable extent. In spite of the

elevated iron and manganese concentrations, Alternative 3 would achieve site-specific RAOs because ICs would prevent exposure to groundwater.

The estimated time frame for TCE remediation is considered reasonable for Site 5 because the groundwater is not currently used and any future water needs by the facility can be met by wells located elsewhere at the facility or by other means. Contamination in the bedrock aquifer should be removed in a comparable time period via natural attenuation alone.

12.2.3.2 Compliance with ARARs

As described below, Alternative 3 complies with all ARARs.

Chemical-Specific ARARs. The aquifers would remain out of compliance with chemical-specific ARARs in the short term because the constituents listed in Table 10-1 would remain present at concentrations above their PRGs. However, the PRB would likely reduce the upgradient TCE to below the PRG, and would also cause precipitation and, hence, removal of dissolved iron and manganese.

It is estimated that chemical-specific ARARs would be met in the alluvial aquifer in approximately 16 years with this alternative. This time was estimated based on a batch flushing model of constituent reduction per pore volume exchange (Table 12-2) and assumes that the landfill cap prevents further leaching of constituents to the groundwater. As discussed previously, the time estimates are for comparative purposes only. Assumptions are listed in Table 12-2, with a most critical assumption being that there is no continuing source.

Location-Specific ARARs. Location-specific ARARs for this alternative are also action-specific ARARs, as described in the following section.

Action-Specific ARARs. Erosion and sediment controls are action-specific ARARs as well as location-specific ARARs. These controls would be used during construction of the PRB to prevent adverse effects on the river. Therefore, the requirements of the Wild and Scenic Rivers Act (16 USC 1271 et seq. and Section 7(a)) would be met. The reactive barrier trench spoils would be disposed in accordance with solid waste disposal regulations. It is anticipated that these soils would be disposed offsite as hazardous waste.

12.2.3.3 Long-Term Effectiveness and Permanence

Magnitude of Residual Risks. TCE is expected to decline from the current maximum concentration of about 100 µg/L to the MCL of 5 µg/L during the remediation period within the area between the landfill and the PRB, assuming no further releases of TCE from the landfill. Dissolved iron and manganese would also be precipitated by the barrier. Downgradient of the PRB, the TCE should naturally attenuate in less time because the constituent migration time to the river is less in this area. Also the bedrock aquifer is expected to remediate more rapidly because of the higher groundwater velocities and lower adsorption expected in the bedrock fractures. Iron and manganese concentrations may persist beyond the TCE remediation timeframe (16 years) because of reducing conditions in alluvial groundwater beneath the landfill. However, these concentrations will decline over time because of a reduction in leachate generated from the landfill.

Following implementation of this alternative, the potential for future exposures to contaminated groundwater would be minimized. ICs would continue to operate as under Alternative 2.

Offsite migration of alluvial aquifer constituents will be minimized. The PRB system would remediate the upgradient constituents to below the PRGs. Constituent concentrations in the groundwater and the river would be monitored to identify constituent fluctuations and potential impacts on the river. Therefore, the risks associated with continued migration would be reduced.

Adequacy and Reliability of Controls. As with Alternative 2, the ICs are expected to be adequate and reliable, and groundwater monitoring is adequate and can be reliably used to track groundwater quality and constituent migration.

PRBs have been shown to be effective in abiotically degrading chlorinated solvents. Extensive laboratory testing has shown the process to be particularly effective in degrading the halogenated ethene series of compounds, including TCE. Numerous-full scale systems have been constructed with promising results. In the event that the landfill continues to release VOCs to groundwater, the PRB may have to be replaced after 20 years. Prior to full-scale implementation of this technology at Site 5, laboratory and pilot-scale testing should be conducted to determine the technology's effectiveness in meeting the PRGs for Site 5 groundwater.

12.2.3.4 Reduction of Toxicity, Mobility, and Volume Through Treatment

The PRB system would significantly reduce the toxicity, mobility and volume of constituents in the groundwater by destroying the VOCs as they migrate through the PRB. The mobility of the iron and manganese would not be expected to change significantly under this alternative.

12.2.3.5 Short-Term Effectiveness

There would be a minimal effect on the ABL facility, and virtually no effect on the community during implementation of this alternative. Large construction equipment would be required in order to install the PRB system. However, Site 5 is fairly isolated from the remainder of the facility.

12.2.3.6 Implementability

Technical Feasibility. Laboratory and field-scale testing should be conducted prior to the full-scale implementation of the PRB technology. Implementation of PRB has been successful at many sites, but the technology has failed at some sites because of groundwater geochemical factors, seasonal variations in hydraulic conditions, and the presence of subsurface obstacles (USEPA, 2002b). Laboratory and field-scale testing would be required to further assess the technical feasibility of PRB implementation at Site 5.

Administrative Feasibility. Groundwater would likely remain contaminated for years under this alternative. Therefore, long-term administrative resources would be required similar to those under Alternative 2, but within a potentially shorter time period.

The issues associated with implementation of ICs under the existing IC plan would be similar to those under Alternative 2.

Availability of Services and Materials. The PRB system is a proprietary technology, available only through ETI. The Navy would be required to pay licensing fees to ETI for use of the technology.

12.2.3.7 Cost

The capital cost of this alternative is approximately $617,000, and includes treatability testing, pilot- and full-scale construction of the PRB system, and miscellaneous construction items. This cost assumes that excess soil generated during the installation of the PRB system would be disposed offsite as a hazardous waste.

O&M costs consist primarily of field labor and analytical costs to collect groundwater data, and office labor to analyze trends and prepare a monitoring report after each monitoring event. For the cost-estimating purposes, the monitoring frequency for Alternative 3 is assumed to be tri-quarterly for the first 10 years, followed by bi-annually for the remaining 10 years. The annual O&M cost is estimated to be $66,000 for the first 10 years and $26,000 for the remaining 10 years. Post-closure costs, estimated at $23,000, comprise preparation of a Closure Report. The present worth, assuming a 30-year project life, is $1,347,000. The cost estimate details are provided in Appendix L.

12.2.4 Alternative 4—Groundwater Collection and Treatment

This alternative is described in detail in Section 11. It consists of installing extraction wells in the alluvial aquifer and inducing an upward gradient through the underlying bedrock aquifer. VOCs in the extracted groundwater would be treated by air stripping in an aeration channel prior to discharge to the North Branch Potomac River.

Groundwater use restrictions would continue to be implemented and groundwater and river monitoring would be conducted as in Alternative 2 until groundwater remediation is complete.

12.2.4.1 Overall Protection of Human Health and the Environment

Alternative 4 is considered protective of human health and the environment. The groundwater VOCs are not currently posing a risk and the groundwater use restrictions

would prevent future exposure to the groundwater. The alluvial and bedrock aquifer groundwater would be collected and treated.

The RAO of returning TCE concentrations in groundwater to the MCL in a reasonable time period is also likely to be met, as discussed below in Section 12.2.4.2, Chemical-Specific ARARs. Because the landfill cap will minimize leachate production, reducing conditions beneath the landfill will decline over time, reducing the extent of iron and manganese dissolution in groundwater. It is not clear how long iron and manganese concentrations would remain above PRGs. In spite of the elevated iron and manganese concentrations, Alternative 4 will achieve site-specific RAOs because ICs would prevent exposure to groundwater.

12.2.4.2 Compliance with ARARs

Alternative 4 complies with all ARARs.

Chemical-Specific ARARs. The aquifers would remain out of compliance with chemical-specific ARARs in the short term because the constituents listed in Table 10-1 would remain present at concentrations above their PRGs.

In this alternative, extracted groundwater from the alluvium would be discharged to the North Branch Potomac River. Chemical-specific ARARs for surface water discharge require that constituent concentrations meet federal and state discharge limits. The preliminary surface water discharge limits discussed in Section 11 indicate that if any treatment prior to discharge is required at all, TCE would likely be the only constituent requiring treatment. An aeration channel would likely be capable of reducing TCE concentrations in the effluent to meet the discharge limit.

The groundwater collection and treatment system may reduce the COCs to their PRGs within a reasonable time period, assuming no further source release and desorption take place. The landfill cap installed on the landfill contents in 1997 should prevent or minimize constituent leaching and future groundwater contamination. The batch flushing model (Table 12-2) predicted a cleanup time of 3 years. However, previous experience with groundwater extraction systems suggests that the time to remediation may be significantly longer, particularly if TCE continues to be released from the landfill or if desorption of TCE from the aquifer matrix is slower than modeled. In addition, data collected as part of the groundwater collection and treatment remedy at ABL Site 1 and Site 10 suggest that actual site conditions at ABL may retard cleanup of dissolved-phase VOC contamination. As such, for cost estimating purposes, an assumption was made that the extraction system would have to run for at least 7 years to attain PRGs.

As previously discussed, the time estimates based on the batch flushing model are for comparative purposes only and are not viewed as accurate estimates of actual times to achieve the PRGs, partly due to the model's assumptions of aquifer homogeneity. Assumptions are listed in Table 12-2, with a most critical assumption being that there is no continuing source of contamination.

Location-Specific ARARs. Location-specific ARARs for this alternative are also action-specific ARARs, as discussed below.

Action-Specific ARARs. Erosion and sediment controls are action-specific ARARs as well as location-specific ARARs that would be implemented to avoid adverse affects on the North Branch Potomac River during construction (Wild and Scenic Rivers Act (16 USC 1271 et seq. and Section 7(a))). Well construction spoils would be disposed in accordance with solid waste disposal regulations. It is anticipated that these soils would be disposed offsite as hazardous waste.

The plume associated with Site 5 is partially located in the 100-year flood plain of the river. According to 40 CFR 264.18(b), any facilities constructed in the flood plain of a scenic river must be designed to avoid washout. The modification of the aeration/rip-rap channel along the riverbank would be constructed to withstand potential buoyant forces produced by floodwaters. Therefore, this ARAR would be met.

12.2.4.3 Long-Term Effectiveness and Permanence

Magnitude of Residual Risks. TCE is expected to decline from the current maximum concentration of about 100 µg/L to the MCL of 5 µg/L during the remediation period, assuming no further releases of TCE from the landfill. Iron and manganese concentrations in the groundwater would be lowered as a result of the groundwater extraction activities, but reducing conditions beneath the landfill could persist after TCE remediation timeframe of 7 years, possibly resulting in iron and manganese concentrations above PRGs immediately downgradient from the landfill. The long-term monitoring program currently in place would ensure bedrock aquifer constituents do not adversely affect river water quality. As with Alternative 2, ICs would prevent human exposure to groundwater. No residual risk would remain at Site 5 following completion of remediation.

Adequacy and Reliability of Controls. The groundwater extraction system would adequately control the residual risk associated with groundwater contamination. In the event that the landfill continues to release VOCs to groundwater, Alternative 5 could be used to continue treatment of groundwater in the future. As with Alternative 2, the ICs are expected to be adequate and reliable, and groundwater and river monitoring is adequate and can be reliably used to track groundwater and river quality and constituent migration.

12.2.4.4 Reduction of Toxicity, Mobility, and Volume Through Treatment

The groundwater extraction system would significantly reduce the mobility of constituents in the groundwater by creating a hydraulic barrier to downgradient migration. The aeration channel would reduce the toxicity and volume of contamination by remediating the groundwater to applicable discharge limits, as previously discussed in Section 11. About 90 percent all the estimated 4.9 pounds of TCE in the plume would be collected and removed from the groundwater. The remaining 10 percent of TCE would remain in groundwater at concentrations below the MCL and naturally attenuate over time. Iron and manganese concentrations would likely decrease, but may remain at concentrations above PRGs after TCE concentrations in groundwater have been reduced to the MCL.

12.2.4.5 Short-Term Effectiveness

There would be no significant effects on the ABL facility during implementation of this alternative. Site 5 is located a significant distance from the majority of the developed portion

of the facility. Construction activities would be limited, consisting only of extraction well, piping, and aeration channel installation.

12.2.4.6 Implementability

Technical Feasibility. There are no known technical difficulties associated with installation of the groundwater extraction system. Extraction wells can easily be installed and effectively operated. The existing rip-rap channel can be utilized, with minor modification, as an aeration channel to provide air stripping capability. Thus, this alternative involves minimal operational requirements. Aquifer testing and modeling should be performed prior to designing the system in order to determine the most effective configuration of the extraction wells.

Administrative Feasibility. Groundwater would remain contaminated over the short term with this alternative. Therefore, long-term administrative resources must be expended to conduct the 5-year site reviews required by the NCP. Administrative resources would also be required to administer the O&M of the extraction system. Also the substantive requirements for obtaining a discharge permit must be met and would require coordination time.

Availability of Services and Materials. Many drillers and contractors are available to install the extraction and treatment system.

12.2.4.7 Cost

The capital cost of this alternative includes the extraction wells and pumps, discharge pipeline, and, potentially, modification of the rip-rap channel. The capital cost is estimated to be $1,272,000. This cost assumes that soil cuttings generated during the installation of extraction wells would be disposed offsite as a hazardous waste. O&M costs include an allowance for regular well preventative maintenance, cleaning, and refurbishment, tri-quarterly groundwater data collection and laboratory analysis, and electrical costs to operate the extraction pumps. The annual O&M cost is estimated to be $109,000. Post-closure costs, estimated at $47,000, comprise decommissioning the groundwater extraction system and preparing a Closure Report. The present worth, assuming a 7-year project life, is $1,984,000. The cost estimate details are provided in Appendix L.

12.3 Comparative Analysis of Remedial Alternatives

In the following analysis, the remedial alternatives are evaluated in relation to one another based on each of the seven criteria. The purpose of this analysis is to identify the relative advantages and disadvantages of each alternative. The groundwater alternatives are listed below to assist in the clarity of this discussion:

- Alternative 1—No Action
- Alternative 2—Enhanced Reductive Dechlorination (ERD)
- Alternative 3—Permeable Reactive Barrier (PRB)
- Alternative 4— Groundwater Extraction and Treatment

It is apparent from the previous evaluation of the remedial alternatives that the performance of the majority of the alternatives is somewhat similar. Therefore, the comparative analysis will focus on factors that provide distinctions between the alternatives.

12.3.1 Protection of Human Health and the Environment

As presented in Section 10, the site-specific RAOs for Site 5 groundwater are to:

- Prevent or minimize exposure of potential future onsite residents to contaminated groundwater originating from Site 5 at concentrations exceeding MCLs or, in the absence of MCLs, an ELCR of 1×10^{-4} to 1×10^{-6} or a HI = 1.
- Prevent or minimize river media from becoming impacted by the Site 5 groundwater COCs such that resulting concentrations present an unacceptable risk to human health or the environment.
- Return groundwater beyond the landfill boundaries to MCLs.

Alternative 1 will not meet either of the first two RAOs because it does nothing to minimize exposure to the groundwater or return the COCs in groundwater to concentrations below cleanup criteria. As a result, Alternative 1 is not considered protective of human health. Alternatives 2 through 4 meet the RAOs and are protective of human health and the environment because they prevent exposure to groundwater exceeding cleanup criteria and result in meeting the cleanup goals for TCE in groundwater within time periods considered reasonable. Although it is not believed that any of the alternatives will reduce iron and manganese concentrations to PRGs within their respective TCE-remediation timeframes, Alternatives 2 through 4 will achieve site-specific RAOs because ICs will prevent exposure to groundwater. Alternative 2 will temporarily increase iron and manganese concentrations by promoting further reducing conditions beneath the landfill.

Any alternative other than Alternative 1 will achieve all RAOs. Alternatives 2 and 3rely in part on natural attenuation to return TCE concentrations to MCLs. Alternative 4 is most protective because it relies on ICs minimally and, according to the batch flushing model, potentially provides the most rapid cleanup time. However, given the relatively small potential for exposure to the groundwater from this controlled site and the lack of impacts on the river from discharge of contaminated groundwater, the differences between the alternatives relative to overall protectiveness are not substantial.

12.3.2 Compliance with ARARs

As described below, all alternative other than Alternative 1 (No Action) meet ARARs.

Chemical-Specific ARARs. With the exception of Alternative 1, all of the other alternatives would achieve chemical-specific ARARs within a reasonable timeframe.

Location-Specific ARARs. Location-specific ARARs for all alternatives can easily be met with proper planning.

Action-Specific ARARs. There are no action-specific ARARs for Alternative 1.

The State of West Virginia Groundwater Protection Act (§47CSR58-8.1.2) requires that cleanup actions shall not rely primarily on dilution and dispersion if active remedial

measures are technically and economically feasible. Alternative 2 relies on natural attenuation processes to remediate groundwater contamination in the alluvial aquifer; Alternatives 2 through 4 rely on natural attenuation to some degree for remediation of the alluvial and/or bedrock aquifers. While dilution and dispersion will occur, biological degradation, geochemical processes, and volatilization will also contribute to reductions in VOC concentrations.

There are action-specific ARARs associated with Alternatives 2, 3, and 4; however, all these ARARs will be met by each alternative.

12.3.3 Long-Term Effectiveness and Permanence

With the exception of Alternative 2, all of the alternatives will provide relatively equal effectiveness and permanence in risk reduction over the long-term. The magnitude of residual risk is the same under Alternatives 1, 3, and 5 because they all will result in achieving the TCE cleanup goals in groundwater. Alternative 2 may result in increased concentrations and mobility of iron and manganese that could persist after TCE has been remediated to the MCL. Although it is not clear how long iron and manganese concentrations would remain above PRGs, Alternatives 2 through 4 would achieve site-specific RAOs.

The adequacy and reliability of controls is similar for Alternatives 2 through 4 because each relies on ICs to prevent exposure to the groundwater during the period of time required to achieve the cleanup goals. While some alternatives show potentially shorter times for TCE remediation than others, this is not considered a significant difference because there is little likelihood for residential use of Site 5 groundwater at ABL. In the event that the landfill continues to release VOCs to groundwater, Alternative 4 offers the best long-term effectiveness because it can be easily used to continue treatment of groundwater in the future. The PRB of Alternative 3 may have to be replaced after approximately 20 years. Alternative 2 is the least adaptable to continued releases because re-injection would be needed at regular intervals to allow continued groundwater treatment.

12.3.4 Reduction of Toxicity, Mobility, and Volume Through Treatment

The reduction in toxicity, mobility and volume through treatment can be compared through the amount of TCE that is removed from the aquifer and destroyed. The estimated amount and treatment time for TCE under each alternative, based on the batch flushing model, are as follows:

- Alternative 1- 4.9 pounds of TCE removed via natural attenuation over 30 years. Most removal is a result of biological degradation, geochemical processes, and volatilization.
- Alternative 2- 2.4 pounds of TCE biologically degraded over 3 years; 2.5 pounds removed via natural attenuation over 21 years.
- Alternative 3- 1.2 pounds of TCE abiotically degraded over 16 years; 3.7 pounds removed via natural attenuation over the 16-year timeframe.
- Alternative 4- 4.4 pounds of TCE removed via collection system over 7 years; 0.5 pounds removed via natural attenuation

As previously discussed, these estimates are only used for comparative purposes between alternatives and not as actual times to achieve the MCL. The model's estimated times to complete TCE remediation are driven by the assumption that there will be no additional releases from the landfill.

Under Alternatives 1 through 3, the relatively low levels of bedrock aquifer contamination would be remediated via natural attenuation. Alternative 4 actively remediates bedrock contamination to some extent via the upward gradients created by the alluvial aquifer collection system.

Although toxicity, mobility and volume of TCE would be reduced under each alternative, iron and manganese concentrations would likely remain in groundwater at concentrations exceeding PRGs beyond the TCE-remediation timeframe.

12.3.5 Short-Term Effectiveness

The most significant adverse impact related to remedy implementation is the expected increase in dissolved iron and manganese concentrations as a result of the injection of substrate under Alternative 2. The reducing conditions may also result in increased discharge of these inorganics to the river, depending on how far the reducing plume expands downgradient. Impacts on the river are not expected to be significant because of the large dilution that would occur. However, there is a potential for orange staining along the riverbank from the oxidation of the iron as it discharges to the river.

There will be no significant impact on the ABL facility during implementation of any of the alternatives. Alternative 1 will produce the least disturbance because no new construction will be required. Alternative 2 will require minimal disturbance in the source area. Alternatives 3 and 4 will produce minor disturbance during construction. However, Site 5 is in the undeveloped portion of the facility, so any disturbance will be minimal.

Estimated timeframes for TCE remediation have been previously discussed and are summarized in Section 12.3.4.

12.3.6 Implementability

There are no significant technical difficulties associated with any of the alternatives. Alternative 3 will likely be the most challenging to implement because the PRB system is a developing technology.

12.3.7 Cost

Table 12-1 presents a comparative cost summary of the alternatives. In terms of capital costs, the least costly alternative, other than No Action, is Alternative 2 – ERD ($593,000), followed by Alternative 3 - PRB ($617,000), and Alternative 4 – Groundwater Extraction ($1,272,000).

Other than No Action, the least costly present-worth cost is Alternative 3 – PRB ($1,347,000), followed by Alternative 2 – ERD ($1,602,000), and Alternative 4 – Groundwater Extraction ($1,984,000).

It should be noted that small changes in implementation (e.g., changes in monitoring frequency) will have a large impact on costs for some alternatives. Finally, it should be

noted that unknowns, particularly the actual time required to remediate the site under each alternative, could have a significant impact on the cost.

TABLE 12-1
Detailed Evaluation of Remedial Alternatives Summary
Final Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Evaluation Criteria	Alternative 1 No Action	Alternative 2 Enhanced Reductive Dechlorination	Alternative 3 Permeable Reactive Barrier (PRB)	Alternative 4 Groundwater Extraction and Treatment
Overall Protection of Human Health and the Environment				
Prevent or Minimize Exposure to Contaminated Groundwater by future onsite residents	No reduction in risk of exposure over current levels.	Groundwater use restrictions will minimize potential for exposure and ERD in the source area will prevent spread of VOC contamination further downgradient. Contamination in groundwater sidegradient of the treatment area and in the bedrock is to naturally attenuate.	Groundwater use restrictions will minimize potential for exposure and PRB will prevent spread of VOC contamination downgradient. Contamination in groundwater downgradient of PRB and in the bedrock is to naturally attenuate.	Groundwater use restrictions will minimize potential for exposure and will and alluvial aquifer extraction will prevent spread of COC contamination. Also will result in collection of bedrock groundwater via induced upward gradients
Prevent or minimize river media from becoming impacted by the Site 5 groundwater COCs such that resulting concentrations present an unacceptable risk to human health or the environment.	Contamination would continue to migrate at present levels. These levels currently do not pose an unacceptable risk to human health or the environment. Natural attenuation will occur without monitoring.	ERD in the source area coupled with attenuation minimizes possibility of offsite migration from alluvium. Migration of alluvial contamination sidegradient of treatment area and in the bedrock would continue until naturally attenuated; monitoring would be used to track constituent concentrations and migration and ensure concentrations in river do not pose an unacceptable risk.	PRB prevents river contamination from site alluvium. Migration of alluvial contamination downgradient of PRB and in the bedrock would continue until naturally attenuated; monitoring would be used to track constituent concentrations and migration and ensure concentrations in river do not pose an unacceptable risk.	Alluvial aquifer extraction system will prevent offsite migration. Also will result in collection of bedrock groundwater via induced upward gradients; monitoring would be used to track constituent concentrations and migration and ensure concentrations in river do not pose an unacceptable risk.
Return Groundwater to PRGs within a Reasonable Time Frame (estimate based on batch flushing method and assumptions, see Table 12-2)	Natural attenuation should reduce TCE to MCL in 30 years assuming no further releases from the landfill and linear desorption. Iron and manganese concentrations may persist at concentrations exceeding PRGs.	ERD in combination with natural attenuation should reduce TCE to MCL in 21 years assuming no further releases from the landfill and linear desorption. This is considered a reasonable time given the low potential for exposure. Iron and manganese concentrations may persist at concentrations exceeding PRGs, but ICs will prevent exposure to groundwater.	The PRB in combination with natural attenuation should reduce TCE to MCL in 16 years assuming no further releases from the landfill and linear desorption. This is considered a reasonable time given the low potential for exposure. Iron and manganese concentrations may persist at concentrations exceeding PRGs, but ICs will prevent exposure to groundwater.	The groundwater collection and treatment system is estimated to reduce TCE to MCL in 7 years assuming no further releases from the landfill and linear desorption. Iron and manganese concentrations may persist at concentrations exceeding PRGs, but ICs will prevent exposure to groundwater.

TABLE 12-1
Detailed Evaluation of Remedial Alternatives Summary
Final Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Evaluation Criteria	Alternative 1 No Action	Alternative 2 Enhanced Reductive Dechlorination	Alternative 3 Permeable Reactive Barrier (PRB)	Alternative 4 Groundwater Extraction and Treatment
Compliance With ARARs				
ARARs	Does not comply with ARARs	Meets ARARs. Will meet substantive requirements of injection permit.	Meets ARARs.	Meets ARARs. Will meet substantive requirements of discharge permit.
Long-Term Effectiveness and Permanence				
Magnitude of Risks	Current conditions.	ERD should reduce TCE more quickly than attenuation alone. However, iron and manganese concentrations increase during ERD implementation. Potential risks are minimized by ICs.	PRB should reduce COC concentrations more quickly (roughly 16 years) than natural attenuation alone. Iron and manganese concentrations may persist at concentrations exceeding PRGs. Potential risks are minimized by ICs.	Extraction would reduce TCE concentrations and possibly iron and manganese concentrations. However, iron and manganese concentrations may persist at concentrations exceeding PRGs. Risks are minimized by ICs.
Adequacy and Reliability of Controls	No controls.	Substrate injection has been proven to be effective at various sites. IC plan is expected to reliably prevent exposure to groundwater until TCE MCL is achieved. In the event of continued releases from the landfill additional substrate injections would be required.	PRBs have been proven to be effective at various sites. IC plan is expected to reliable prevent exposure to groundwater until TCE MCL is achieved. In the event of continued releases from the landfill, the PRB may require replacement after about 20 years.	Groundwater collection and treatment are effective for removing VOCs and some iron and manganese from groundwater. IC plan is expected to reliably prevent exposure to groundwater until cleanup goals are achieved. Possibility that ICs can be lifted more quickly than with other alternatives. If TCE continues to be released from the landfill or aquifer material groundwater collection can easily be continued as necessary.

TABLE 12-1
Detailed Evaluation of Remedial Alternatives Summary
Final Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Evaluation Criteria	Alternative 1 No Action	Alternative 2 Enhanced Reductive Dechlorination	Alternative 3 Permeable Reactive Barrier (PRB)	Alternative 4 Groundwater Extraction and Treatment
Reduction of Toxicity, Mobility, or Volume Through Treatment				
Estimated amount of TCE removed and treatment time.	Natural attenuation will remove the estimated 4.9 pounds of TCE over 30 years. Contaminated groundwater will continue to migrate to the river at low levels until naturally attenuated. No active remediation.	ERD will biologically degrade an estimated 2.4 pounds of TCE. The remaining 2.5 pounds of TCE in the alluvial aquifer will naturally attenuate over 21 years. TCE in the bedrock aquifer and metals will naturally attenuate.	The PRB will abiotically degrade an estimated 1.2 pounds of TCE. The remaining 3.7 pounds of TCE in the alluvial aquifer will naturally attenuate over 16 years. TCE in the bedrock aquifer and metals will naturally attenuate.	The groundwater collection system will remove nearly all the estimated 4.9 pounds of TCE from the aquifer within 7 years. The cascade aeration channel will result in treatment of about 90% or 4.4 pounds of TCE. The removed TCE will be transferred to the air where it will photolytically degrade.
Short-Term Effectiveness				
Impacts on workers, the community and the environment during implementation.	Not relevant.	Impacts on the facility would be minor, and consist primarily of increased activity in the area. ERD will result in increase in iron and manganese in aquifer which are expected to persist and cause objectionable taste long after the TCE has been reduced to MCLs. Also ERD may result in iron staining along the banks of the river.	Impacts on the facility would be minor, and consist primarily of temporary increase in construction traffic.	Impacts on the facility would be minor, and consist primarily of temporary increase in construction traffic.
Time Until Action Is Complete (Estimate based on batch flushing method and assumptions, see Table 12-2)	Not applicable.	Estimated at 3 years within injection zone (area of highest levels of contamination). Estimated at 21 years for TCE remediation of plume.	Estimated at approximately 16 years for TCE remediation of plume.	Estimated at approximately 7 years for TCE remediation of plume, provided all assumptions are met and no additional TCE is released from the landfill or aquifer material.
Implementability				
	Not applicable.	Implementation is simple and straightforward. Easily constructed; minimal operational requirement.	Laboratory/pilot scale testing is required. Easily constructed; minimal operational requirement.	Easily constructed and operated. Aquifer testing activities required prior to final design.

TABLE 12-1
Detailed Evaluation of Remedial Alternatives Summary
Final Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Evaluation Criteria	Alternative 1 No Action	Alternative 2 Enhanced Reductive Dechlorination	Alternative 3 Permeable Reactive Barrier (PRB)	Alternative 4 Groundwater Extraction and Treatment
		Cost		
Capital Cost	$0	$593,000	$617,000	$1,272,000
Annual O&M Cost	$0	$186,000 (Years 1 and 2) $59,000 (Years 3 through 10) $26,000 (Years 11 through 25)	$66,000 (Years 1 through 10) $26,000 (Years 11 through 20)	$109,000 (Years 1 through 7)
Post-Closure Cost	$0	$98,000	$23,000	$47,000
Present-Worth	$0	$1,602,000	$1,347,000	$1,984,000

TABLE 12-2
Estimated Time to Achieve TCE MCL in Alluvial Aquifer
Using Batch Flushing Method
Focused RI/FS
Stie 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

		Pore Volumes	Alt 1 No Action	Alt 2 ERD	Alt 3 PRB	Alt 4 GW Collection/ Treatment
Alluvial Aquifer TCE Plume Area (sf)[a]			240,000	165,000	140,000	240,000
TCE Plume Thickness (ft)			10	10	10	10
TCE Plume Aquifer Volume (gal)			3,590,400	2,468,400	2,094,400	3,590,400
Soil density(gr/cm3)- p	1.88					
Effective Porosity- n_e	0.2					
f_{oc}	0.002					
TCE K_{oc}	170					
TCE K_d (mL/gr) = K_{oc} * f_{oc}	0.34					
TCE R=1+ p(K_d/ne)	4.20					
TCE Drinking Water MCL (ug/L)			5	5	5	5
TCE Cw initial (ug/l)[b]		0	69	32	69	69
Cw @ PV1		1	53	24	53	53
Cw @ PV2		2	40	19	40	40
Cw @ PV3		3	30	14	30	30
Cw @ PV4		4	23	11	23	23
Cw @ PV5		5	18	8	18	18
Cw @ PV6		6	13	6	13	13
Cw @ PV7		7	10	5	10	10
Cw @ PV8		8	8	4	8	8
Cw @ PV9		9	6	3	6	6
Cw @ PV10		10	5	2	5	5
Time to Achieve MCL-[c]						
Pore Volumes to achieve MCL			10	7	10	10
Groundwater flow rate- (gal/yr)[d]			1,300,000	810,000	1,300,000	14,000,000
Time to achieve MCL (yrs)			**28**	**21**	**16**	**2.6**

Critical Assumptions
This method is intended for use in comparing alternatives and assumes linear desorption. As a result, the estimated times may un
The mass removed is based on the amount desorbed from the aquifer matrix, and is strongly dependent on the aquifer organic con
The model does not take into account TCE attenuation due to biodegradation.

Notes:
sf = square feet
ft = feet
gal = gallons
gr/cm^3 = grams per cubic centimeter
mL = milliliters
yr = year
ug/L = micrograms per liter
MCL = maximum contaminant level
K_d = soil distribution coefficient
K_{oc} = organic carbon/water partition coefficient
f_{oc} = fraction of organic carbon
R = retardation factor
C_w = average contaminant concentration
C_w=C_o * exp((-LN(R/R-1))) * PV)
a. Plume area for Alts 2 and 5 is the entire plume (600 ft x 400 ft = 240,000 sf; Plume area for Alt 3 is area outside the 50 ug/L cont
i.e. the area outside the substrate injection area; Plume area for Alt 4 is the larger of the area upgradient of PRB
(350 ft x 400 ft = 140,000 sf) or downgradient (350 ft x 300 ft = 105,000 sf).
b. C_w for Alts 2, 4 and 5 is average of MWs (April 2001 data) within 50 ug/L contour ((96 ug/L +48 ug/L +62 ug/L)/3 = 69 ug/L);
C_w for Alt 3 is assumed to be average of MWs between the 5 and 50 ug/l contour ((17 ug/l +46 ug/L)/2 = 32 ug/L);
c. Assumes no further upgradient source contaminant loading.
d. Alt 2 and 4 Groundwater flow rate = seepage velocity x porosity x area = 217 ft/yr x 0.2 x 10 ft x 400 ft x 7.48 gal/cf = 1,300,000
Alt 3 groundwater flow rate = 217 ft/yr x 0.2 x 10 ft x 250 ft x 7.48 gal/cf = 810,000 gal/yr
Alt 5 Groundwater extraction rate = 13 wells x 2 gal/min/well x 1440 min/day x 365 days/yr = 14,000,000

SECTION 13

Summary and Conclusions of Focused FS

Based on findings of the Focused RI, a Focused FS was performed to develop RAOs, ARARs, and PRGs; develop and screen remedial technologies; and develop site-specific remedial alternatives for Site 5 groundwater. An evaluation of the analytical data for surface water and sediment indicate that existing constituent concentrations in both media do not pose a risk to human health or the environment. For this reason, no further remedial action is deemed necessary for these media and no remedial alternatives were considered. To address potential risks associated with Site 5 groundwater, four remedial alternatives were developed:

- Alternative 1—No Action
- Alternative 2—Enhanced Reductive Dechlorination
- Alternative 3—Permeable Reactive Barrier
- Alternative 4— Groundwater Extraction and Treatment

These alternatives were compared using the following seven NCP criteria:

- Protection of human health and the environment
- Compliance with ARARs
- Long-term effectiveness and permanence
- Reduction of toxicity, mobility, and volume through treatment
- Short-term effectiveness
- Implementability
- Cost

Two additional criteria, State acceptance and Community acceptance, will be addressed in a ROD for Site 5 groundwater, surface water and sediment.

Based on collective consideration of all screening criteria, Alternative 3, Permeable Reactive Barrier, provides the best value for Site 5 groundwater. Alternative 3 will meet all three RAOs presented in Section 10. The chemical-specific ARARs would be met during the remediation period. Both location-specific and action-specific ARARs would be met by Alternative 3. Previous laboratory and field applications of PRBs have shown it to be an effective treatment for the reduction of TCE. The PRB would be adequately designed to meet the remediation goals. The PRB system would significantly reduce the toxicity, mobility and volume of constituents in the groundwater by destroying the VOCs as they migrate through the PRB. There would be a minimal effect on the ABL facility, and no anticipated effect on the community during implementation of this alternative. Laboratory and field-scale testing would be required to further assess the technical feasibility of PRB implementation at Site 5. The PRB system is a proprietary technology, available only through ETI. The Navy would be required to pay licensing fees to ETI for use of the technology. The capital cost of this alternative is approximately $617,000, and includes treatability testing, pilot- and full-scale construction of the PRB system, and miscellaneous construction items. The annual O&M cost is estimated to be $66,000 for the first 10 years and

$26,000 for the remaining 10 years. Post-closure costs, estimated at $23,000, comprise preparation of a Closure Report. The present worth, assuming a 30-year project life, is $1,347,000. The cost estimate details are provided in Appendix L. Alternative 3 is the least costly, most effective alternative.

SECTION 14

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Appendix A
DPT Soil Boring Logs

PROJECT NUMBER	Boring Number: AS05 - DP01
138762.FI.MW	

SOIL BORING LOG

PROJECT : Site 5 MNA — LOCATION : Allegany Ballistics Laboratory, Rocket Center, West Virginia

ELEVATION : N/A — DRILLING CONTRACTOR : Eichelbergers

DRILLING METHOD AND EQUIPMENT USED : Geoprobe Direct Push

WATER LEVELS : N/A — START : 5/30/00 — END : 5/30/00 — LOGGER : James Hutton

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	Recovery Inches	USGS CODE	Moisture Content	Munsell Code	CORE DESCRIPTION: SOIL NAME, COLOR RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. PID (ppm)
2_ 4_	0 - 4	24"	CL CH	Moist	5YR 5/6 10YR 5/4	0 -6" Medium Sandy CLAY with 30% limestone fragments. Light Brown 6" - 24" Sandy CLAY, Moderate Yellowish Brown Sand is fine to medium grained 40% limestone fragments Lower end of spoon is more plastic in nature Spoon sample is firm through out	No readings above background level
6_ 8_	4' - 8'	12"	CH	Moist	5YR 5/6 10YR 5/4	Sandy CLAY Sand is medium grained Red mottling present with some residual redness fading into main to colors of sample. Limestone fragments present Spoon sample is soft and plastic in nature	No readings above background level
10__ 12_		48"	CH	Moist	10YR 5/4	Sandy CLAY Sand is medium grained and poorly graded Moderate Yellow Brown to Dark Yellow Orange in color 10% of limestone fragments present Sample is very firm and becomes just firm down spoon	No readings above background level
14_	12' - 15'	36"	CH	Wet	Not Recorded	Sandy CLAY Grayish Black Sand is fine to medium Up to 60% limestone fragments Sandy CLAY with cobbles cobbles are sandstone CLAY throughout spoon is plastic	No readings above Background levels
16_ 18_ 20__						Refusal at 15' (Encountering Bedrock) END OF BORING	
22_							

PROJECT NUMBER	Boring Number: AS05 - DP05
138762.FI.MW	

SOIL BORING LOG

PROJECT : Site 5 MNA — LOCATION : Allegany Ballistics Laboratory, Rocket Center, West Virginia

ELEVATION : N/A — DRILLING CONTRACTOR : Eichelbergers

DRILLING METHOD AND EQUIPMENT USED : Geoprobe Direct Push

WATER LEVELS : N/A — START : 5/31/00 — END : 5/31/00 — LOGGER : James Hutton

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	Recovery Inches	USGS CODE	Moisture Content	Munsell Code	CORE DESCRIPTION: SOIL NAME, COLOR RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. PID (ppm)
2_ 4_	0 - 4	30"	CL	Moist	5YR 3/4	Sandy CLAY with 30% limestone fragments. Light Brown Sand is fine to medium grained Spoon sample is firm through out	No readings above background level
6_ 8_	4' - 8'	48"	CH	Moist	5YR 4/4	Sandy CLAY Sand is fine to medium grained Spoon sample is firm through out	No readings above background level
10__ 12_	8' - 12'	36"	CH CH - SP	Moist	10YR 5/4 10YR 5/4	8' - 9.5' Sandy CLAY Soft Sand is medium to coarse grained and well graded Moderate Yellow Brown limestone fragments present upto 1/2" diameter 9.5' - 12' Sandy CLAY Sand is coarse grained No limestone fragments or cobbles present Sand is more prevelent in this interval	No readings above background level
14_	12' - 15.5'	36"	CH	Wet	10YR 5/4	Sandy CLAY Grayish Black Sand is coarse grained Cobbles present are sandstone Sample in spoon is soft	No readings above Background levels
16_ 18_ 20__						Refusal at 15.5' (Encountering Bedrock) END OF BORING	
22_							

	PROJECT NUMBER 138762.FI.MW	Boring Number: AS05 - DP07

SOIL BORING LOG

PROJECT :Site 5 MNA — LOCATION : Allegany Ballistics Laboratory, Rocket Center, West Virginia

ELEVATION : N/A — DRILLING CONTRACTOR : Eichelbergers

DRILLING METHOD AND EQUIPMENT USED : Geoprobe Direct Push

WATER LEVELS : N/A — START : 5/31/00 — END : 5/31/00 — LOGGER : James Hutton

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	Recovery Inches	USGS CODE	Moisture Content	Munsell Code	CORE DESCRIPTION: SOIL NAME, COLOR RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. PID (ppm)
2_ 4_	0 - 4	30"	CL	Moist		Top 8" Top soil Sandy CLAY Moderate Yellow Brown Sand is fine to medium grained Spoon sample is firm through out	No readings above background level
6_ 8_	4' - 8'	48"	CL	Moist		Sandy CLAY Sand is fine to medium grained Spoon sample is very firm through out Dry Moderate Yellow Brown	No readings above background level
10__ 12_	8' - 12'	48"	CH CH - SP	Moist		8' - 9.5' Sandy CLAY Soft Sand is fine to medium grained Moderate Yellow Brown limestone fragments present upto 1/2" diameter 9.5' - 12' Sandy CLAY Sand is coarse grained Up to 80% limestone fragments or cobbles present Dry	No readings above background level
14_	12' - 16'	40"	GW	Moist		Sand Cobbles and CLAY Sand is coarse grained Cobbles present are sandstone and limestone Sample in spoon is soft Layers interchange between clayish and cobbly Cobbles are upto 1/2" in Dia.	No readings above Background levels
16_ 18_ 20__	16' - 20'	38"	GW	Wet		Sand, Pebbles, and Clay Sand is well graded medium to coarse pebbles are sub rounded to rounded and upto 1" in diameter Spoon sample is soft	No readings above Background levels
22_						Refusal at 20' (Encountering Bedrock) END OF BORING	

	PROJECT NUMBER 138762.FI.MW	Boring Number: AS05 - DP20

SOIL BORING LOG

PROJECT : Site 5 MNA — LOCATION : Allegany Ballistics Laboratory, Rocket Center, West Virginia

ELEVATION : N/A — DRILLING CONTRACTOR : Eichelbergers

DRILLING METHOD AND EQUIPMENT USED : Geoprobe Direct Push

WATER LEVELS : N/A — START : 6/5/00 — END : 6/5/00 — LOGGER : James Hutton

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	Recovery Inches	USGS CODE	Moisture Content	Munsell Code	CORE DESCRIPTION: SOIL NAME, COLOR RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. PID (ppm)
2	0 - 2'	N/A	SL - CL	Moist	5YR 211	Silty CLAY layer, Very Organic Layer Brownish Black in color Medium Stiff	Not above background reading of 3ppm
4, 6, 8	2' - 8'	N/A	CL	Moist	5YR 4/4	Silty CLAY Medium Stiff to Stiff	Not above background reading of 3ppm
10, 12	8' - 12'	N/A	CL	Moist	5YR 4/4	Silty CLAY Moderate Brown Moist Stiff	8.3ppm
14, 16, 18	12' - 18'	N/A	SP - CL	Wet	5YR 4/4	Silty SAND with Clay Sand is porrly graded and medium grained Moderate Brown Medium Stiff	Not Recorded
	18' - 19'	N/A	GW	Saturated	N/A	Sandy GRAVEL with Silt — Gravel up to 2" in Dai. Moderate Brown — Soft	7ppm
20, 22						Refusal at 19' (Encountering Bedrock) END OF BORING	

PROJECT NUMBER	Boring Number: AS05 - DP24
138762.FI.MW	

SOIL BORING LOG

PROJECT : Site 5 MNA — LOCATION : Allegany Ballistics Laboratory, Rocket Center, West Virginia

ELEVATION : N/A — DRILLING CONTRACTOR : EICHELBERGERS

DRILLING METHOD AND EQUIPMENT USED : Geoprobe Direct Push

WATER LEVELS : N/A — START : 6/5/00 — END : 6/5/00 — LOGGER : James Hutton

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	Recovery Inches	USGS CODE	Moisture Content	Munsell Code	CORE DESCRIPTION: SOIL NAME, COLOR RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. PID (ppm)
	0 - 6"	N/A	SL	Dry	5YR 3/2	Organic Silty Soil. Grayish Brown. Moderately Stiff.	Not above background reading of 3ppm
2_ 4_ 6_ 8_	6" - 8'	N/A	GW	Dry	10YR 5/4	Gravel up to 2" in Dia. Unconsolidated Moderate Yellow Brown	Not above background reading of 3ppm
10__	8 - 10.5	N/A	GW - CL	Slightly Moist	10YR 4/2	GRAVEL with Clay Dark Yellow Brown Medium Stiff	Not above background reading of 3ppm
12_	10.5' - 12'	N/A	SL - GW	Slightly Moist	10YR 4/2	SILT with Clay, with Gravel and Sand Medium Stiff	No readings above Background levels
14_ 16_	12' - 16'	N/A	N/A	N/A	N/A	No Recovery	N/A
18_	16' - 18'	N/A	GW	Dry	10YR 4/2	GRAVEL with fine Sand and Clay Dark Yellow Brown Medium Stiff	No readings above Background levels
	18' - 19.5'	N/A	CL	Moist	5YR 3/4	Silty CLAY Moderate Brown Stiff to Medium Stiff	No readings above Background levels
20__ 22_						Refusal at 19.5' (Encountering Bedrock) END OF BORING	

Appendix B
Monitoring Well Construction Details

PROJECT NUMBER:157852.FI.WS	WELL NUMBER:5GW19

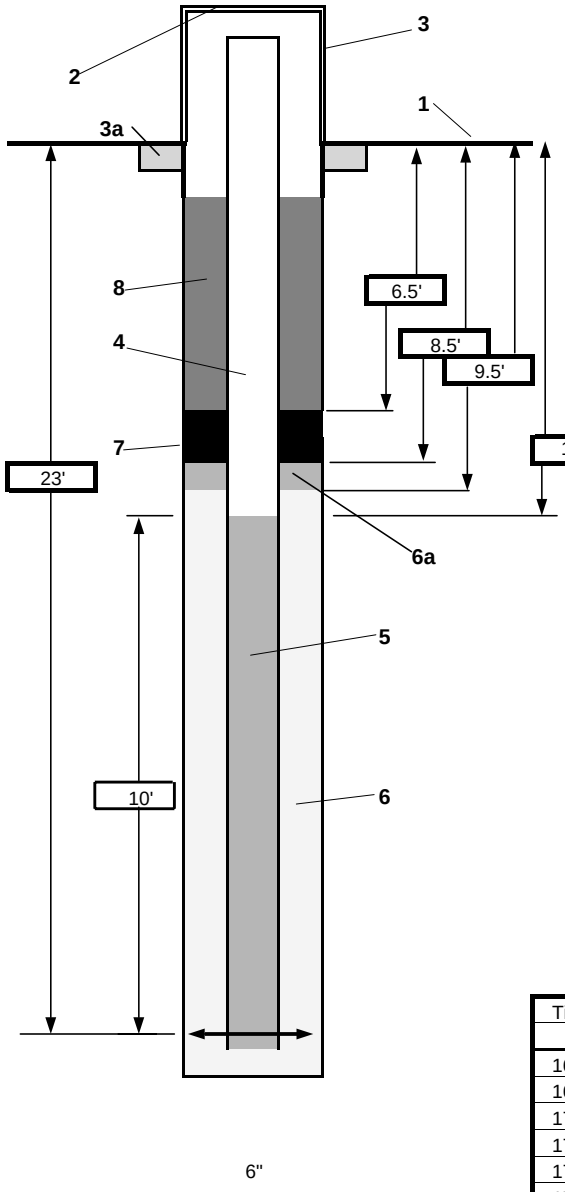
WELL COMPLETION DIAGRAM

PROJECT :Site 5, MNA Investigation — LOCATION :Allegany Ballistics Laboratory, Rocket Center, West Virginia

DRILLING CONTRACTOR :Eichelbergers

DRILLING METHOD AND EQUIPMENT USED :Schramm Model 450 Air Rig, 5&7/8" Diameter bit.

START :7/13/00 — END :7/13/00 — LOGGER : F. Calef



1- Ground elevation at well

2- Top of casing elevation

3- Wellhead protection cover type: Stick Up with Pads and Posts
(a) concrete pad dimensions

4- Dia./type of well casing: 2" Schedule PVC Riser

5- Type/slot size of screen: 10 Slot Screen
2" Schedule PVC screen

6- Type screen filter: Morie #2 Sand
a) Other type: Morie #00 (1 bag)

7- Type of seal: Bentonite Seal

8- Grout
a) Grout mix used: Grout/Bentonite
b) Method of placement: Tremmie

Development method: Purging

Development time: 1 hour and eight minutes

Estimated purge volume: Not Reported

Comments: Bedrock was encountered at 23 ft. bgs.

Time	pH	Conductivity (S/m)	Turb (NTU)	Temperature (Celcius)
1647	6.55	0.310	+999	14.97
1657	6.40	0.236	+999	14.34
1707	6.43	0.237	+999	14.06
1717	6.40	0.226	+999	14.06
1727	6.49	0.229	+999	13.66
1737	6.47	0.225	604	13.53
1747	6.16	0.225	279	13.23
1755	6.04	0.226	198	13.20

PROJECT NUMBER:157852.FI.WS	WELL NUMBER:5GW20

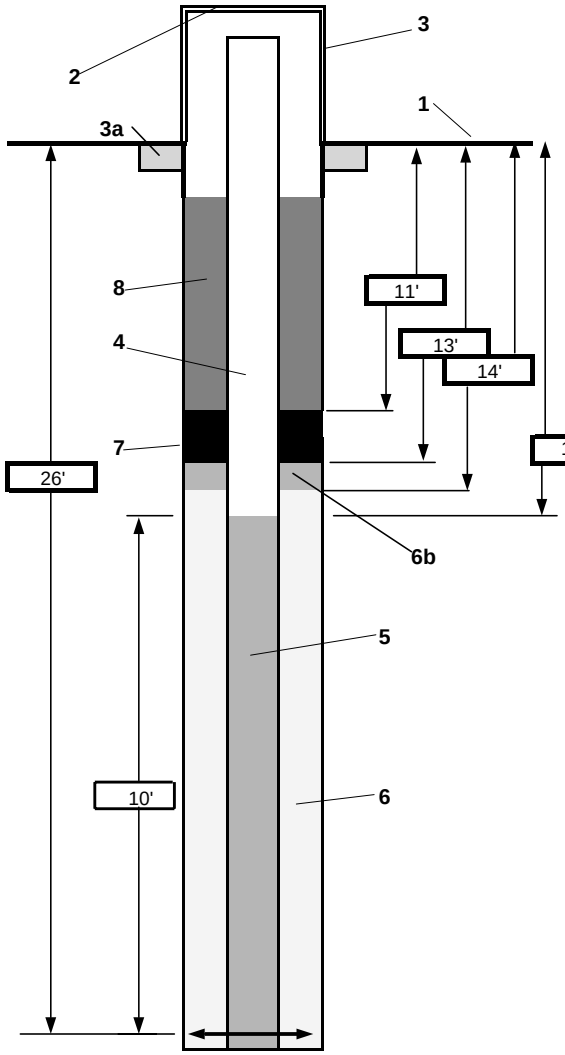
WELL COMPLETION DIAGRAM

PROJECT :ABL SWMU Investigation — LOCATION :Allegany Ballistics Laboratory, Rocket Center, West Virginia

DRILLING CONTRACTOR :Eichelbergers

DRILLING METHOD AND EQUIPMENT USED :Schramm Model 450 Air Rig, 7&7/8" Diameter bit.

WATER LEVELS : — START :7/13/00 — END :7/13/00 — LOGGER : F. Calef



1- Ground elevation at well	
2- Top of casing elevation	
3- Wellhead protection cover type	Stick Up with Pads and Posts
(a) concrete pad dimensions	
4- Dia./type of well casing	2" Schedule PVC Riser
5- Type/slot size of screen	10 Slot Screen
	2" Schedule PVC screen
6- Type screen filter	Morie #2 Sand
a) Quantity used	17 x 50lb bags
b) Other type	Morie #00 (1 bag)
7- Type of seal	Bentonite Seal
a) Quantity used	2 x 50lb bags
8- Grout	
a) Grout mix used	Grout/Bentonite
b) Method of placement	Tremmie
c) Vol. of well casing grout	38 gallons
Development method	Purging
Development time	10 minutes
Estimated purge volume	Approximately 45 gallons.
Comments	Water clears quickly
	Well surged five times.
	Bedrock encountered at 25.5 ft. bgs

Time	pH	Conductivity	DO	Temperature	Salinity
		S/m	mg/l	Celcius	per mil
0850	8.05	0.809	7.48	11.7	0.03
0855	7.96	0.798	8.32	11.9	0.03
0900	7.92	0.799	8.30	11.9	0.03

PROJECT NUMBER:157852.FI.WS	**WELL NUMBER:5GW21**

CH2MHILL

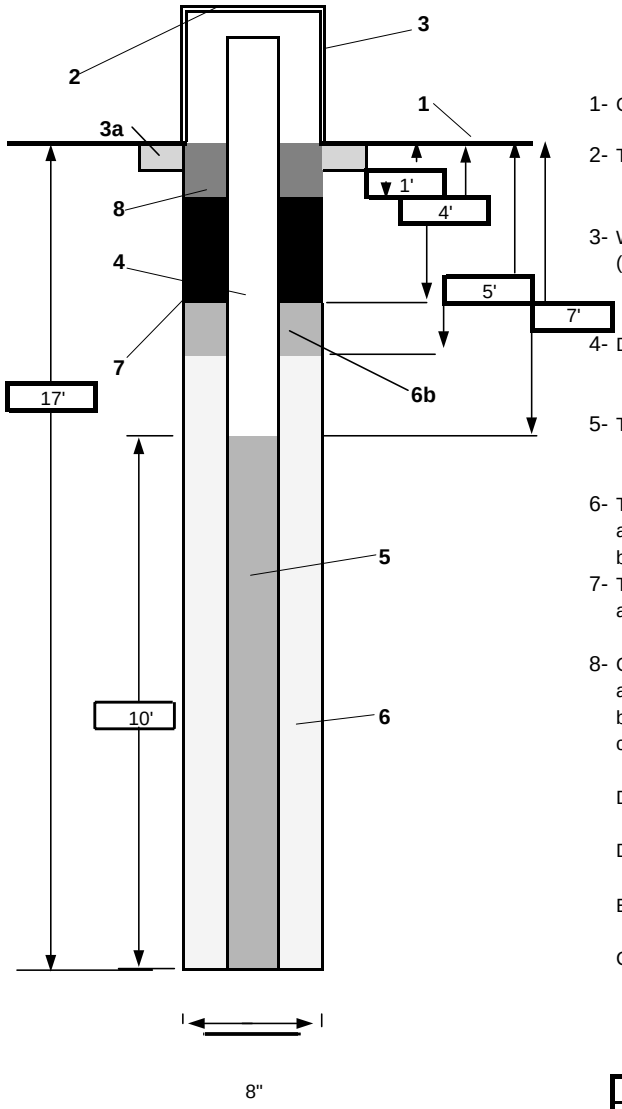
WELL COMPLETION DIAGRAM

PROJECT :ABL SWMU Investigation — LOCATION :Allegany Ballistics Laboratory, Rocket Center, West Virginia

DRILLING CONTRACTOR :Eichelbergers

DRILLING METHOD AND EQUIPMENT USED :Schramm Model 450 Air Rig, 7&7/8" Diameter bit.

WATER LEVELS : — START :7/13/00 — END :7/13/00 — LOGGER : F. Calef



1- Ground elevation at well	
2- Top of casing elevation	
3- Wellhead protection cover type	Stick Up with Pads and Posts
(a) concrete pad dimensions	
4- Dia./type of well casing	2" Schedule PVC Riser
5- Type/slot size of screen	10 Slot Screen 2" Schedule PVC screen
6- Type screen filter	Morie #2 Sand
a) Quantity used	17 x 50lb bags
b) Other type	Morie #00 (1 bag)
7- Type of seal	Bentonite Seal
a) Quantity used	2 x 50lb bags
8- Grout	
a) Grout mix used	Grout/Bentonite
b) Method of placement	Tremmie
c) Vol. of well casing grout	38 gallons
Development method	Purging
Development time	10 minutes
Estimated purge volume	Approximately 45 gallons.
Comments	Water clears quickly
	Well surged five times.
	Bedrock encountered at 17 ft. bgs

Time	pH	Conductivity	DO	Temperature	Salinity
		S/m	mg/l	Celcius	per mil
0850	8.05	0.809	7.48	11.7	0.03
0855	7.96	0.798	8.32	11.9	0.03
0900	7.92	0.799	8.30	11.9	0.03

CH2MHILL	PROJECT NUMBER:157852.FI.WS	WELL NUMBER:5GW22

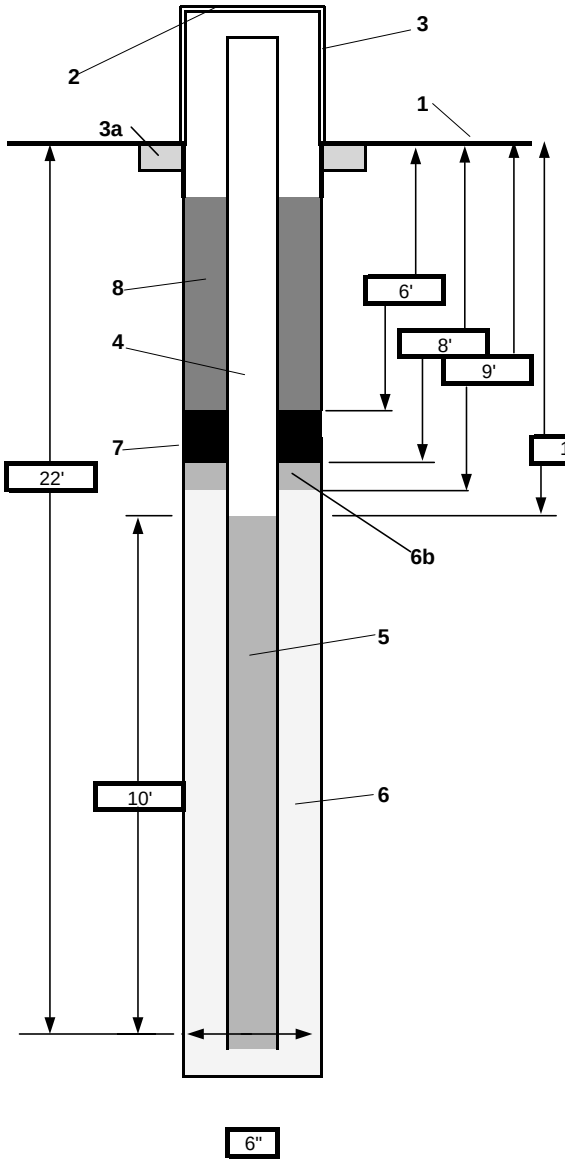
WELL COMPLETION DIAGRAM

PROJECT :ABL SWMU Investigation — LOCATION :Allegany Ballistics Laboratory, Rocket Center, West Virginia

DRILLING CONTRACTOR :Eichelbergers

DRILLING METHOD AND EQUIPMENT USED :Schramm Model 450 Air Rig, 7&7/8" Diameter bit.

WATER LEVELS : — START :7/12/00 — END :7/12/00 — LOGGER : F. Calef



1- Ground elevation at well	
2- Top of casing elevation	
3- Wellhead protection cover type	Stick Up with Pads and Posts
(a) concrete pad dimensions	
4- Dia./type of well casing	2" Schedule PVC Riser
5- Type/slot size of screen	10 Slot Screen
	2" Schedule PVC screen
6- Type screen filter	Morie #2 Sand
b) Other type	Morie #00 (1 bag)
7- Type of seal	Bentonite Seal
a) Quantity used	2 x 50lb bags
8- Grout	
a) Grout mix used	Grout/Bentonite
b) Method of placement	Tremmie
Development method	Purging
Development time	1 hour and 16 minutes
Estimated purge volume	Approximately 45 gallons.
Comments	Water clears slowly, and very little.
	Bedrock encountered at 22 ft. bgs

Time	pH	Turbidity (NTU)	Conductivity (S/m)	Temperature (Celcius)
0823	7.30	+999	0.372	Not Recorded
0833	7.27	+999	0.362	14.96
0843	7.16	+999	0.350	16.35
0853	7.03	+999	0.358	14.85
0903	6.83	+999	0.350	15.85
0913	6.80	+999	0.358	14.99
0923	6.75	+999	0.358	14.88
0937	6.72	+999	0.360	15.26

CH2MHILL	PROJECT NUMBER:157852.FI.WS	WELL NUMBER:5GW23

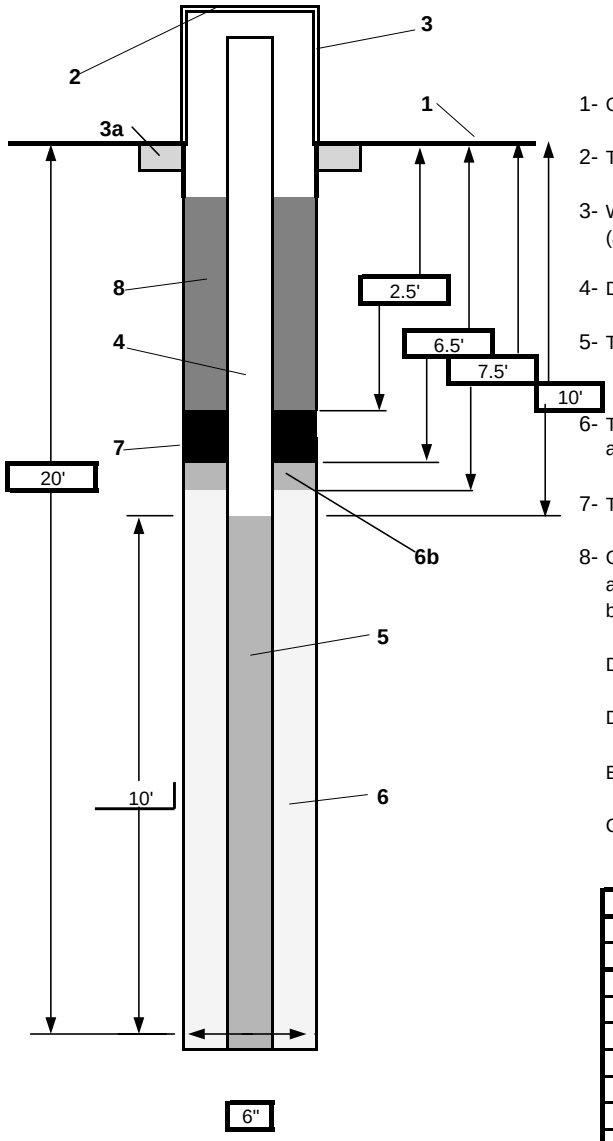
WELL COMPLETION DIAGRAM

PROJECT :ABL Site 5 MNA — LOCATION :Allegany Ballistics Laboratory, Rocket Center, West Virginia

DRILLING CONTRACTOR :Eichelbergers

DRILLING METHOD AND EQUIPMENT USED :Schramm Model 450 Air Rig, 5&7/8" Diameter bit.

WATER LEVELS : — START :7/12/00 — END :7/12/00 — LOGGER : F. Calef



1- Ground elevation at well	
2- Top of casing elevation	
3- Wellhead protection cover type	Stick Up with Pads and Posts
(a) concrete pad dimensions	4'x4'x6"
4- Dia./type of well casing	2" Schedule PVC Riser
5- Type/slot size of screen	10 Slot Screen
	2" Schedule PVC screen
6- Type screen filter	Morie #2 Sand
a) Other type	Morie #00 (1 bag)
7- Type of seal	Bentonite Seal
8- Grout	
a) Grout mix used	Grout/Bentonite
b) Method of placement	Tremmie
Development method	Purging
Development time	1 hour and 5 minutes
Estimated purge volume	55 gallons
Comments	Water initially very turbid
	Water cleared slightly
	Bedrock was encountered at 20 ft. bgs

Well Development Parameters

Time	pH	Conductivity S/m	Temperature Celcius
1553	7.24	0.514	Not Recorded
1603	7.22	0.464	Not Recorded
1613	7.15	0.477	Not Recorded
1623	7.09	0.460	Not Recorded
1633	7.01	0.464	Not Recorded
1643	6.95	0.461	Not Recorded
1648	6.87	0.464	Not Recorded
1653	6.87	0.458	Not Recorded
1658	6.86	0.459	Not Recorded

PROJECT NUMBER:157852.FI.WS	WELL NUMBER:5GW24

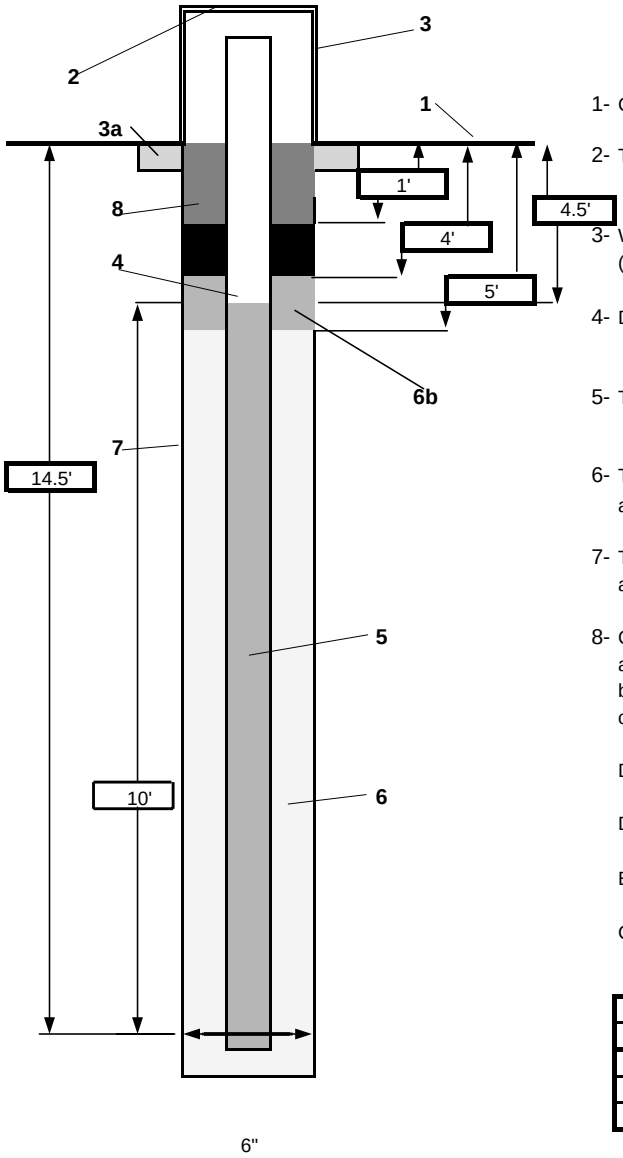
WELL COMPLETION DIAGRAM

PROJECT :ABL Site 5 MNA — LOCATION :Allegany Ballistics Laboratory, Rocket Center, West Virginia

DRILLING CONTRACTOR :Eichelbergers

DRILLING METHOD AND EQUIPMENT USED :Schramm Model 450 Air Rig, 5&7/8" Diameter bit.

WATER LEVELS : — START :7/12/00 — END :7/12/00 — LOGGER : F. Calef



1- Ground elevation at well	
2- Top of casing elevation	
3- Wellhead protection cover type	Stick Up with Pads and Posts
(a) concrete pad dimensions	
4- Dia./type of well casing	2" Schedule PVC Riser
5- Type/slot size of screen	10 Slot Screen
	2" Schedule PVC screen
6- Type screen filter	Morie #2 Sand
a) Other type	Morie #00 (1 bag)
7- Type of seal	Bentonite Seal
a) Quantity used	1 x 50lb bags
8- Grout	
a) Grout mix used	Grout/Bentonite
b) Method of placement	Tremmie
c) Vol. of well casing grout	27 bags used in 19 gallons of grout.
Development method	Purging
Development time	20 minutes
Estimated purge volume	Approximately 110 gallons.
Comments	Water consistently very turbid
	Well regularly ran dry
	Bedrock encountered at 14' bgs

Time	pH	Conductivity	DO	Temperature	Salinity
		S/m	mg/l	Celcius	per mil
1415	8.26	0.462	7.22	14.1	0.03
1425	8.27	0.444	7.30	13.8	0.03
1435	8.26	0.445	7.20	13.5	0.03

Appendix C
Detected Historic Groundwater Data

Table C-1
Historical Groundwater Analytical Results
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Sample ID **Sample Date**	5GW1(84) 01/01/1984	5GW1(86) 01/01/1986	5GW1(87) 01/01/1987	5GW1(92) 01/01/1992	5GW1(94) 12/07/1994	AS05-5GW01-R01 05/05/1998	AS05-5GW01-R02 10/12/1998	AS05-5GW01-R03 01/19/1999	AS05-5GW01-R04 10/21/1999
Chemical Name									
Volatile Organic Compounds									
(UG/L)									
Methylene chloride	10 U	5 J	9 B	5 U	10 U	0.6 B	0.6 J	2 U	1 U
Trichloroethene	10 U	10	5 U	3 J	10 U	1 U	1 U	1 U	1 U
Total Metals (UG/L)									
Aluminum	NS	NS	NS	125,000	NS	NS	51,100	51,100	37,600
Antimony	NS	NS	NS	12.4 U	NS	3.1 J	2.7 B	3 U	5 U
Arsenic	NS	NS	NS	3.40	NS	2.3 UL	31.9	41.5	11.2
Barium	NS	NS	NS	634	NS	34.6 B	258	322	506
Beryllium	NS	NS	NS	8.5	NS	0.61 U	3 B	4.5 B	5.3
Calcium	NS	NS	NS	47,500	NS	NS	21,700	38,100	52,800
Chromium	NS	NS	NS	174	NS	20.5 B	185	102	197
Cobalt	NS	NS	NS	87.7	NS	15.6 K	32.8 B	32.7 B	61.8
Copper	NS	NS	NS	192	NS	5.5 U	68.2	113	119
Iron	NS	NS	NS	225,000 JS	NS	NS	78,400	130,000	67,400
Lead	NS	NS	NS	128	NS	6.1 B	72.7	106	146
Magnesium	NS	NS	NS	18,900	NS	NS	8,320	11,300	11,800
Manganese	NS	NS	NS	1,470	NS	NS	571	658	1,150
Mercury	NS	NS	NS	0.17	NS	0.16 B	0.13 U	0.2 U	0.44
Nickel	NS	NS	NS	177	NS	12.7 J	146	88.9	164
Potassium	NS	NS	NS	12,400	NS	NS	8,020	6,090	5,730
Thallium	NS	NS	NS	2.1 U	NS	2.6 J	15.5	3 U	7 U
Vanadium	NS	NS	NS	233	NS	8.4 B	97.8	111	79.2
Zinc	NS	NS	NS	808	NS	33.6 B	277	446	336
Dissolved Metals (UG/L)									
Aluminum	NS	NS	NS	NS	15.3 U	NS	2,740	41 B	34 B
Barium	NS	NS	NS	NS	18.5 B	NS	14.7 B	15.1 B	16.4 B
Calcium	NS	NS	NS	NS	23,200	NS	12,200	22,400	25,500
Chromium	NS	NS	NS	NS	5 U	NS	40.6	1.3 B	1 U
Iron	NS	NS	NS	NS	45.7 U	NS	549	99.1 B	16 U
Magnesium	NS	NS	NS	NS	3,060 B	NS	1,750 B	3,140 B	3,430 B
Manganese	NS	NS	NS	NS	4.1 U	NS	42.1	3.2 B	3.5 B
Nickel	NS	NS	NS	NS	7.0 U	NS	55	2.6 B	9.8 B
Potassium	NS	NS	NS	NS	967 B	NS	889 B	860 B	855 B
Sodium	NS	NS	NS	NS	2,220 B	NS	2,690 B	2,700 B	2,680 BE
Zinc	NS	NS	NS	NS	8.6 U	NS	14.4 B	27.4	5.2 B
Wet Chemistry (MG/L)									
Alkalinity	NS	NS	NS	NS	NS	31.8	37.9	30	64
Ammonia	NS	NS	NS	NS	NS	0.22	0.1 U	0.1 U	NS
Bicarbonate	NS	NS	NS	NS	NS	31.8	37.9	2 U	63
Biological oxygen demand	NS	NS	NS	NS	NS	2 U	2 U	3	15
Chemical oxygen demand	NS	NS	NS	NS	NS	5 U	5 U	5 U	5 U
Chloride	NS	NS	NS	NS	NS	2.4	1.9	5 U	5 U
Hardness	NS	NS	NS	NS	NS	NS	NS	141	175
Nitrate	NS	NS	NS	NS	NS	NS	NS	0.543	1.05
Nitrate/Nitrite	NS	NS	NS	NS	NS	1.63	1.46	NS	NS
Nitrite	NS	NS	NS	NS	NS	NS	NS	0.05 U	0.05 U
Oil and Grease	NS	NS	NS	NS	NS	1.2	1 U	NS	NS
Sulfate	NS	NS	NS	NS	NS	5 U	5 U	1 U	59.14
Total dissolved solids (TDS)	NS	NS	NS	NS	NS	90	166	82	90
Total organic carbon (TOC)	NS	NS	NS	NS	NS	3.6	5.7	10 U	100 U

NS - Not sampled
B - Analyte not detected above associated blank
K - estimated

R - Unreliable result
J - Reported value is estimated
E - Exceeds calibration range

U - Analyte not detected
UL - Not detected, quantitation limit is probably higher

Table C-2
Historical Groundwater Analytical Results
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Sample ID **Sample Date**	5GW2(84) 01/01/1984	5GW2(86) 01/01/1986	5GW2(87) 01/01/1987	5GW2(92) 01/01/1992	5GW2(94) 12/07/1994	AS05-5GW02-R01 05/06/1998	AS05-5GW02-R02 10/13/1998	AS05-5GW02-R03 01/20/1999	AS05-5GW02-R04 10/22/1999	AS05-5GW02P-R04 10/22/1999
Chemical Name										
Volatile Organic Compounds (UG/L)										
1,1,1-Trichloroethane	10 U	10 U	1 J	1 JC	10 U	10 U	1 U	1 U	1 U	1 U
Methylene chloride	10 U	4 J	9 B	2 J	10 U	10 U	2 U	2 U	1.1 J	1.4 J
Trichloroethene	15	17	18	17	5 J	8	5	6.4	8	8.2
cis-1,2-Dichloroethene	NS	NS	NS	NS	NS	NS	1 U	1 U	0.8 J	1 J
Total Metals (UG/L)										
Aluminum	NS	NS	NS	2,330	NS	36.7 U	43.3 U	115 B	15.4 B	29.5 B
Barium	NS	NS	NS	136	NS	30.4 B	25 B	25.5 B	24.7 B	22.9 B
Boron	NS	NS	NS	NS	NS	NS	NS	NS	203	179
Cadmium	NS	NS	NS	2.8	NS	0.87 B	0.59 U	1 U	1 U	1 U
Calcium	NS	NS	NS	65,000	NS	69,400	68,700	65,400	72,100	66,000
Chromium	NS	NS	NS	4.5	NS	6.6 U	6.1 U	1 U	1 U	1 U
Cobalt	NS	NS	NS	7	NS	7.5 B	9.4 B	6.8 B	10.6 B	10.6 B
Iron	NS	NS	NS	6,070	NS	113 B	952	4,360	2,510	2,320
Lead	NS	NS	NS	10.2	NS	8.2 B	2.2 U	1 U	2 U	2 U
Magnesium	NS	NS	NS	23,800	NS	22,800	23,800	22,300	24,500	22,400
Manganese	NS	NS	NS	2,520	NS	5,400	2,170	1,010	1,690	1,540
Nickel	NS	NS	NS	42.5	NS	7.4 J	41.1	26.8 B	42.3	38.8 B
Potassium	NS	NS	NS	3,340	NS	3,070 J	3,130 B	3,020 B	3,090 B	2,770 B
Selenium	NS	NS	NS	1.9 U	NS	4.3 K	2.9 U	4 U	5 U	5 U
Sodium	NS	NS	NS	65,100	NS	40,700 J	38,000	37,300	35,300	32,200
Vanadium	NS	NS	NS	3.9	NS	5.8 U	5.3 U	1 U	2 U	2 U
Zinc	NS	NS	NS	66.2 UJB	NS	22.9 B	22.1	37.3	32.6	37.2
Dissolved Metals (UG/L)										
Barium	NS	NS	NS	NS	NS	31.6 B	24.1 B	20.8 B	23.8 B	24.2 B
Boron	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Calcium	NS	NS	NS	NS	NS	68,000	69,300	51,800	69,600	70,900
Cobalt	NS	NS	NS	NS	NS	9.2 B	7.1 B	3.8 B	12.2 B	11.5 B
Copper	NS	NS	NS	NS	NS	5.5 U	5 U	4.7 B	22.8 B	45
Iron	NS	NS	NS	NS	NS	155 B	712	3,100	2,540	2,510
Lead	NS	NS	NS	NS	NS	16.3 J	2.2 U	3.4	2 U	2 U
Magnesium	NS	NS	NS	NS	NS	23,500	23,600	18,800	23,200	23,900
Manganese	NS	NS	NS	NS	NS	5,190	2,150	817	1,570	1,640
Nickel	NS	NS	NS	NS	NS	12 J	34.2 B	21.1 B	42.2	41.7
Potassium	NS	NS	NS	NS	NS	3,290 J	3,180 B	2,480 B	2,840 B	3,040 B
Silver	NS	NS	NS	NS	NS	4.9 L	1.3 B	2 U	1 U	1 U
Sodium	NS	NS	NS	NS	NS	41,400	36,300	31,400	33,000	34,300
Zinc	NS	NS	NS	NS	NS	25.1	22.1	28.7	54.6	40.8
Wet Chemistry (MG/L)										
Alkalinity	NS	NS	NS	NS	NS	163	111	118	101	98
Ammonia	NS	NS	NS	NS	NS	0.76	0.18	0.1 U	NS	NS
Bicarbonate	NS	NS	NS	NS	NS	163	111	2 U	100	97.9
Biological oxygen demand	NS	NS	NS	NS	NS	5	2 U	0.66	2.4	2.64
Chemical oxygen demand	NS	NS	NS	NS	NS	7.6	5 U	5 U	5 U	5 U
Chloride	NS	NS	NS	NS	NS	24.1	57.8	47.9	NS	NS
Hardness	NS	NS	NS	NS	NS	NS	NS	255	281	258
Methane	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Nitrate	NS	NS	NS	NS	NS	NS	NS	0.075	0.1	0.15
Nitrate/Nitrite	NS	NS	NS	NS	NS	0.46	0.1	NS	NS	NS
Sulfate	NS	NS	NS	NS	NS	194	192	204	114	108.3
Total dissolved solids (TDS)	NS	NS	NS	NS	NS	465	464	367	370	360
Total organic carbon (TOC)	NS	NS	NS	NS	NS	4.5	5.6	10 U	100 U	100 U
Total recoverable phenolics	NS	NS	NS	NS	NS	NS	NS	50 U	0.425	0.165

NS - Not Sampled
B - Analyte not detected above associated blank
K - Reported value may be biased high
J - Reported value is estimated
R - Unreliable result
U - Analyte not detected
UL - Not detected, quantitation limit is probably higher

Table C-3
Historical Groundwater Analytical Results
Focused Remedial Investigation
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Sample ID	5GW3(84)	5GW3(86)	5GW3(87)	5GW3(92)	5GW3(94)	AS05-5GW03-R01	AS05-5GW03-R02	AS05-5GW03P-R02	AS05-5GW03-R03	AS05-5GW03P-R03	AS05-5GW03-R04
Sample Date	01/01/1984	01/01/1986	01/01/1987	01/01/1992	12/08/1994	05/06/1998	10/13/1998	10/13/1998	01/20/1999	01/20/1999	10/22/1999
Chemical Name											
Volatile Organic Compounds (UG/L)											
1,1,1-Trichloroethane	10 U	10 U	1 J	5 UJC	10 U	1 U	1 U	1 U	1 U	1 U	1 U
1,2-Dichloroethene (total)	NS	10 U	5 U	2 J	10 U	NS	NS	NS	NS	NS	NS
Acetone	NS	NS	2 JB	7 J	10 U	2 R	5 U	5 U	5 U	5 U	NS
Carbon disulfide	NS	NS	5 U	5 U	10 U	1 U	1 U	0.6 J	1 U	1 U	1 U
Methylene chloride	10 U	5 J	9 B	12	10 U	1 U	2 U	2 U	2 U	2 U	1 U
Trichloroethene	10 U	3 J	5	29	19	4	9	10	9.4	3.5	14
cis-1,2-Dichloroethene	NS	NS	NS	NS	NS	NS	0.9 J	1	1 U	1 U	NS
Total Metals (UG/L)											
Aluminum	NS	NS	NS	426	NS	NS	304	302	2,930	4,360	79.6 B
Barium	NS	NS	NS	40.4	NS	30.7 B	30.1 B	36.2 B	80.5 B	118 B	27.8 B
Beryllium	NS	NS	NS	0.24 U	NS	1 J	0.91 U	0.91 U	1 U	1 U	1 U
Boron	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	121
Calcium	NS	NS	NS	49,200	NS	NS	65,700	74,000	84,400	74,600	61,600
Copper	NS	NS	NS	5.7 UJB	NS	5.5 U	5 U	60.9	13.9 B	23.5 B	32.1
Iron	NS	NS	NS	1,450	NS	NS	715	667	6,440	11,200	41.2 B
Lead	NS	NS	NS	0.94 U	NS	11.7 B	2.3 B	2.2 U	2.9 B	5.3	2 U
Magnesium	NS	NS	NS	15,100	NS	NS	20,800	23,100	22,700	20,800	21,200
Manganese	NS	NS	NS	372	NS	NS	653	736	1,210	1,430	549
Nickel	NS	NS	NS	36.8	NS	6.8 U	95.5	108	59.8	63.2	40.7
Potassium	NS	NS	NS	2,400	NS	NS	3,190 B	3,430 B	3,240 B	3,140 B	2,900 B
Sodium	NS	NS	NS	45,800	NS	NS	24,700	27,600	17,500	16,900	25,500
Zinc	NS	NS	NS	51	NS	22.9 B	38.3	39.9	53	64.6	48
Dissolved Metals (UG/L)											
Barium	NS	NS	NS	NS	NS	NS	30.1 B	28.7 B	21.9 B	25.1 B	27.6 B
Calcium	NS	NS	NS	NS	NS	NS	78,200	75,400	80,900	79,200	61,700
Iron	NS	NS	NS	NS	NS	NS	75.7 B	127	104	57.2 B	16 U
Magnesium	NS	NS	NS	NS	NS	NS	23,200	22,200	21,400	21,600	21,300
Manganese	NS	NS	NS	NS	NS	NS	675	613	944	833	537
Nickel	NS	NS	NS	NS	NS	NS	91.1	87.6	50.7	51.1	40.2
Potassium	NS	NS	NS	NS	NS	NS	3,130 B	2,920 B	2,390 B	2,580 B	2,910 B
Sodium	NS	NS	NS	NS	NS	NS	25,800	23,500	17,800	19,100	25,400
Zinc	NS	NS	NS	NS	NS	NS	36.7	38.4	35.4	36.5	40.5
Wet Chemistry (MG/L)											
Alkalinity	NS	NS	NS	NS	NS	128	116	117	172	162	65
Bicarbonate	NS	NS	NS	NS	NS	128	116	117	2 U	2 U	64.9
Biological oxygen demand	NS	NS	NS	NS	NS	2 U	2 U	2 U	2.1	1.92	1.8
Chemical oxygen demand	NS	NS	NS	NS	NS	5 U	7	5 U	5 U	5 U	5 U
Chloride	NS	NS	NS	NS	NS	7.6	16.3	16.4	17.7	16	17.7
Hardness	NS	NS	NS	NS	NS	NS	NS	NS	304	270	243
Nitrate	NS	NS	NS	NS	NS	NS	NS	NS	0.05 U	0.05 U	0.4
Nitrate/Nitrite	NS	NS	NS	NS	NS	1.29	0.49	0.46	NS	NS	NS
Oil and Grease	NS	NS	NS	NS	NS	1.2	1	1 U	NS	NS	NS
Sulfate	NS	NS	NS	NS	NS	133	182	170	166	162	127.9
Total dissolved solids (TDS)	NS	NS	NS	NS	NS	320	400	374	354	351	300
Total organic carbon (TOC)	NS	NS	NS	NS	NS	3.3	5	6.2	10 U	10 U	100 U

NS - Not Sampled
B - Analyte not detected above associated blank
K - Reported value may be biased high

J - Reported value is estimated
R - Unreliable result

U - Analyte not detected
UL - Not detected, quantitation limit is probably highe

Table C-4
Historical Groundwater Analytical Results
Focused Remedial Investigation
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Sample ID **Sample Date**	5GW4(92) 01/01/1992	5GW4(94) 12/08/1994
Chemical Name		
Volatile Organic Compounds (UG/L)		
Trichloroethene	6	10 U
Total Metals (UG/L)		
Barium	2,840	NS
Calcium	64,200	NS
Iron	160	NS
Magnesium	11,000	NS
Manganese	59.70	NS
Sodium	13,500	NS

NS - Not sampled
B - Analyte not detected above associated blank
J - Reported value is estimated
U - Analyte not detected
K - Reported value may be biased high
R - Unreliable result
UJ - Not detected, quantitation limit is probably higher

Table C-5
Historical Groundwater Analytical Results
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Sample ID **Sample Date**	5GW5(94) 12/08/1994
Chemical Name	
Volatile Organic Compounds (UG/L)	
1,2-Dichloroethene (total)	10 U
Methylene chloride	10 U
Trichloroethene	10 U
Total Metals (UG/L)	
Aluminum	NS
Barium	NS
Calcium	NS
Iron	NS
Magnesium	NS
Manganese	NS
Sodium	NS
Zinc	NS

NS - Not sampled
B - Analyte not detected above associated blank
K - Reported value may be biased high
J - Reported value is estimated
R - Ureliable result
U - Analyte not detected
UL - Not detected, quantitation limit is probably higher

Table C-6
Historical Groundwater Analytical Results
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Sample ID **Sample Date**	5GW6(94) 12/08/1994	AS05-5GW06-R01 05/08/1998	AS05-5GW06-R02 10/12/1998
Chemical Name			
Volatile Organic Compounds (UG/L)			
Acetone	5,300 D	13 J	6
Benzene	1 J	1 U	1 U
Carbon disulfide	10 U	1 U	0.8 J
Chloroform	1 J	1 U	1 U
Semi-volatile Organic Compounds (UG/L)			
bis(2-Ethylhexyl)phthalate	73 J	NS	NS
Total Metals (UG/L)			
Aluminum	311	NS	43.3 U
Barium	77.8 B	192 J	197 B
Boron	NS	NS	NS
Calcium	81,000	NS	91,600
Chromium	11.2	52.2	7.4 B
Cobalt	3 U	14.3 J	5 U
Copper	4 B	5.5 U	5 U
Iron	3,750	NS	6,490
Magnesium	23,400	NS	29,000
Manganese	215	NS	115
Nickel	7.2 B	56.7 K	18.8 B
Potassium	3,780 B	NS	5,820
Selenium	2 U	3.6 U	2.9 U
Sodium	14,200	NS	16,700
Zinc	25.5	26.4 B	17.2 B
Dissolved Metals (UG/L)			
Barium	76.3 B	NS	179 B
Boron	NS	NS	NS
Calcium	89,100	NS	90,700
Iron	67.1 B	NS	4,420
Magnesium	24,800	NS	28,000
Manganese	188	NS	132
Nickel	7 U	NS	23.3 B
Potassium	3,940 B	NS	5,880
Sodium	15,600	NS	16,500
Wet Chemistry (MG/L)			
Alkalinity	NS	2,920	311
Bicarbonate	NS	1,250	311
Biological oxygen demand	NS	2 U	2 U
Chemical oxygen demand	NS	17.2	5 U
Chloride	NS	11.9	4.2
Hardness	NS	NS	NS
Oil and Grease	NS	1.9	1
Sulfate	NS	5 U	79.3
Total dissolved solids (TDS)	NS	3,010	429
Total organic carbon (TOC)	NS	7.6	6.8

NS - Not sampled
B - Analyte not detected above associated blank
K - Reported value may be biased
J - Reported value is estimated
R - Unreliable result
U - Analyte not detected
UL - Not detected, quantitation limit is probably higher

Table C-7
Historical Groundwater Analytical Results
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Sample ID **Sample Date**	5GW7(94) 12/08/1994	AS05-5GW07-R01 05/06/1998	AS05-5GW07-R02 10/13/1998	AS05-5GW07-R03 01/20/1999	AS05-5GW07-R04 10/22/1999
Chemical Name					
Volatile Organic Compounds (UG/L)					
Acetone	7 J	10 UJ	5 U	5 U	5 U
Total Metals (UG/L)					
Aluminum	9,500	444 B	879	4,500	49.3 B
Barium	199 B	75.4 J	83.3 B	117 B	62.1 B
Calcium	47,100 J	43,600	42,700	42,900	40,300
Chromium	20.90	6.6 U	6.1 U	9.6 B	1 U
Cobalt	50.30	36.9 J	31.2 B	32.3 B	27.1 B
Copper	76.20	5.5 U	5.4 B	36.8	20.4 B
Iron	34,900 J	16,900	14,900	27,400	9,740
Lead	12.70	3.2 B	2.3 B	5.5	2 U
Magnesium	22,500 J	19,300	20,100	20,600	18,000
Manganese	1,100	1,050	996	855	831
Nickel	142	81.4	90.6	89.9	72.3
Potassium	4,390 B	2,650 J	2,820 B	3,450 B	2,100 B
Silver	4 U	4.9 L	3.2 B	2 U	1 U
Sodium	23,700 J	18,900 J	18,800	19,800	14,400
Thallium	3 U	1.7 J	2.8 U	3 U	7 U
Zinc	436	99.5	118	195	105
Dissolved Metals (UG/L)					
Barium	117 B	65.7 J	66.1 B	66 B	68.9 B
Calcium	52,900 J	39,800	41,200	44,800	45,100
Cobalt	45.70 B	35.6 B	29.7 B	27.3 B	30.6 B
Copper	2 U	5.5 U	7.8 B	18.8 B	31.9
Iron	16,800	10,100 J	11,400	11,700	10,700
Lead	1 U	18.2 J	2.2 U	1 U	2 U
Magnesium	23,300 J	18,400	19,100	20,700	20,000
Manganese	1,150 J	942	944	853	927
Nickel	124	81.5	83.1	76.9	81.8
Potassium	3,110 B	2,470 J	2,630 B	2,430 B	2,510 B
Silver	4 U	5.3 L	3.4 B	2 U	1 U
Sodium	25,300 J	17,900	18,000	21,200	18,200
Zinc	269	113 B	112	120	109

NS - Not sampled
B - Analyte not detected above associated blank
K - Reported value may be biased high
J - Reported value is estimated
R - Unreliable result
U - Analyte not detected
UL - Not detected, quantitation limit is probably high

Table C-8
Historical Groundwater Analytical Results
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Sample ID	5GW8(94)	
Sample Date	12/08/94	
Chemical Name		
Volatile Organic Compounds (UG/L)		
No Detections		
Semivolatile Organic Compounds (UG/L)		
No Detections		
Explosives (UG/L)		
No Detections		
Total Metals (UG/L)		
Aluminum	774	
Calcium	37,100	J
Iron	15,400	J
Magnesium	17,500	J
Manganese	1,010	
Nickel	90.4	
Sodium	17,800	J
Zinc	124	
Dissolved Metals (UG/L)		
Calcium	39,500	J
Iron	13,600	
Magnesium	18,000	J
Manganese	1,040	J
Nickel	95.4	
Sodium	17,700	J
Zinc	122	

NA - Not analyzed
B - Blank contamination
J - Estimated
U - Undetected

Table C-9
Historical Groundwater Analytical Results
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Sample ID	5GW9(94)		AS05-5GW09-R01		AS05-5GW09-R02		AS05-5GW09-R03		AS05-5GW09-R04	
Sample Date	12/08/1994		05/06/1998		10/14/1998		01/21/1999		10/22/1999	
Chemical Name										
Volatile Organic Compounds (UG/L)										
1,1,1-Trichloroethane	14		10	U	1	U	1	U	1	U
1,2-Dichloroethane	10	U	10	U	0.6	J	1	U	1	U
1,2-Dichloroethene (total)	3	J	NS		NS		NS		NS	
Carbon disulfide	10	U	10	U	1		1	U	1	U
Trichloroethene	28		65	J	46		NS		52	
cis-1,2-Dichloroethene	NS		NS		5		3.1		NS	
Total Metals (UG/L)										
Aluminum	1,760		NS		23,800		996		42.4	B
Arsenic	4.60	U	2.3	UL	14.1		4	U	6	U
Barium	112	B	38.8	J	823		152	B	40.7	B
Boron	NS		NS		NS		NS		53.2	
Calcium	39,200	J	NS		45,600		39,300		67,000	
Chromium	5	U	10.6	B	59.9		13.1		1	U
Cobalt	18.20	B	18.1	B	20.5	B	9.9	B	6.9	B
Copper	3.90	B	5.5	U	38.9		13.7	B	19.1	B
Iron	4,450	J	NS		64,000		3,570		163	
Lead	1.70	B	5.1	B	29.4		1.9	B	2	U
Magnesium	13,400	J	NS		19,400		14,400		23,500	
Manganese	494		NS		1,550		1,510		1,760	
Nickel	42.30		33.2	J	70.3		30.8	B	33.9	B
Potassium	2,540	B	NS		5,250		2,190	B	2,770	B
Sodium	16,600	J	NS		11,900		11,700		16,900	
Thallium	3	U	1.7	U	11.4		3	U	7	U
Vanadium	2	J	6.5	B	50.7		3.3	B	2	U
Zinc	102		28.1	B	153		50.7		53.2	
Dissolved Metals (UG/L)										
Barium	70.10	B	NS		43.2	B	65.8	B	40.2	B
Boron	NS		NS		NS		NS		NS	
Calcium	44,000	J	NS		52,500		48,900		69,900	
Cobalt	20	B	NS		5	U	10.4	B	7.4	B
Iron	452		NS		317		621		105	
Magnesium	14,500	J	NS		18,700		18,900		24,100	
Manganese	495	J	NS		1,470		1,640		1,790	
Nickel	46.60		NS		29.2	B	26.8	B	34.8	B
Potassium	2,430	B	NS		2,820	B	2,990	B	2,810	B
Sodium	17,400	J	NS		13,800		14,400		17,100	
Zinc	98		NS		40.2		50.3		47.3	

NS - Not sampled
B - Analyte not detected above associated blank
K - Reported value may be biased high
J - Reported value is estimated
R - Unreliable result
U - Analyte not detected
UL - Not detected, quantitationlimit is probably higher

Table C-9
Historical Groundwater Analytical Results
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Sample ID	5GW9(94)		AS05-5GW09-R01		AS05-5GW09-R02		AS05-5GW09-R03		AS05-5GW09-R04	
Sample Date	12/08/1994		05/06/1998		10/14/1998		01/21/1999		10/22/1999	
Chemical Name										
Wet Chemistry (MG/L)										
Alkalinity	NS		136		65.8		70		64	
Ammonia	NS		0.14		0.1	U	0.1	U	NS	
Bicarbonate	NS		136		65.8		2	U	63.9	
Biological oxygen demand	NS		2	U	2	U	0.2	U	3.06	
Chemical oxygen demand	NS		5	U	8.5		5	U	5	U
Chloride	NS		16.7		27.6		31.9		28.3	
Hardness	NS		NS		NS		156		266	
Nitrate	NS		NS		NS		0.05	U	0.1	
Nitrate/Nitrite	NS		0.77		0.05	U	NS		NS	
Sulfate	NS		181		91		124		108.3	
Total dissolved solids (TDS)	NS		445		288		253		310	
Total organic carbon (TOC)	NS		3.1		13.7		10	U	100	U

NS - Not sampled
B - Analyte not detected above associated blank
K - Reported value may be biased high
J - Reported value is estimated
R - Unreliable result
U - Analyte not detected
UL - Not detected, quantitationlimit is probably higher

Table C-10
Historical Groundwater Analytical Results
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Sample ID	5GW10(94)		5GW10(94)DUP		AS05-5GW10-R01		AS05-5GW10-R02		AS05-5GW10-R03		AS05-5GW10-R04	
Sample Date	12/08/1994		12/08/1994		05/06/1998		10/12/1998		01/20/1999		10/21/1999	
Chemical Name												
Total Metals (UG/L)												
Barium	217		201		169	J	185	B	143	B	167	B
Calcium	83,200	J	76,600	J	NS		82,800		76,700		74,300	
Iron	196	U	194	U	NS		1,050		966		959	
Magnesium	7,570	J	6,930	J	NS		8,190		7,610		7,160	
Manganese	121		111		NS		149		99.9		114	
Sodium	4,860	J	4,410	J	NS		5,320		5,600		5,410	E
Zinc	6.40	U	5	U	27.6	B	487		23.1		5.2	B
Dissolved Metals (UG/L)												
Aluminum	14	U	32.80	U	NS		344		32.8	B	40.3	B
Barium	212		235		NS		232		149	B	168	B
Calcium	83,200	J	90,700	J	NS		109,000		75,000		73800	
Iron	204		235		NS		1,520		937		904	
Magnesium	7,400	J	8,060	J	NS		10,800		7,390		7130	
Manganese	119	J	129	J	NS		177		97.2		114	
Sodium	4,590	J	5,010	J	NS		7,010		5,560		5200	E
Zinc	3.60	U	4.5	U	NS		11.9	B	22.1		4.5	B
Wet Chemistry (MG/L)												
Alkalinity	NS		NS		208		209		230		171	
Ammonia	NS		NS		0.14		0.1	U	0.1	U	0.1	U
Bicarbonate	NS		NS		208		209		2	U	170	
Biological oxygen demand	NS		NS		2	U	2	U	0.9		1.92	
Chemical oxygen demand	NS		NS		5	U	9.8		5	U	5	U
Chloride	NS		NS		6.4		3.4		5	U	5	U
Hardness	239		NS		NS		NS		224		209	
Nitrate	NS		NS		NS		NS		0.05	U	0.2	
Sulfate	NS		NS		21.4		18.5		17		9.84	
Total dissolved solids (TDS)	NS		NS		258		268		217		220	
Total organic carbon (TOC)	NS		NS		2.3		2.5		10	U	100	U

J - Reported value is estimated
R - Unreliable result

NS - Not sampled
B - Analyte not detected above associated blank
K - Reported value may be biased high

U - Analyte not detected
UL - Not detected, quantitation limit is probably higher

Table C-11
Historical Groundwater Analytical Results
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Sample ID **Sample Date**	5GW11(94) 12/09/1994	AS05-5GW11-R01 05/05/1998	AS05-5GW11P-R01 05/05/1998
Chemical Name			
Volatile Organic Compounds (UG/L)			
Acetone	19	2 R	2 R
Total Metals (UG/L)			
Aluminum	124,000	NS	NS
Arsenic	139	2.3 UL	2.3 UL
Barium	4,490	51.3 J	161 J
Beryllium	9.80	0.61 U	0.61 U
Cadmium	45	0.89 B	1 B
Calcium	217,000 J	NS	NS
Chromium	264	7.1 B	6.6 U
Cobalt	215	8.8 K	5.7 U
Copper	653	5.5 U	5.5 U
Iron	326,000 J	NS	NS
Lead	198	4.7 B	11.8 B
Magnesium	57,200 J	NS	NS
Manganese	5,100	NS	NS
Nickel	570	14.3 J	6.8 U
Potassium	65,600	NS	NS
Selenium	41.20	3.6 U	3.6 U
Silver	23.80	3.6 L	2.8 UL
Sodium	14,800 J	NS	NS
Thallium	15.20	2.1 J	1.8 J
Vanadium	238	5.8 U	5.8 U
Zinc	1,400	25.9 B	17.6 B
Wet Chemistry (MG/L)			
Alkalinity	NS	84.1	214
Bicarbonate	NS	84.1	214
Chemical oxygen demand	NS	5.6	5 U
Chloride	NS	15	6.2
Hardness	NS	NS	NS
Nitrate	NS	NS	NS
Nitrate/Nitrite	NS	4.29	0.05 U
Oil and Grease	NS	1.1	1 U
Sulfate	NS	192	20.6
Total dissolved solids (TDS)	NS	380	261
Total organic carbon (TOC)	NS	4.9	2.5

NS - Not Sampled
B - Analyte not detected above associated blank
K - Reported value may be biased high
J - Reported value may be biased high
R - Unreliable result
U - Analyte not detected
UL - Not detected, quantitation limit is probably higher

Table C-12
Historical Groundwater Analytical Results
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Sample ID	5GW12(94)
Sample Date	12/09/1994
Chemical Name	
Volatile Organic Compounds	
(UG/L)	
None detected	
Total Metals (UG/L)	
Barium	25800
Calcium	69,000 J
Cobalt	13.70 B
Lead	1.80 B
Magnesium	12800 J
Manganese	21.10
Potassium	912 B
Sodium	8800 J
Vanadium	1 UJ
Dissolved Metals (UG/L)	
Barium	25800
Calcium	70,000 J
Iron	336
Magnesium	13,100 J
Manganese	17 J
Potassium	879 B
Sodium	9,280 J
Wet Chemistry (MG/L)	
Hardness	225

NS - Not sampled
B - Analyte not detected above associated blank
K - Reported value may be biased high
J - Reported value is estimated
R - Unreliable result
U - Analyte not detected
UL - Not detected, quantitation limit is probably higher

Table C-13
Historical Groundwater Analytical Results
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Sample ID	5GW13(94)	AS05-5GW13-R01	AS05-5GW13-R02	AS05-5GW13P-R02	AS05-5GW13-R03	AS05-5GW13P-R03	AS05-5GW13-R04
Sample Date	12/09/1994	05/07/1998	10/14/1998	10/14/1998	01/21/1999	01/21/1999	10/22/1999
Chemical Name							
Volatile Organic Compounds (UG/L)							
1,2-Dichloroethene (total)	7 J	NS	NS	NS	NS	NS	NS
Carbon disulfide	10 U	1 UJ	1	0.7 J	1 U	1 U	1 U
Trichloroethene	110	67 J	40	26 B	43 D	37 D	61 D
Vinyl chloride	10 U	0.4 UJ	0.6 J	1 U	1 U	1 U	1 U
cis-1,2-Dichloroethene	NS	NS	5	4	3	3.5	NS
Total Metals (UG/L)							
Aluminum	76.80 U	NS	255	478	196 B	141 B	54.1 B
Barium	106 B	32.8 B	42.6 B	35.4 B	30.6 B	32.8 B	28.5 B
Boron	NS	NS	NS	NS	NS	NS	50 U
Calcium	88,400 J	NS	132,000	140,000	98,300	110,000	149,000
Chromium	5 U	8 J	6.1 U	6.1 U	1.3 B	1 U	1 U
Cobalt	9.60 B	18.1 B	9.3 B	10.3 B	4.7 B	5.4 B	6.7 B
Copper	2 U	5.5 U	5.9 B	8.2 B	9.1 B	9.9 B	25.1
Iron	1,600 J	NS	3,240	3,640	3,000	3,280	3,320
Magnesium	11,000 J	NS	23,200	24,600	14,500	16,100	25,800
Manganese	519	NS	1,200	1,270	693	823	1,430
Nickel	33.30 B	40.1	28.5 B	31.5 B	23.1 B	25.8 B	31.3 B
Potassium	1,010 B	NS	1,020 B	1,390 B	955 B	1,070 B	1,290 B
Sodium	7,560 J	NS	11,300	12,200	10,800	12,200	13,900
Tin	NS	65.5 J	NS	NS	NS	NS	NS
Zinc	110	89.9 B	72.1	84.8	70.5	67.2	78.9
Dissolved Metals (UG/L)							
Aluminum	427	NS	43.3 U	3,130	23.9 B	19.9 B	54 B
Barium	120 B	NS	25.5 B	23.8 B	29.2 B	33.4 B	29.4 B
Calcium	101,000 J	NS	138,000	138,000	116,000	135,000	162,000
Cobalt	10.20 B	NS	9.3 B	8.4 B	5.6 B	6.1 B	6.2 B
Iron	2,120	NS	3,310	3,410	3,110	3,550	3,590
Lead	1 U	NS	2.2 U	2.2 U	1 U	1 U	2 U
Magnesium	13,700 J	NS	23,800	23,400	17,300	20,000	28,100
Manganese	573 J	NS	1,280	1,290	825	950	1,550
Nickel	35.40 B	NS	28.5 B	39.2 B	26.2 B	29 B	32.3 B
Potassium	1,390 B	NS	1,250 B	1,190 B	1,160 B	1,380 B	1,390 B
Sodium	8,280 J	NS	11,900	11,800	14,200	16,500	14,900
Zinc	104	NS	64.2	67.1	72.9	77.4	86.6

NS - Not sampled
B - Analyte not detected above associated blank
J - Reported value is estimated
U - Analyte not detected
K - Reported value may be biased high
R - Unreliable Result
UL - Not detected, quantitation limit is probably higher

Table C-13
Historical Groundwater Analytical Results
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Sample ID	5GW13(94)	AS05-5GW13-R01	AS05-5GW13-R02	AS05-5GW13P-R02	AS05-5GW13-R03	AS05-5GW13P-R03	AS05-5GW13-R04
Sample Date	12/09/1994	05/07/1998	10/14/1998	10/14/1998	01/21/1999	01/21/1999	10/22/1999
Chemical Name							
Wet Chemistry (MG/L)							
Alkalinity	NS	222	219	238	228	238	218
Ammonia	NS	0.1 U	0.1 U	0.14	0.1 U	0.1 U	0.1 U
Bicarbonate	NS	222	219	238	2 U	2 U	217
Biological oxygen demand	NS	5.3	2 U	2 U	0.2 U	0.2 U	2.04
Chemical oxygen demand	NS	5 U	6.3	6.6	5 U	5 U	5 U
Chloride	NS	22.7	30.1	30.1	26.6	31.9	33.6
Hardness	NS	NS	NS	NS	304	342	478
Nitrate	NS	NS	NS	NS	0.05 U	0.05 U	0.08
Oil and Grease	NS	3	1 U	1 U	NS	NS	NS
Phenol	NS	0.28	0.1 U	0.1 U	NS	NS	NS
Sulfate	NS	309	184	187	171	190	82.68
Total dissolved solids (TDS)	NS	708	525	528	416	427	510
Total organic carbon (TOC)	NS	3.4	173	38.8	10 U	10 U	100 U
Total recoverable phenolics	NS	NS	NS	NS	50 U	50 U	611

NS - Not sampled
B - Analyte not detected above associated blank
K - Reported value may be biased high
J - Reported value is estimated
R - Unreliable Result
U - Analyte not detected
UL - Not detected, quantitation limit is probably higher

Table C-14
Historical Groundwater Analytical Results
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Sample ID	5GW14(96)	AS05-5GW14-R01	AS05-5GW14P-R01	AS05-5GW14-R02	AS05-5GW14-R03	AS05-5GW14-R04
Sample Date	04/171996	05/06/1998	05/06/1998	10/14/1998	01/21/1999	10/25/1999
Chemical Name						
Volatile Organic Compounds (UG/L)						
Carbon disulfide	10 U	10 U	10 U	0.9 J	1 U	1 U
Trichloroethene	10 U	10 U	10 U	1 U	7.7	1 U
Total Metals (UG/L)						
Aluminum	31.20 U	532	592	43.3 U	52 B	66.7 B
Barium	35.5 B	150 J	133 J	38.7 B	37 B	48.5 B
Beryllium	1 U	0.61 U	0.8 J	0.91 U	1 U	1 U
Boron	NS	NS	NS	NS	NS	50 U
Calcium	52,900	82,600	70,700	68,000	76,300	67,600
Cobalt	6.30 U	11.9 B	13.8 B	13.1 B	4.5 B	6.3 B
Iron	8,400	106,000 J	91,000 J	15,200	23,500	47,800
Lead	2 U	9.9 B	11.7 B	2.2 U	1 U	92.7
Magnesium	16,400	22,900	19,900	22,500	22,700	20,900
Manganese	450	1,990	1,710	663	664	1,080
Nickel	29.20 B	55.2	53.6	36.2 B	28.5 B	35.8 B
Potassium	1,760 B	2,050 J	2,110 J	1,520 B	1,530 B	1,600 B
Silver	5 U	13.4 L	10.9 L	4.4 B	2 U	1 U
Sodium	9,170	13,600 J	11,900 J	11,300	12,400	12,300 E
Thallium	4 U	2.9 J	8.4 J	5.2 B	3 U	7 U
Zinc	12.5 U	120 B	96.1 B	33.3	36.7	71.9
Dissolved Metals (UG/L)						
Barium	37.20 B	52.5 J	49.2 J	20.5 B	32 B	41.6 B
Calcium	56,600	74,800	71,900	66,500	81,300	71,600
Cobalt	6.70 B	6.3 B	9.2 B	7.5 B	4.3 B	6.2 B
Copper	4 U	5.5 U	5.5 U	7 B	7.8 B	53.1 E
Iron	8,780	82,200 J	78,600 J	14,300	22,200	49,100
Lead	2.30 U	6.2 B	5.7 B	2.2 U	1 U	46.2
Magnesium	17,600	22,200	21,300	22,000	24,500	22,200
Manganese	481	1,680	1,610	640	684	1,130
Nickel	34.40 B	13.1 J	16.5 J	25.5 B	21.8 B	29.9 B
Potassium	1,820 B	2,060 J	2,070 J	1,490 B	1,710 B	1,690 B
Silver	5 U	9.7 L	11.1 L	4.1 B	2 U	1 U
Sodium	9,750	12,900	12,400	10,900	13,600	13,100 E
Thallium	4 U	3.4 J	4.9 J	7.2 B	3 U	7 U
Zinc	16.60 U	23.4	16.7 B	35.4	29.5	62.4
Wet Chemistry (MG/L)						
Alkalinity	NS	170	174	138	162	199
Ammonia	NS	0.12	0.1 U	0.2	0.1 U	0.4
Bicarbonate	NS	170	174	138	2 U	198
Biological oxygen demand	NS	2 U	3.9	2 U	0.2 U	7.56
Chemical oxygen demand	NS	13.8	12.4	6.3	5 U	7
Chloride	NS	27.6	27.8	30	26.6	23
Hardness	254	NS	NS	NS	285	255
Nitrate	NS	NS	NS	NS	0.05 U	0.4
Nitrite	NS	NS	NS	NS	0.05 U	0.07
Oil and Grease	NS	1 U	1.8	1 U	NS	NS
Sulfate	NS	114	226	147	134	61.03
Total dissolved solids (TDS)	NS	406	391	395	354	350
Total organic carbon (TOC)	NS	2.2	2.3	4.4	10 U	100 U

NS - Not Sampled
B - Analyte not detected above associated blank
K - Reported value may be biased high
J - Reported value is estimated
R - Unreliable result
U - Analyte not detected
UL - Not detected, quantitation limit is probably higher

Table C-15
Historical Groundwater Analytical Results
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Sample ID	5GW15(96)	
Sample Date	04/16/96	
Chemical Name		
Volatile Organic Compounds (UG/L)		
1,2-Dichloroethene (total)	3	J
Trichloroethene	56	
Semivolatile Organic Compounds (UG/L)		
No Detections		
Explosives (UG/L)		
No Detections		
Total Metals (UG/L)		
Calcium	109,000	
Iron	7,290	
Magnesium	19,500	
Manganese	826	
Sodium	7,620	
Dissolved Metals (UG/L)		
Calcium	109,000	
Iron	1,860	
Magnesium	20,300	
Manganese	752	
Sodium	8,230	
Wet Chemistry (MG/L)		
Hardness	442	

NA - Not analyzed
B - Blank contamination
J - Estimated
U - Undetected

Table C-16
Historical Groundwater Analytical Results
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Sample ID **Sample Date**	5GW16(96) 04/16/1996	AS05-5GW16-R01 03/07/1998	AS05-5GW16-R02 10/14/1998	AS05-5GW16-R03 01/21/1999	AS05-5GW16-R04 10/22/1999
Chemical Name					
Volatile Organic Compounds (UG/L)					
Acetone	10 U	10 UJ	5 U	7	5 U
Carbon disulfide	10 U	10 U	0.7 J	1 U	1 U
Methylene chloride	10 U	10 U	0.6 BJ	2 U	1.4 J
Toluene	10 U	10 U	1 U	0.6 J	1 U
Total Metals (UG/L)					
Aluminum	114 U	560 B	575	77.2 B	32.6 B
Antimony	46 U	6.2 J	1.9 U	3 U	5 U
Barium	75.40 B	68.7 J	142 B	27 B	27.7 B
Calcium	65,600	112,000	137,000	98,000	29,100
Iron	4,100	35,400	8,850	27,400	4,300
Magnesium	15,500	21,500	27,200	23,300	16,700
Manganese	622	862	948	480	314
Silver	5 U	3.6 L	4 B	2 U	1 U
Sodium	7,500	9,070	10,300	10,500	9,110
Zinc	60.60	20.4 B	18.4 B	20.9	28.6
Dissolved Metals (UG/L)					
Antimony	46 U	2.3 J	1.9 U	3 U	5.6 B
Barium	74.30 B	25.3 B	15.5 B	33 B	25.1 B
Calcium	66,500	103,000	128,000	117,000	26,700
Cobalt	2.70 B	8 J	5 U	1 U	1 U
Iron	2,930	18,000	4,090	29,800	1390
Magnesium	15,700	19,800	25,400	28,500	15,700
Manganese	622	736	847	528	280
Molybdenum	NS	NS	NS	NS	NS
Potassium	1,160 B	559 J	478 B	627 B	418 B
Sodium	7,560	8,530	9,640	11,900	9,230
Vanadium	2 U	8 J	5.3 U	1 U	2 U
Zinc	54.20	19.2 B	9.3 B	22.6	32.4
Wet Chemistry (MG/L)					
Alkalinity	NS	200	221	214	55
Ammonia	NS	0.32	0.22	0.1 U	0.1 U
Bicarbonate	NS	200	221	2 U	54.9
Biological oxygen demand	NS	2 U	2 U	0.2 U	3.96
Chemical oxygen demand	NS	5 U	5 U	67.3	5 U
Chloride	NS	15.1	20	16	NS
Hardness	280	NS	NS	342	140
Sulfate	NS	177	214	248	98.42
Total dissolved solids (TDS)	NS	451	535	409	170
Total organic carbon (TOC)	NS	1.8	18.9	10 U	100 U
Total recoverable phenolics	NS	NS	NS	50 U	59.5

NS - Not sampled
B - Analyte not detected above associated blank
K - Reported value may be biased high
J - Reported value is estimated
R - Unreliable result
U - Analyte not detected
UL - Not detected, quantitation limit is probably higher

Table C-17
Historical Groundwater Analytical Results
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Sample ID	5GW17(96)	5GW17(96)DUP	AS05-5GW17-R01	AS05-5GW17-R02	AS05-5GW17-R03	AS05-5GW17-R04	AS05-5GW17P-R04
Sample Date	04/16/1996	04/16/1996	03/07/1998	10/15/1998	01/21/1999	10/25/1999	10/25/1999
Chemical Name							
Volatile Organic Compounds							
(UG/L)							
Carbon disulfide	10 U	10 U	10 U	1	1 U	1 U	NS
Trichloroethene	14	14	23	11 B	19	17	NS
cis-1,2-Dichloroethene	NS	NS	NS	2	1.7	1.3	NS
Total Metals (UG/L)							
Aluminum	221	144 U	9,860	23,300	3,780	546	NS
Arsenic	2 U	2 U	7.8 B	10.5	4 U	6 U	NS
Barium	166 B	138 B	365	563	316	85 B	NS
Calcium	59,800	50,100	51,400	58,800	48,400	56,700	NS
Chromium	5 U	5 U	17.8 K	31.2	8.8 B	1 U	NS
Cobalt	2.30 U	2 U	12 J	21.5 B	4.1 B	1 U	NS
Copper	4 U	4 U	14.2 B	55.2	19.9 B	25.7 E	NS
Iron	158	111	11,700	31,200	7,180	962	NS
Lead	5.60 U	2 U	8.6 B	12.1	4.6	7.8	NS
Magnesium	14,200	11,900	14,200	17,900	12,500	14,400	NS
Manganese	278	236	540	901	457	411	NS
Mercury	0.13 U	0.13 U	0.7	0.18 B	0.2 U	0.2 U	NS
Nickel	9 U	9 U	25.9 K	49.9	16.6 B	9 B	NS
Potassium	864 B	694 B	2,920 J	4,300 B	1,250 B	863 B	NS
Sodium	9,210	7,690	8,910	10,300	9,620	10,500 E	NS
Vanadium	2 U	2 U	22.2 J	40.5 B	6.1 B	2 U	NS
Zinc	12.20 U	10 U	64 B	139	51.3	33.2	NS
Dissolved Metals (UG/L)							
Antimony	46 U	46 U	5 J	1.9 U	3 U	NS	5 U
Barium	125 B	140 B	63.9 J	62 B	53.8 B	NS	184 B
Calcium	47,800	53,200	55,800	55,500	49,600	NS	59,000
Copper	4 U	4 U	5.5 U	18.2 B	13.5 B	NS	32.4 E
Iron	27.70 U	74.90 U	124 B	30.1 B	60.3 B	NS	7310
Lead	2 U	2 U	2.2 B	2.2 U	1.2 B	NS	3.2
Magnesium	11,300	12,600	14,400	14,700	12,600	NS	8,550
Manganese	211	233	393	443	356	NS	432
Mercury	0.13 U	0.13 U	0.13 U	0.13 U	0.2 U	NS	1.3
Nickel	9 U	9 U	6.8 U	8.8 U	5.8 B	NS	2 U
Potassium	648 B	717 B	760 J	636 B	716 B	NS	577 B
Sodium	7,410	8,260	9,610	10,200	10,900	NS	7,470 E
Zinc	6.60 U	15.10 U	24.8 B	25.4	28.1	NS	27.2

NS - Not sampled
B - Analyte not detected above associated blank
J - Reported value is estimated
U - Analyte not detected
K - Reported value may be biased high
R - Unrelaible result
UL - Not detected, quanititation limit is probably higher

Table C-17
Historical Groundwater Analytical Results
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Sample ID **Sample Date**	5GW17(96) 04/16/1996	5GW17(96)DUP 04/16/1996	AS05-5GW17-R01 03/07/1998	AS05-5GW17-R02 10/15/1998	AS05-5GW17-R03 01/21/1999	AS05-5GW17-R04 10/25/1999	AS05-5GW17P-R04 10/25/1999
Chemical Name							
Wet Chemistry (MG/L)							
Alkalinity	NS	NS	68.8	74.9	80	62	NS
Bicarbonate	NS	NS	68.8	74.9	2 U	61.9	NS
Biological oxygen demand	NS	NS	2 U	2 U	0.2 U	4.26	NS
Chemical oxygen demand	NS	NS	5 U	18.9	5 U	5 U	NS
Chloride	NS	NS	19.7	19.2	33.7	17.73	NS
Hardness	235	222	NS	NS	171	201	NS
Nitrate/Nitrite	NS	NS	1.12	0.62	NS	NS	NS
Oil and Grease	NS	NS	1.7	1 U	NS	NS	NS
Sulfate	NS	NS	135	115	82.3	88.58	NS
Total dissolved solids (TDS)	NS	NS	344	334	237	230	NS
Total organic carbon (TOC)	NS	NS	2.4	8.3	10 U	100 U	NS

NS - Not sampled
B - Analyte not detected above associated blank
K - Reported value may be biased high
J - Reported value is estimated
R - Unrelaible result
U - Analyte not detected
UL - Not detected, quanititation limit is probably higher

Table C-18
Historical Groundwater Analytical Results
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Sample ID **Sample Date**	AS05-5GW18-R01 03/07/1998	AS05-5GW18-R02 10/15/1998	AS05-5GW18-R03 01/21/1999	AS05-5GW18-R04 10/25/1999	AS05-5GW18P-R04 10/25/1999
Chemical Name					
Volatile Organic Compounds (UG/L)					
1,2-Dichloroethene (total)	7	NS	NS	NS	NS
Carbon disulfide	10 U	1	1 U	1 U	1 U
Trichloroethene	41	70	NS	19	20
cis-1,2-Dichloroethene	NS	17	14	3	3.2
Total Metals (UG/L)					
Aluminum	343	339	421	307	362
Barium	93.6 J	194 B	292	250	234
Calcium	83,700	78,500	70,200	60,900	58,500
Copper	5.5 U	5 U	14.5 B	32.4 E	41.3 E
Iron	4,430 J	6,380	14,100	11,900	12,100
Lead	15 B	2.2 U	3.6	90.6	20.3
Magnesium	11,000	11,500	9,510	8,860	8,500
Manganese	548	632	726	463	444
Nickel	6.8 U	8.8 U	2.8 B	4.2 B	5.4 B
Potassium	858 J	570 B	710 B	589 B	636 B
Sodium	8,100 J	7,370	7,960	7,560 E	7,290 E
Zinc	21.9 B	12.9 B	27.3	59.6	44.3
Dissolved Metals (UG/L)					
Aluminum	48.1 B	415	22.5 B	NS	35 B
Antimony	4 J	1.9 U	3 U	NS	5 U
Barium	93.6 J	159 B	273	NS	66 B
Calcium	90,900	90,600	82,300	NS	57,600
Iron	3,570 J	4,410	8,940	NS	16 U
Magnesium	12,300	13,400	11,200	NS	14,600
Manganese	592	714	967	NS	412
Nickel	7.9 J	8.8 U	1.3 B	NS	7 B
Potassium	640 B	355 B	682 B	NS	753 B
Sodium	8,700	8,340	9,620	NS	10,500 E
Zinc	17.7 B	21	26.5	NS	22.1

NS - Not sampled
B - Analyte not detected above associated blank
K - Reported value may be biased high
J - Reported value is estimated
R - Unreliable result
U - Not detected
UL - Not detected, quantitaion limit is probably higher

Table C-18
Historical Groundwater Analytical Results
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Sample ID **Sample Date**	AS05-5GW18-R01 03/07/1998	AS05-5GW18-R02 10/15/1998	AS05-5GW18-R03 01/21/1999	AS05-5GW18-R04 10/25/1999	AS05-5GW18P-R04 10/25/1999
Chemical Name					
Wet Chemistry (MG/L)					
Alkalinity	139	157	168	128	128
Ammonia	0.13	0.42	0.1 U	0.1 U	0.1 U
Bicarbonate	139	157	2 U	127	127
Biological oxygen demand	8.7	2 U	0.2 U	4.74	4.92
Chemical oxygen demand	11.6	6	5 U	5 U	5 U
Chloride	9.2	9.6	12.4	5 U	5 U
Hardness	NS	NS	213	186	179
Nitrate	NS	NS	0.05 U	0.05 U	0.25
Nitrate/Nitrite	0.18	0.14	NS	NS	NS
Oil and Grease	3	1 U	NS	NS	NS
Sulfate	140	64.8	86.9	27.57	47.25
Total dissolved solids (TDS)	332	280	261	210	210
Total organic carbon (TOC)	2.5	31.9	10 U	100 U	100 U
Total recoverable phenolics	NS	NS	50 U	50 U	643

NS - Not sampled
B - Analyte not detected above associated blank
K - Reported value may be biased high
J - Reported value is estimated
R - Unreliable result
U - Not detected
UL - Not detected, quantitaion limit is probably higher

Appendix D
Raw Groundwater Data

Table D-1
Groundwater Analytical Results for Alluvial Wells
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Station ID	5GW01				5GW07			5GW09			5GW11			5GW13		
Sample ID	AS05-5GW01-R05	AS05-5GW01P-R05	AS05-5GW01-R06	AS05-5GW01-R07	AS05-5GW07-R05	AS05-5GW07-R06	AS05-5GW07-R07	AS05-5GW09-R05	AS05-5GW09-R06	AS05-5GW09-R07	AS05-5GW11-R05	AS05-5GW11-R06	AS05-5GW11-R07	AS05-5GW13-R05	AS05-5GW13-R06	AS05-5GW13-R07
Sample Date	08/08/00	08/08/00	04/10/01	02/04/02	08/07/00	04/11/01	02/01/02	08/03/00	04/17/01	02/06/02	08/02/00	04/11/01	02/07/02	08/09/00	04/18/01	02/07/02
Chemical Name																
Volatile Organic Compounds (UG/L)																
1,1,1,2-Tetrachloroethane	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,1,1-Trichloroethane	1 U	1 U	1 U	1 U	1 U	1 U	1 U	0.5 J	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,1,2,2-Tetrachloroethane	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,1,2-Trichloroethane	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,1-Dichloroethane	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,1-Dichloroethene	1 UJ	1 UJ	1 U	1 U	1 U	1 U	1 U	1 UJ	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,2,3-Trichloropropane	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2,4-Trichlorobenzene	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,2-Dibromo-3-chloropropane	1 UJ	1 UJ	1 R	1 U	1 UJ	1 R	1 U	1 UJ	5 R	1 U	1 UJ	1 R	1 U	1 UJ	5 R	1 U
1,2-Dibromoethane	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,2-Dichlorobenzene	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,2-Dichloroethane	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,2-Dichloroethene (total)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2-Dichloropropane	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,3-Dichlorobenzene	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,4-Dichlorobenzene	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,4-Dioxane	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-Butanone	5 R	5 R	5 U	5 U	5 R	5 R	5 U	5 R	25 R	5 U	5 R	5 R	5 U	5 U	25 R	5 U
2-Chloro-1,3-butadiene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-Hexanone	5 UJ	5 UJ	5 U	5 U	5 UJ	5 U	5 U	5 UJ	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
4-Methyl-2-pentanone	5 UJ	5 UJ	5 U	5 U	5 U	5 U	5 U	5 UJ	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Acetone	5 R	5 R	5 R	5 U	5 R	5 R	5 U	5 R	25 R	5 U	5 R	5 R	5 U	5 R	25 R	5 U
Acetonitrile	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Acrolein	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Acrylonitrile	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Allyl chloride	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzene	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Bromochloromethane	1 UJ	1 UJ	1 U	1 U	1 U	1 U	1 U	1 UJ	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Bromodichloromethane	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Bromoform	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Bromomethane	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Carbon disulfide	1 UJ	1 UJ	1 U	1 U	1 U	1 U	1 U	1 UJ	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Carbon tetrachloride	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Chlorobenzene	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Chloroethane	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Chloroform	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Chloromethane	1 UJ	1 UJ	1 U	1 U	1 U	1 U	1 U	1 UJ	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Dibromochloromethane	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Dibromomethane	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dichlorodifluoromethane(Freon-12)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ethyl methacrylate	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ethylbenzene	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Hexachlorobutadiene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Iodomethane	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Isobutanol	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Methacrylonitrile	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Methyl methanesulfonate	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Methylene chloride	1.6 B	1.6 B	1.9 B	0.8 B	0.7 B	0.6 B	1.4 B	1.2 B	2 U	0.6 B	2 U	0.5 B	2 U	3.6	4.1 B	0.6 B
Pentachloroethane	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Propionitrile	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Styrene	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Tetrachloroethene	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Toluene	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Trichloroethene	1 U	1 U	1 U	1 U	1 U	1 U	1 U	48	46	26	1 U	1 U	1 U	81	62	62
Trichlorofluoromethane(Freon-11)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Vinyl acetate	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Vinyl chloride	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 UJ	1 U	1 U	1 U	1 U	1 U	0.6 J	1 U	1 U
Xylene, total	1 U	1 U	NA	NA	1 U	NA	NA	1 U	NA	NA	1 U	NA	NA	1 U	NA	NA
cis-1,2-Dichloroethene	1 U	1 U	1 U	1 U	1 U	1 U	1 U	7.1	4	3.5	1 U	1 U	1 U	5.2	3.2	22
cis-1,3-Dichloropropene	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
m- and p-Xylene	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
o-Xylene	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
trans-1,2-Dichloroethene	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U

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Groundwater Analytical Results for Alluvial Wells
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Station ID	5GW01				5GW07			5GW09			5GW11			5GW13		
Sample ID	AS05-5GW01-R05	AS05-5GW01P-R05	AS05-5GW01-R06	AS05-5GW01-R07	AS05-5GW07-R05	AS05-5GW07-R06	AS05-5GW07-R07	AS05-5GW09-R05	AS05-5GW09-R06	AS05-5GW09-R07	AS05-5GW11-R05	AS05-5GW11-R06	AS05-5GW11-R07	AS05-5GW13-R05	AS05-5GW13-R06	AS05-5GW13-R07
Sample Date	08/08/00	08/08/00	04/10/01	02/04/02	08/07/00	04/11/01	02/01/02	08/03/00	04/17/01	02/06/02	08/02/00	04/11/01	02/07/02	08/09/00	04/18/01	02/07/02
Chemical Name																
trans-1,3-Dichloropropene	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
trans-1,4-Dichloro-2-butene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Semivolatile Organic Compounds (UG/L)																
1,2,4,5-Tetrachlorobenzene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,4-Naphthoquinone	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1-Naphthylamine	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2,2'-Oxybis(1-chloropropane)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2,3,4,6-Tetrachlorophenol	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2,4,5-Trichlorophenol	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2,4,6-Trichlorophenol	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2,4-Dichlorophenol	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2,4-Dimethylphenol	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2,4-Dinitrophenol	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2,6-Dichlorophenol	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-Acetylaminofluorene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-Chloronaphthalene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-Chlorophenol	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-Methyl-5-nitroaniline	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-Methylaniline	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-Methylnaphthalene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-Methylphenol	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-Naphthylamine	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-Nitroaniline	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-Nitrophenol	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-Picoline	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3,3'-Dichlorobenzidine	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3,3'-Dimethylbenzidine	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3-Methylcholanthrene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3-Nitroaniline	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4,6-Dinitro-2-methylphenol	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4-Aminobiphenyl	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4-Bromophenyl-phenylether	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4-Chloro-3-methylphenol	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4-Chloroaniline	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4-Chlorophenyl-phenylether	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4-Methylphenol	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4-Nitroaniline	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4-Nitrophenol	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4-Nitroquinoline-1-oxide	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
7,12-Dimethylbenz(a)anthracene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Acenaphthene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Acenaphthylene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Acetophenone	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Anthracene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Aramite	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(a)anthracene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(a)pyrene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(b)fluoranthene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(g,h,i)perylene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(k)fluoranthene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzoic acid	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzyl alcohol	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Butylbenzylphthalate	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Carbazole	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chlorobenzilate	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chrysene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Di-n-butylphthalate	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Di-n-octylphthalate	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Diallate	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dibenz(a,h)anthracene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dibenzofuran	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Diethylphthalate	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dimethoate	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

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Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Station ID	5GW01				5GW07			5GW09			5GW11			5GW13		
Sample ID	AS05-5GW01-R05	AS05-5GW01P-R05	AS05-5GW01-R06	AS05-5GW01-R07	AS05-5GW07-R05	AS05-5GW07-R06	AS05-5GW07-R07	AS05-5GW09-R05	AS05-5GW09-R06	AS05-5GW09-R07	AS05-5GW11-R05	AS05-5GW11-R06	AS05-5GW11-R07	AS05-5GW13-R05	AS05-5GW13-R06	AS05-5GW13-R07
Sample Date	08/08/00	08/08/00	04/10/01	02/04/02	08/07/00	04/11/01	02/01/02	08/03/00	04/17/01	02/06/02	08/02/00	04/11/01	02/07/02	08/09/00	04/18/01	02/07/02
Chemical Name																
Dimethyl phthalate	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dinoseb	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Diphenylamine	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Disulfoton	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ethyl methanesulfonate	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Famphur	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Fluoranthene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Fluorene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Hexachlorobenzene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Hexachlorobutadiene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Hexachlorocyclopentadiene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Hexachloroethane	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Hexachloropropene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Isodrin	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Isophorone	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Isosafrole	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Methapyrilene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Methyl parathion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
N-Nitrosomorpholine	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
N-Nitrosopiperidine	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Naphthalene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
O,O,O-Triethyl phosphorothioate	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Parathion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pentachlorobenzene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pentachloronitrobenzene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pentachlorophenol	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Phenacetin	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Phenanthrene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Phenol	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Phorate	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pronamide	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pyrene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pyridine	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Safrole	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sulfotepp	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Thionazin	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
bis(2-Chloroethoxy)methane	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
bis(2-Chloroethyl)ether	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
bis(2-Ethylhexyl)phthalate	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
n-Nitroso-di-n-butylamine	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
n-Nitroso-di-n-propylamine	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
n-Nitroso-n-methylethylamine	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
n-Nitrosodiethylamine	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
n-Nitrosodimethylamine	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
n-Nitrosodiphenylamine	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
n-Nitrosopyrrolidine	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
p-Dimethylaminoazobenzene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
p-Phenylenediamine	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pesticide/Polychlorinated Biphenyls (UG/L)																
4,4'-DDD	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4,4'-DDE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4,4'-DDT	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Aldrin	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Aroclor-1016	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Aroclor-1221	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Aroclor-1232	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Aroclor-1242	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Aroclor-1248	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Aroclor-1254	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Aroclor-1260	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dieldrin	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Endosulfan I	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

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Station ID	5GW01				5GW07			5GW09			5GW11			5GW13		
Sample ID	AS05-5GW01-R05	AS05-5GW01P-R05	AS05-5GW01-R06	AS05-5GW01-R07	AS05-5GW07-R05	AS05-5GW07-R06	AS05-5GW07-R07	AS05-5GW09-R05	AS05-5GW09-R06	AS05-5GW09-R07	AS05-5GW11-R05	AS05-5GW11-R06	AS05-5GW11-R07	AS05-5GW13-R05	AS05-5GW13-R06	AS05-5GW13-R07
Sample Date	08/08/00	08/08/00	04/10/01	02/04/02	08/07/00	04/11/01	02/01/02	08/03/00	04/17/01	02/06/02	08/02/00	04/11/01	02/07/02	08/09/00	04/18/01	02/07/02
Chemical Name																
Endosulfan II	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Endosulfan sulfate	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Endrin	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Endrin aldehyde	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Endrin ketone	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Heptachlor	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Heptachlor epoxide	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Methoxychlor	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Toxaphene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
alpha-BHC	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
alpha-Chlordane	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
beta-BHC	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
delta-BHC	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
gamma-BHC (Lindane)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
gamma-Chlordane	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Herbicides (UG/L)																
2,4,5-T	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2,4,5-TP (Silvex)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2,4-D	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2,4-DB	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2,4-DP (Dichloroprop)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dalapon	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dicamba	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MCPA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MCPP	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Explosives (UG/L)																
1,3,5-Trinitrobenzene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,3-Dinitrobenzene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2,4-Dinitrotoluene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2,6-Dinitrotoluene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Nitrobenzene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total Metals (UG/L)																
Aluminum	68,900	61,000	NA	2,070	22.6 B	NA	63.6 J	136 B	NA	17.2 U	83.7 B	NA	5,260	29.3 B	NA	50.4 B
Antimony	4.9 U	4.9 U	NA	5 U	4.9 U	NA	5 U	4.9 U	NA	5 U	4.9 U	NA	5 U	4.9 B	NA	5 U
Arsenic	60.9	52.9	NA	5.1 U	4.3 B	NA	5.1 U	4.1 B	NA	5.1 U	3.8 U	NA	6.9 J	3.8 U	NA	5.1 U
Barium	432	442	NA	42.1 J	63.6 J	NA	78.3 J	32.8 J	NA	47.2 J	25.4 J	NA	305	21.7 J	NA	25.7 J
Beryllium	5.4	5.5	NA	0.26 J	0.1 U	NA	0.1 U	0.1 U	NA	0.1 U	0.1 U	NA	0.46 J	0.12 B	NA	0.1 J
Boron	NA	NA	NA	10 U	NA	NA	40.4 J	83.6	NA	36.9 J	50 R	NA	28.4 J	59.2	NA	47.8 J
Cadmium	0.4 U	0.4 U	NA	1.7 U	0.4 U	NA	1.7 U	0.4 UL	NA	1.7 U	0.4 U	NA	1.7 U	0.4 UL	NA	1.7 U
Calcium	49,000	52,600	NA	30,100	47,000	NA	56,800	90,700	NA	55,200	33,300	NA	39,000	196,000	NA	167,000
Chromium	122	111	NA	182	0.96 B	NA	1.4 J	0.7 UL	NA	2.7 B	0.7 UL	NA	20.5 B	6.2 B	NA	7.3 B
Cobalt	53.6	54.3	NA	3.3 J	31.5 J	NA	40.3 J	8.8 J	NA	72.3	8.3 J	NA	4.8 J	8.8 K	NA	7.8 J
Copper	113	114	NA	7.6 J	4 B	NA	1.5 U	0.7 U	NA	2.3 J	13.6 L	NA	39	3.2 B	NA	1.5 U
Cyanide	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	19	10 U	10 U	10 U	10 U	10 U	100	10 U
Iron	142,000 J	137,000 J	NA	5,080	10,600 J	NA	13,200	562	NA	9,400	15.9 U	NA	13,800	920 J	NA	3,890
Lead	138	138	NA	6.9	5.4 B	NA	2.9 U	2 U	NA	3.3	2 U	NA	17.4	2 U	NA	2.9 U
Magnesium	14,200	13,900	NA	4,080 J	21,300	NA	25,200	32,400	NA	22,000	13,600	NA	14,400	42,800	NA	31,300
Manganese	977	1,010	NA	62	1,030	NA	1,260	1,990	NA	2,200	214	NA	65.1	4,510	NA	2,840
Mercury	0.1 U	0.1 U	NA	0.2 U	0.1 U	NA	0.2 UL	0.1 U	NA	0.2 U	0.14 B	NA	0.2 U	0.1 U	NA	0.2 U
Molybdenum	NA	NA	NA	22.6 B	NA	NA	10 U	10 U	NA	10 U	10 U	NA	10 U	10 U	NA	10 U
Nickel	118	114	NA	135	84.4	NA	91.8	23.6 J	NA	24.2 J	36.6 J	NA	43.7	31.7 K	NA	28.2 J
Potassium	9,280 J	7,970 J	NA	1,090 J	2,730 J	NA	2,430 J	3,980 K	NA	2,940 J	1,920 J	NA	4,820 J	1,890 J	NA	1,400 J
Selenium	6.8 B	2.2 UL	NA	4 U	2.3 B	NA	4 U	2.2 U	NA	4 U	2.2 U	NA	4 U	2.2 U	NA	4 U
Silver	0.6 U	0.6 U	NA	0.6 U	0.6 U	NA	0.6 U	0.6 UL	NA	0.6 U	0.6 UL	NA	1.3 J	0.82 B	NA	0.6 U
Sodium	1,800 B	2,480 B	NA	1,850 J	16,500	NA	17,100	16,700	NA	14,000	7,190	NA	6,840	14,600	NA	13,800
Thallium	13.2 B	14.4 B	NA	5 U	2.3 UL	NA	5 U	2.3 U	NA	5 U	2.3 UL	NA	5 U	2.3 UL	NA	5 U
Tin	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Vanadium	146	137	NA	5.5 J	1 U	NA	0.8 U	1 U	NA	1.2 B	1 U	NA	11.8 J	1 U	NA	0.8 U
Zinc	524	512	NA	49.2 B	121	NA	121 B	39 B	NA	47.8	133	NA	79.3 B	50.7	NA	48.6 B
Dissolved Metals (UG/L)																

NA - Not analyzed
B - Analyte not detected above associated blank
D - Result came from a diluted sample
E - Exceedance - Interference

J - Reported value is estimated
K - Biased high
L - Biased low
R - Rejected
U - Undetected

Table D-1
Groundwater Analytical Results for Alluvial Wells
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Station ID	5GW01				5GW07			5GW09			5GW11			5GW13		
Sample ID	AS05-5GW01-R05	AS05-5GW01P-R05	AS05-5GW01-R06	AS05-5GW01-R07	AS05-5GW07-R05	AS05-5GW07-R06	AS05-5GW07-R07	AS05-5GW09-R05	AS05-5GW09-R06	AS05-5GW09-R07	AS05-5GW11-R05	AS05-5GW11-R06	AS05-5GW11-R07	AS05-5GW13-R05	AS05-5GW13-R06	AS05-5GW13-R07
Sample Date	08/08/00	08/08/00	04/10/01	02/04/02	08/07/00	04/11/01	02/01/02	08/03/00	04/17/01	02/06/02	08/02/00	04/11/01	02/07/02	08/09/00	04/18/01	02/07/02
Chemical Name																
Aluminum	19.2 U	19.2 U	99,800	NA	19.2 U	70.3 B	NA	92 B	79.6 B	NA	NA	110 B	NA	19.2 U	47.8 J	NA
Antimony	4.9 U	4.9 U	5.5 J	NA	4.9 U	3.1 U	NA	4.9 U	3.1 U	NA	NA	3.4 J	NA	4.9 U	3.1 U	NA
Arsenic	3.8 U	3.8 U	81.1	NA	7.6 B	3.5 B	NA	4.1 B	2.5 U	NA	NA	2.9 B	NA	4.9 B	2.5 U	NA
Barium	16.3 J	16.1 J	675	NA	63.3 J	74 B	NA	35.1 J	33.4 J	NA	NA	38.7 J	NA	20.6 J	23.7 J	NA
Beryllium	0.1 U	0.1 U	8	NA	0.1 U	0.36 B	NA	0.1 U	0.1 U	NA	NA	0.43 B	NA	0.1 U	0.12 J	NA
Boron	NA	NA	50.2	NA	NA	98.1	NA	57.5	112	NA	NA	71	NA	50 U	50 U	NA
Cadmium	0.4 U	0.4 UL	0.4 U	NA	0.4 U	0.6 B	NA	0.4 U	0.4 U	NA	NA	0.73 B	NA	0.4 UL	1.5 J	NA
Calcium	31,000	31,400	48,800	NA	49,700	51,200	NA	96,100	122,000	NA	NA	40,800	NA	189,000	237,000	NA
Chromium	0.7 U	0.7 U	206	NA	0.7 U	0.8 U	NA	0.7 U	0.8 U	NA	NA	0.8 U	NA	1.6 B	0.8 U	NA
Cobalt	1.1 U	1.1 U	77.4	NA	33.5 J	37.2 J	NA	8.9 J	5.3 J	NA	NA	5 J	NA	9.1 K	14.2 J	NA
Copper	0.7 UL	0.7 U	183	NA	0.7 UL	2.7 J	NA	0.7 UL	1.7 J	NA	NA	8.9 J	NA	1.2 B	2.3 J	NA
Iron	15.9 U	15.9 U	201,000	NA	10,600	12,100	NA	461	464	NA	NA	298	NA	1,350	1,130	NA
Lead	2 U	2 U	203	NA	2 U	2.5 U	NA	4.2 B	2.5 U	NA	NA	2.5 U	NA	2.9 K	2.5 U	NA
Magnesium	4,270 J	4,200 J	17,400	NA	22,200	23,500	NA	30,800	36,300	NA	NA	13,400	NA	39,400	54,300	NA
Manganese	0.94 B	1.1 B	1,290	NA	1,080	1,100	NA	2,110	1,990	NA	NA	43.8	NA	4,050	8,030	NA
Mercury	0.1 U	0.1 U	0.2 UL	NA	0.1 U	1 B	NA	0.1 U	0.2 U	NA	NA	0.2 UL	NA	0.13 B	0.2 U	NA
Molybdenum	NA	NA	10.3 J	NA	NA	10 U	NA	10 U	10 U	NA	NA	10 U	NA	10 U	10 U	NA
Nickel	2 U	3 B	174	NA	88.6	95.3	NA	29.1 J	24.1 J	NA	NA	11.6 J	NA	29.5 K	32 J	NA
Potassium	1,150 J	923 J	11,900	NA	3,850 J	3,250 J	NA	4,050 J	4,550 J	NA	NA	2,270 J	NA	1,990 J	2,460 J	NA
Selenium	2.2 UL	2.2 U	15.3	NA	2.2 UL	3.2 U	NA	16.3 B	3.2 U	NA	NA	3.2 U	NA	8.3 B	3.2 U	NA
Silver	0.6 U	0.78 B	7.1 J	NA	0.6 U	1.3 U	NA	1.3 B	1.3 U	NA	NA	1.3 U	NA	0.64 B	1.3 U	NA
Sodium	1,500 J	2,170 B	2,270 J	NA	18,800	19,300	NA	17,600 J	19,500 J	NA	NA	13,000	NA	16,200	20,000	NA
Thallium	2.3 UL	2.3 U	10.9 B	NA	2.3 UL	3.9 U	NA	2.3 U	3.9 U	NA	NA	6 B	NA	2.3 U	3.9 U	NA
Vanadium	1 U	1.3 B	192	NA	1 U	34.9 U	NA	1 U	34.9 U	NA	NA	34.9 U	NA	1 U	34.9 U	NA
Zinc	9.1 J	4.9 B	802 J	NA	105	139 B	NA	33.3 B	46.7 J	NA	NA	77.1 B	NA	38.7	56.3	NA
Wet Chemistry (MG/L)																
Alkalinity	94	90	74	87	85	65	70	120	170	82	52	89	56	260	210	240
Ammonia	0.2 U	0.2 U	NA	0.2 U	0.2 U	NA	0.2 U	0.22	NA	0.2 U	0.2 U	NA	0.2 U	0.2 U	NA	0.2 U
BOD-5day (total)	NA	NA	6.1	6.5	NA	8.6	2 U	NA	2 U	2 U	NA	9.3	17	NA	2 U	6.1
Bicarbonate	94	90	74	87	85	65	70	120	170	82	52	88	56	260	210	240
Biological oxygen demand	82	2 U	NA	NA	2 U	NA	NA	2 U	NA	NA	NA	NA	NA	2 U	NA	NA
Chemical oxygen demand	230	9	14	5 U	5 U	50	5 U	5	38	10	5 U	40	28	5 U	12	6
Chloride	1.2	1.1	2.2	5	30	29	44	24	35	45	6	5.5	7.9	35	42	42
Ethane	1.00E-03 U	1.00E-03 U	0.004	0.004 U	1.00E-03 U	0.004 U	0.004 U	1.00E-03 U	0.004 U	0.004 U	NA	0.004 U	0.004 U	NA	0.004 U	0.008
Ethene	1.00E-03 U	1.00E-03 U	0.004	0.004 U	1.00E-03 U	0.004 U	0.004 U	1.00E-03 U	0.004 U	0.004 U	NA	0.004 U	0.004 U	NA	0.004 U	0.005
Hardness	180	190	190	92	210	225	250	360	454	230	140	157	160	670	810	555
Methane	0.001 U	0.001 U	0.02	0.002 U	0.0128	0.012	0.01 B	0.0639 U	0.144	0.11	NA	0.002 U	0.002 U	NA	0.002 U	0.13 B
Nitrate	0.93	1.5	NA	0.8	0.5 U	NA	0.5 U	0.74	NA	0.5 U	0.83	NA	2.2	0.5 U	NA	0.5 U
Nitrate/Nitrite	NA	NA	1.6	NA	NA	0.55 U	NA	NA	1.4	NA	NA	1.4	NA	NA	0.55 U	NA
Nitrite	0.36	0.05 U	NA	0.05 U	0.05 U	NA	0.05 U	0.05 U	NA	0.05 U	NA	NA	0.05 U	0.05 U	NA	0.05 U
Nitrogen	NA	NA	0.2 U	NA	NA	0.37	NA	NA	0.2 U	NA	NA	0.2 U	NA	NA	0.2 U	NA
Oil and Grease	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sulfate	40	3	8	8	150	190	160	210	360	160	110	98	89	NA	800	320
Total dissolved solids (TDS)	94	92	160 L	540	NA	300	410	370	630	390	180	270	780	590	1,100	780
Total organic carbon (TOC)	1 U	1 U	1.9	1.2	1 U	1.7	1.1	2.4	2.5	3.2	2.5	3.9	8.7	3	3.2	2.1
Total recoverable phenolics	0.03 U	0.03 U	0.025 U	0.025 U	0.03 U	0.029	0.025 U	0.03 U	0.025 U	0.025 U	0.025 U	0.025 U	0.025 U	0.03 U	0.031	0.025 U
Reactivity (MG/L)																
Reactive cyanide	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Reactive sulfide	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

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E - Exceedance - Interference

J - Reported value is estimated
K - Biased high
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Table D-1
Groundwater Analytical Results for Alluvial Wells
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Station ID	5GW17				5GW18				5GW19			5GW20			5GW21	
Sample ID	AS05-5GW17-R05	AS05-5GW17P-R05	AS05-5GW17-R06	AS05-5GW17-R07	AS05-5GW18-R05	AS05-5GW18-R06	AS05-5GW18P-R06	AS05-5GW18-R07	AS05-5GW19-R05	AS05-5GW19-R06	AS05-5GW19-R07	AS05-5GW20-R05	AS05-5GW20-R06	AS05-5GW20-R07	AS05-5GW21-R05	AS05-5GW21-R06
Sample Date	08/10/00	08/10/00	04/06/01	02/06/02	08/10/00	04/19/01	04/19/01	02/06/02	08/09/00	04/05/01	02/04/02	08/09/00	04/04/01	02/06/02	08/08/00	04/04/01
Chemical Name																
Volatile Organic Compounds (UG/L)																
1,1,1,2-Tetrachloroethane	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,1,1-Trichloroethane	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,1,2,2-Tetrachloroethane	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,1,2-Trichloroethane	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,1-Dichloroethane	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,1-Dichloroethene	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 UJ	1 U
1,2,3-Trichloropropane	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2,4-Trichlorobenzene	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,2-Dibromo-3-chloropropane	1 UJ	1 UJ	1 R	1 U	1 UJ	10 R	10 R	1 U	1 UJ	1 R	1 U	1 UJ	1 R	1 U	1 UJ	1 R
1,2-Dibromoethane	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,2-Dichlorobenzene	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,2-Dichloroethane	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,2-Dichloroethene (total)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2-Dichloropropane	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,3-Dichlorobenzene	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,4-Dichlorobenzene	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,4-Dioxane	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-Butanone	5 R	5 R	5 U	5 U	5 R	50 R	50 R	5 U	5 U	5 R	5 U	5 U	5 R	5 U	5 R	5 R
2-Chloro-1,3-butadiene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-Hexanone	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 UJ	5 U
4-Methyl-2-pentanone	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 UJ	5 U
Acetone	5 R	5 R	5 R	5 U	5 R	50 R	50 R	5 U	5 R	5 R	5 U	5 R	5 R	5 U	5 R	5 R
Acetonitrile	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Acrolein	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Acrylonitrile	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Allyl chloride	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzene	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Bromochloromethane	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 UJ	1 U
Bromodichloromethane	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Bromoform	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Bromomethane	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Carbon disulfide	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 UJ	1 U
Carbon tetrachloride	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Chlorobenzene	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Chloroethane	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Chloroform	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Chloromethane	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 UJ	1 U
Dibromochloromethane	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Dibromomethane	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dichlorodifluoromethane(Freon-12)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ethyl methacrylate	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ethylbenzene	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Hexachlorobutadiene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Iodomethane	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Isobutanol	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Methacrylonitrile	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Methyl methanesulfonate	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Methylene chloride	2 UJ	2 UJ	0.6 B	0.6 B	2 UJ	2 U	2 U	0.9 B	4.1	0.7 B	0.7 B	3.6	0.6 B	0.6 B	1.9 B	0.6 B
Pentachloroethane	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Propionitrile	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Styrene	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Tetrachloroethene	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Toluene	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Trichloroethene	10	11	17	27	77	48	46	44	1 U	1 U	2	3.6	14	28	1 U	1 U
Trichlorofluoromethane(Freon-11)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Vinyl acetate	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Vinyl chloride	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Xylene, total	1 U	1 U	NA	NA	1 U	NA	NA	NA	1 U	NA	NA	1 U	NA	NA	1 U	NA
cis-1,2-Dichloroethene	1.3	1.3	0.9 J	1.8	9.9	11	9.6	24	1 U	1 U	1 U	0.7 J	0.9 J	2.3	1 U	1 U
cis-1,3-Dichloropropene	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
m- and p-Xylene	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
o-Xylene	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
trans-1,2-Dichloroethene	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U

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Table D-1
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Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Station ID	5GW17				5GW18				5GW19			5GW20			5GW21	
Sample ID	AS05-5GW17-R05	AS05-5GW17P-R05	AS05-5GW17-R06	AS05-5GW17-R07	AS05-5GW18-R05	AS05-5GW18-R06	AS05-5GW18P-R06	AS05-5GW18-R07	AS05-5GW19-R05	AS05-5GW19-R06	AS05-5GW19-R07	AS05-5GW20-R05	AS05-5GW20-R06	AS05-5GW20-R07	AS05-5GW21-R05	AS05-5GW21-R06
Sample Date	08/10/00	08/10/00	04/06/01	02/06/02	08/10/00	04/19/01	04/19/01	02/06/02	08/09/00	04/05/01	02/04/02	08/09/00	04/04/01	02/06/02	08/08/00	04/04/01
Chemical Name																
trans-1,3-Dichloropropene	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
trans-1,4-Dichloro-2-butene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Semivolatile Organic Compounds (UG/L)																
1,2,4,5-Tetrachlorobenzene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,4-Naphthoquinone	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1-Naphthylamine	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2,2'-Oxybis(1-chloropropane)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2,3,4,6-Tetrachlorophenol	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2,4,5-Trichlorophenol	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2,4,6-Trichlorophenol	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2,4-Dichlorophenol	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2,4-Dimethylphenol	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2,4-Dinitrophenol	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2,6-Dichlorophenol	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-Acetylaminofluorene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-Chloronaphthalene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-Chlorophenol	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-Methyl-5-nitroaniline	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-Methylaniline	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-Methylnaphthalene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-Methylphenol	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-Naphthylamine	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-Nitroaniline	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-Nitrophenol	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-Picoline	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3,3'-Dichlorobenzidine	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3,3'-Dimethylbenzidine	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3-Methylcholanthrene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3-Nitroaniline	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4,6-Dinitro-2-methylphenol	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4-Aminobiphenyl	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4-Bromophenyl-phenylether	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4-Chloro-3-methylphenol	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4-Chloroaniline	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4-Chlorophenyl-phenylether	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4-Methylphenol	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4-Nitroaniline	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4-Nitrophenol	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4-Nitroquinoline-1-oxide	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
7,12-Dimethylbenz(a)anthracene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Acenaphthene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Acenaphthylene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Acetophenone	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Anthracene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Aramite	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(a)anthracene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(a)pyrene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(b)fluoranthene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(g,h,i)perylene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(k)fluoranthene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzoic acid	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzyl alcohol	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Butylbenzylphthalate	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Carbazole	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chlorobenzilate	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chrysene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Di-n-butylphthalate	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Di-n-octylphthalate	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Diallate	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dibenz(a,h)anthracene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dibenzofuran	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Diethylphthalate	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dimethoate	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

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Site 5, Allegany Ballistics Laboratory
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Station ID	5GW17				5GW18				5GW19			5GW20			5GW21	
Sample ID	AS05-5GW17-R05	AS05-5GW17P-R05	AS05-5GW17-R06	AS05-5GW17-R07	AS05-5GW18-R05	AS05-5GW18-R06	AS05-5GW18P-R06	AS05-5GW18-R07	AS05-5GW19-R05	AS05-5GW19-R06	AS05-5GW19-R07	AS05-5GW20-R05	AS05-5GW20-R06	AS05-5GW20-R07	AS05-5GW21-R05	AS05-5GW21-R06
Sample Date	08/10/00	08/10/00	04/06/01	02/06/02	08/10/00	04/19/01	04/19/01	02/06/02	08/09/00	04/05/01	02/04/02	08/09/00	04/04/01	02/06/02	08/08/00	04/04/01
Chemical Name																
Dimethyl phthalate	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dinoseb	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Diphenylamine	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Disulfoton	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ethyl methanesulfonate	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Famphur	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Fluoranthene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Fluorene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Hexachlorobenzene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Hexachlorobutadiene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Hexachlorocyclopentadiene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Hexachloroethane	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Hexachloropropene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Isodrin	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Isophorone	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Isosafrole	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Methapyrilene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Methyl parathion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
N-Nitrosomorpholine	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
N-Nitrosopiperidine	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Naphthalene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
O,O,O-Triethyl phosphorothioate	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Parathion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pentachlorobenzene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pentachloronitrobenzene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pentachlorophenol	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Phenacetin	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Phenanthrene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Phenol	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Phorate	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pronamide	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pyrene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pyridine	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Safrole	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sulfotepp	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Thionazin	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
bis(2-Chloroethoxy)methane	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
bis(2-Chloroethyl)ether	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
bis(2-Ethylhexyl)phthalate	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
n-Nitroso-di-n-butylamine	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
n-Nitroso-di-n-propylamine	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
n-Nitroso-n-methylethylamine	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
n-Nitrosodiethylamine	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
n-Nitrosodimethylamine	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
n-Nitrosodiphenylamine	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
n-Nitrosopyrrolidine	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
p-Dimethylaminoazobenzene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
p-Phenylenediamine	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pesticide/Polychlorinated Biphenyls (UG/L)																
4,4'-DDD	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4,4'-DDE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4,4'-DDT	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Aldrin	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Aroclor-1016	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Aroclor-1221	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Aroclor-1232	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Aroclor-1242	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Aroclor-1248	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Aroclor-1254	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Aroclor-1260	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dieldrin	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Endosulfan I	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

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Sample ID	AS05-5GW17-R05	AS05-5GW17P-R05	AS05-5GW17-R06	AS05-5GW17-R07	AS05-5GW18-R05	AS05-5GW18-R06	AS05-5GW18P-R06	AS05-5GW18-R07	AS05-5GW19-R05	AS05-5GW19-R06	AS05-5GW19-R07	AS05-5GW20-R05	AS05-5GW20-R06	AS05-5GW20-R07	AS05-5GW21-R05	AS05-5GW21-R06
Sample Date	08/10/00	08/10/00	04/06/01	02/06/02	08/10/00	04/19/01	04/19/01	02/06/02	08/09/00	04/05/01	02/04/02	08/09/00	04/04/01	02/06/02	08/08/00	04/04/01
Chemical Name																
Endosulfan II	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Endosulfan sulfate	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Endrin	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Endrin aldehyde	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Endrin ketone	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Heptachlor	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Heptachlor epoxide	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Methoxychlor	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Toxaphene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
alpha-BHC	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
alpha-Chlordane	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
beta-BHC	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
delta-BHC	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
gamma-BHC (Lindane)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
gamma-Chlordane	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Herbicides (UG/L)																
2,4,5-T	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2,4,5-TP (Silvex)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2,4-D	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2,4-DB	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2,4-DP (Dichloroprop)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dalapon	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dicamba	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MCPA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MCPP	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Explosives (UG/L)																
1,3,5-Trinitrobenzene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,3-Dinitrobenzene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2,4-Dinitrotoluene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2,6-Dinitrotoluene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Nitrobenzene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total Metals (UG/L)																
Aluminum	412	348	NA	61.4 J	19.2 U	34.3 B	48 B	17.2 U	16,300	NA	447	7,090	NA	185 J	1,930	NA
Antimony	4.9 U	4.9 U	NA	5 U	4.9 B	3.1 U	3.1 U	5 U	4.9 U	NA	5 U	5.7 B	NA	5 U	4.9 U	NA
Arsenic	3.8 U	3.8 U	NA	5.1 U	5.5 B	2.5 U	2.5 U	5.1 U	7.4 B	NA	5.1 U	4.8 B	NA	5.1 U	6.4 B	NA
Barium	99.8 J	87.7 J	NA	38.9 J	36 J	26.8 B	25.1 B	76 J	366	NA	101 J	185 J	NA	103 J	117 J	NA
Beryllium	0.1 U	0.1 U	NA	0.1 U	0.1 U	0.73 B	0.72 J	0.1 U	1.1 J	NA	0.1 U	0.54 J	NA	0.1 U	0.24 B	NA
Boron	50 U	50 U	NA	27.7 J	50 U	50 R	50 R	13.8 J	50 U	NA	17.5 J	50 U	NA	27.7 J	NA	NA
Cadmium	0.4 UL	0.4 UL	NA	1.7 U	0.4 UL	0.4 U	0.4 U	1.7 U	0.4 UL	NA	1.7 U	0.4 UL	NA	1.7 U	0.4 U	NA
Calcium	58,700	60,600	NA	66,100	111,000	110,000	106,000	93,600	31,400	NA	25,900	42,900	NA	58,100	55,000	NA
Chromium	7.1 J	6.4 B	NA	3.4 B	5.2 B	0.8 U	0.8 U	1.5 B	33.8	NA	3 J	15.9	NA	2.6 B	6.3 B	NA
Cobalt	4 B	3.5 B	NA	2.1 J	1.1 U	1 U	1.3 B	1.3 U	41.4 J	NA	1.3 U	15.2 J	NA	1.3 U	2.5 B	NA
Copper	1.5 B	2.2 B	NA	1.5 U	1.7 B	0.8 U	3.1 J	1.5 U	37.2	NA	1.5 U	15 J	NA	1.5 U	7.7 B	NA
Cyanide	10 U	10 U	10 U	10 U	10 U	11	11	10 U	10 U	1	10 U	10 U	1	10 U	10 U	1
Iron	786 J	609 J	NA	50.6 B	1,470 J	1,740	1,690	4,280	28,500 J	NA	730	14,500 J	NA	218	6,030 J	NA
Lead	2 U	2 U	NA	2.9 U	2 U	2.5 U	2.5 U	3.3	29.9	NA	2.9 U	10.2	NA	2.9 U	4.9 B	NA
Magnesium	15,100	15,600	NA	17,400	15,600	15,900	15,200	12,900	8,710	NA	5,780	10,200	NA	7,760	6,970	NA
Manganese	579	597	NA	535	91.8	394	371	448	2,900	NA	145	672	NA	19	108	NA
Mercury	0.1 U	0.1 U	NA	0.2 U	0.1 U	0.2 U	0.2 U	0.2 U	0.21 B	NA	0.2 U	0.1 U	NA	0.2 U	0.1 U	NA
Molybdenum	10 U	10 U	NA	10 U	10 U	10 R	10 R	10 U	10 U	NA	10 U	10 U	NA	10 U	NA	NA
Nickel	16 J	15.3 J	NA	9.4 J	10.5 J	3.3 B	1.7 U	2.1 U	61.2	NA	3 J	27.2 J	NA	2.1 U	13.8 B	NA
Potassium	926 J	902 J	NA	698 J	468 J	504 J	457 J	451 J	2,840 J	NA	548 J	2,160 J	NA	347 J	866 J	NA
Selenium	2.2 U	2.2 U	NA	4 U	2.2 U	3.2 U	3.2 U	4 U	2.2 U	NA	4 U	2.2 U	NA	4 U	2.5 B	NA
Silver	0.6 U	0.96 B	NA	0.6 U	0.92 B	1.3 U	1.3 U	0.6 U	0.84 B	NA	0.6 U	0.6 U	NA	0.6 U	0.6 U	NA
Sodium	7,630	7,970	NA	9,780	9,640	10,700	10,200	8,470	3,470 B	NA	3,320 J	4,480 B	NA	6,380	7,000	NA
Thallium	2.3 UL	2.3 UL	NA	5 U	2.3 UL	3.9 U	3.9 U	5 U	2.3 UL	NA	5 U	2.3 UL	NA	5 U	3.5 B	NA
Tin	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Vanadium	1 U	1 U	NA	1.5 B	1 U	34.9 U	34.9 U	0.89 B	32.9 J	NA	0.89 J	12.4 J	NA	1.1 B	4.6 B	NA
Zinc	28.6	30.6	NA	15.2 B	30.6	61 R	26.7 R	8.9 B	150	NA	34.2 B	72.4	NA	12.5 B	43.5	NA
Dissolved Metals (UG/L)																

NA - Not analyzed
B - Analyte not detected above associated blank
D - Result came from a diluted sample
E - Exceedance - Interference

J - Reported value is estimated
K - Biased high
L - Biased low
R - Rejected
U - Undetected

Table D-1
Groundwater Analytical Results for Alluvial Wells
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Station ID	5GW17				5GW18				5GW19			5GW20			5GW21	
Sample ID	AS05-5GW17-R05	AS05-5GW17P-R05	AS05-5GW17-R06	AS05-5GW17-R07	AS05-5GW18-R05	AS05-5GW18-R06	AS05-5GW18P-R06	AS05-5GW18-R07	AS05-5GW19-R05	AS05-5GW19-R06	AS05-5GW19-R07	AS05-5GW20-R05	AS05-5GW20-R06	AS05-5GW20-R07	AS05-5GW21-R05	AS05-5GW21-R06
Sample Date	08/10/00	08/10/00	04/06/01	02/06/02	08/10/00	04/19/01	04/19/01	02/06/02	08/09/00	04/05/01	02/04/02	08/09/00	04/04/01	02/06/02	08/08/00	04/04/01
Chemical Name																
Aluminum	19.2 U	19.2 U	50.8 B	NA	19.2 U	34.3 B	48 B	NA	19.2 U	58.1 B	NA	19.2 U	259	NA	19.2 U	49.7 B
Antimony	4.9 U	4.9 U	3.1 U	NA	4.9 U	3.1 U	3.1 U	NA	6.2 B	3.1 U	NA	4.9 U	3.1 U	NA	4.9 U	3.1 U
Arsenic	3.8 U	3.8 U	3.4 B	NA	4.1 B	2.5 U	2.5 U	NA	3.8 U	3.4 K	NA	3.8 U	2.6 K	NA	7.7 B	2.5 U
Barium	67.9 J	67.3 J	57.1 J	NA	33.3 J	26.8 B	25.1 B	NA	75.6 J	78.5 J	NA	82.9 J	92.6 J	NA	89.4 J	106 J
Beryllium	0.1 U	0.1 U	0.33 B	NA	0.1 U	0.73 B	0.72 J	NA	0.1 U	0.21 B	NA	0.1 U	0.26 B	NA	0.1 U	0.28 B
Boron	50 U	50 U	50 U	NA	50 U	50 R	50 R	NA	50 U	50 U	NA	50 U	50 U	NA	NA	50 U
Cadmium	0.4 UL	0.4 UL	0.65 B	NA	0.4 UL	0.4 U	0.4 U	NA	0.4 UL	0.4 U	NA	0.4 UL	0.58 B	NA	0.4 U	0.56 B
Calcium	64,100	63,700	71,000	NA	122,000	110,000	106,000	NA	26,900	29,200	NA	38,200	51,000	NA	61,800	67,200
Chromium	2.3 B	2.7 B	0.8 U	NA	2.7 B	0.8 U	0.8 U	NA	1.7 B	0.8 U	NA	2.2 B	4.6 J	NA	0.8 B	1 J
Cobalt	2.9 B	3.3 B	1.8 J	NA	1.1 U	1 U	1.3 B	NA	1.1 B	1 U	NA	1.8 B	1	NA	1.1 U	1.6 J
Copper	0.7 U	0.7 U	0.8 U	NA	0.7 U	0.8 U	3.1 J	NA	0.7 U	1.8 J	NA	0.7 U	4.7 B	NA	0.7 UL	3.2 J
Iron	15.9 U	15.9 U	46.2 J	NA	495	1,740	1,690	NA	15.9 U	41.5 J	NA	15.9 U	455	NA	15.9 U	79.5 J
Lead	2 U	2 U	2.5 U	NA	2 U	2.5 U	2.5 U	NA	2 U	2.5 U	NA	2 U	2.5 U	NA	2 U	2.5 U
Magnesium	16,400	16,200	19,500	NA	17,100	15,900	15,200	NA	5,800	5,990	NA	8,480	6,680	NA	7,430	8,340
Manganese	636	644	502	NA	99.7	394	371	NA	117	13.4 J	NA	46.6	29.7	NA	24.7	18.2
Mercury	0.1 U	0.17 B	0.2 UL	NA	0.1 U	0.2 U	0.2 U	NA	0.1 U	0.2 UL	NA	0.1 U	0.2 UL	NA	0.1 U	0.2 UL
Molybdenum	10 U	10 U	10 U	NA	10 U	10 R	10 R	NA	10 U	10 U	NA	10 U	10 U	NA	NA	10 U
Nickel	11.7 K	11.8 K	12.1 K	NA	6.4 B	3.3 B	1.7 U	NA	8.3 B	2.4 J	NA	6.2 B	6.1 J	NA	4 B	3.6 J
Potassium	913 J	928 J	885 B	NA	578 J	504 J	457 J	NA	637 J	585 J	NA	853 J	388 J	NA	256 B	277 J
Selenium	4.4 B	4.5 B	3.2 U	NA	2.2 U	3.2 U	3.2 U	NA	2.2 U	3.2 U	NA	2.2 U	3.2 U	NA	2.4 B	3.2 U
Silver	0.6 U	0.7 B	1.3 U	NA	0.79 B	1.3 U	1.3 U	NA	0.6 U	1.3 U	NA	0.6 U	1.3 U	NA	0.6 U	1.3 U
Sodium	8,600	8,780	10,100	NA	11,700	10,700	10,200	NA	3,940 B	3,540 J	NA	5,320	5,170	NA	7,870	9,150
Thallium	2.3 UL	2.3 UL	5.2 K	NA	2.3 UL	3.9 U	3.9 U	NA	2.3 UL	5.8 K	NA	2.3 U	4.7 K	NA	2.3 UL	4.1 K
Vanadium	1 U	1 U	34.9 U	NA	1 U	34.9 U	34.9 U	NA	1.1 B	34.9 U	NA	1 U	34.9 U	NA	1 U	34.9 U
Zinc	16.2 J	16.9 J	40.3 B	NA	17.3 J	61 R	26.7 R	NA	14.5 B	35 B	NA	11.3 B	34 B	NA	21	44.9
Wet Chemistry (MG/L)																
Alkalinity	98	99	69	86	120	130	130	160	43	45	46	74	63	70	100	110
Ammonia	0.2 U	0.2 U	NA	0.2 U	0.2 U	NA	NA	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
BOD-5day (total)	NA	NA	2 U	2 U	NA	2 U	2	2 U	NA	2 U	2 U	NA	2 U	2 U	NA	2 U
Bicarbonate	98	99	69	86	120	130	130	160	43	45	46	74	63	70	100	110
Biological oxygen demand	2 U	2.6	NA	NA	2 U	NA	NA	NA	2 U	NA	NA	3.9	NA	NA	2 U	NA
Chemical oxygen demand	5 U	5 U	26	7	5 U	23	18	5 U	5 U	56	5 U	5 U	30	5 U	5 U	33
Chloride	20	20	14	19	21	16	16	23	4	3.5	5	12	7.7	13	28	28
Ethane	NA	NA	0.004 U	0.006	NA	0.004 U	0.004 U	0.004 U	NA	0.004 U	0.005	NA	0.004 U	0.004 U	1.00E-03 U	0.004 U
Ethene	NA	NA	0.004 U	0.004	NA	0.004 U	0.004 U	0.011	NA	0.004 U	0.004 U	NA	0.004 U	0.004 U	1.00E-03 U	0.004 U
Hardness	210	220	258	240	340	340	330	290	110	100	88	150	160	180	170	200
Methane	NA	NA	0.002 U	0.14	NA	0.02 U	0.02 U	0.8	NA	0.002 U	0.014	NA	0.002 U	0.002 U	0.001 U	0.002 U
Nitrate	0.5 U	0.5 U	NA	0.5 U	0.5 U	NA	NA	0.5 U	0.58	NA	0.5 U	0.51	NA	0.5 U	0.5 U	NA
Nitrate/Nitrite	NA	NA	0.55 U	NA	NA	0.55 U	0.55 U	NA	NA	0.88	NA	NA	0.61	NA	NA	0.55 U
Nitrite	0.05 U	0.05 U	NA	0.05 U	0.05 U	NA	NA	0.05 U	0.05	NA	0.05 U	0.05 U	NA	0.05 U	0.09	NA
Nitrogen	NA	NA	0.2 U	NA	NA	0.2 U	0.2 U	NA	NA	NA	NA	NA	NA	NA	NA	NA
Oil and Grease	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sulfate	130	120	180	160	250	200	220	160	NA	51	450	NA	110	96	62	75
Total dissolved solids (TDS)	250	240	360	380	370	390	380	390	100	170 L	210	150	200 L	280	210	260 L
Total organic carbon (TOC)	1.1	1.1	27	0.95	1.3	1.2	1.2	0.89	1 U	10	1.3	1 U	1 U	0.8	1 U	1.3
Total recoverable phenolics	0.03 U	0.03 U	0.025 U	0.025 U	0.03 U	0.025 U	0.025 U	0.025 U	0.03 U	0.025 U	0.025 U	0.03 U	0.025 U	0.025 U	0.03 U	0.025 U
Reactivity (MG/L)																
Reactive cyanide	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Reactive sulfide	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

NA - Not analyzed
B - Analyte not detected above associated blank
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J - Reported value is estimated
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Table D-1
Groundwater Analytical Results for Alluvial Wells
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Station ID		5GW22				5GW23			5GW24		
Sample ID	AS05-5GW21-R07	AS05-5GW22-R05	AS05-5GW22-R06	AS05-5GW22-R07	AS05-5GW22P-R07	AS05-5GW23-R05	AS05-5GW23-R06	AS05-5GW23-R07	AS05-5GW24-R05	AS05-5GW24-R06	AS05-5GW24-R07
Sample Date	02/04/02	08/08/00	04/19/01	02/07/02	02/07/02	08/08/00	04/04/01	02/05/02	08/07/00	04/09/01	02/05/02
Chemical Name											
Volatile Organic Compounds (UG/L)											
1,1,1,2-Tetrachloroethane	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,1,1-Trichloroethane	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,1,2,2-Tetrachloroethane	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,1,2-Trichloroethane	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,1-Dichloroethane	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,1-Dichloroethene	1 U	1 UJ	1 U	1 U	1 U	1 UJ	1 U	1 U	1 U	1 U	1 U
1,2,3-Trichloropropane	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2,4-Trichlorobenzene	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,2-Dibromo-3-chloropropane	1 U	1 UJ	10 R	1 U	1 U	1 UJ	1 R	1 U	1 UJ	1 R	1 U
1,2-Dibromoethane	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,2-Dichlorobenzene	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,2-Dichloroethane	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,2-Dichloroethene (total)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2-Dichloropropane	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,3-Dichlorobenzene	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,4-Dichlorobenzene	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,4-Dioxane	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-Butanone	5 U	5 R	50 R	5 U	5 U	5 R	5 R	5 U	5 R	5 U	5 U
2-Chloro-1,3-butadiene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-Hexanone	5 U	5 UJ	5 U	5 U	5 U	5 UJ	5 U	5 U	5 UJ	5 U	5 U
4-Methyl-2-pentanone	5 U	5 UJ	5 U	5 U	5 U	5 UJ	5 U	5 U	5 U	5 U	5 U
Acetone	5 U	5 R	50 R	5 U	5 U	5 R	5 R	5 U	5 R	5 R	5 U
Acetonitrile	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Acrolein	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Acrylonitrile	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Allyl chloride	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzene	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Bromochloromethane	1 U	1 UJ	1 U	1 U	1 U	1 UJ	1 U	1 U	1 U	1 U	1 U
Bromodichloromethane	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Bromoform	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Bromomethane	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Carbon disulfide	1 U	1 UJ	1 U	1 U	1 U	1 UJ	1 U	1 U	2.1 B	1 U	1 U
Carbon tetrachloride	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Chlorobenzene	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Chloroethane	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Chloroform	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Chloromethane	1 U	1 UJ	1 U	1 U	1 U	1 UJ	1 U	1 U	1 U	1 U	1 U
Dibromochloromethane	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Dibromomethane	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dichlorodifluoromethane(Freon-12)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ethyl methacrylate	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ethylbenzene	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Hexachlorobutadiene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Iodomethane	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Isobutanol	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Methacrylonitrile	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Methyl methanesulfonate	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Methylene chloride	0.9 B	1.6 B	2 U	0.5 B	0.6 B	1.8 B	0.7 B	2.7 B	0.6 B	1.8 B	2.6 B
Pentachloroethane	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Propionitrile	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Styrene	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Tetrachloroethene	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Toluene	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Trichloroethene	4.7	82	96	130	150	4.2	3.9	3.7	1 U	1 U	1 U
Trichlorofluoromethane(Freon-11)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Vinyl acetate	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Vinyl chloride	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Xylene, total	NA	1 U	NA	NA	NA	1 U	NA	NA	1 U	NA	NA
cis-1,2-Dichloroethene	1 U	13	14	20	20	1 U	1 U	1 U	1 U	1 U	1 U
cis-1,3-Dichloropropene	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
m- and p-Xylene	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
o-Xylene	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
trans-1,2-Dichloroethene	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U

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Table D-1
Groundwater Analytical Results for Alluvial Wells
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Station ID	5GW22					5GW23			5GW24		
Sample ID	AS05-5GW21-R07	AS05-5GW22-R05	AS05-5GW22-R06	AS05-5GW22-R07	AS05-5GW22P-R07	AS05-5GW23-R05	AS05-5GW23-R06	AS05-5GW23-R07	AS05-5GW24-R05	AS05-5GW24-R06	AS05-5GW24-R07
Sample Date	02/04/02	08/08/00	04/19/01	02/07/02	02/07/02	08/08/00	04/04/01	02/05/02	08/07/00	04/09/01	02/05/02
Chemical Name											
trans-1,3-Dichloropropene	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
trans-1,4-Dichloro-2-butene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Semivolatile Organic Compounds (UG/L)											
1,2,4,5-Tetrachlorobenzene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,4-Naphthoquinone	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1-Naphthylamine	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2,2'-Oxybis(1-chloropropane)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2,3,4,6-Tetrachlorophenol	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2,4,5-Trichlorophenol	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2,4,6-Trichlorophenol	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2,4-Dichlorophenol	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2,4-Dimethylphenol	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2,4-Dinitrophenol	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2,6-Dichlorophenol	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-Acetylaminofluorene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-Chloronaphthalene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-Chlorophenol	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-Methyl-5-nitroaniline	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-Methylaniline	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-Methylnaphthalene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-Methylphenol	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-Naphthylamine	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-Nitroaniline	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-Nitrophenol	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2-Picoline	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3,3'-Dichlorobenzidine	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3,3'-Dimethylbenzidine	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3-Methylcholanthrene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3-Nitroaniline	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4,6-Dinitro-2-methylphenol	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4-Aminobiphenyl	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4-Bromophenyl-phenylether	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4-Chloro-3-methylphenol	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4-Chloroaniline	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4-Chlorophenyl-phenylether	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4-Methylphenol	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4-Nitroaniline	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4-Nitrophenol	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4-Nitroquinoline-1-oxide	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
7,12-Dimethylbenz(a)anthracene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Acenaphthene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Acenaphthylene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Acetophenone	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Anthracene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Aramite	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(a)anthracene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(a)pyrene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(b)fluoranthene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(g,h,i)perylene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(k)fluoranthene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzoic acid	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzyl alcohol	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Butylbenzylphthalate	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Carbazole	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chlorobenzilate	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chrysene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Di-n-butylphthalate	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Di-n-octylphthalate	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Diallate	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dibenz(a,h)anthracene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dibenzofuran	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Diethylphthalate	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dimethoate	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

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Table D-1
Groundwater Analytical Results for Alluvial Wells
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Station ID		5GW22				5GW23			5GW24		
Sample ID	AS05-5GW21-R07	AS05-5GW22-R05	AS05-5GW22-R06	AS05-5GW22-R07	AS05-5GW22P-R07	AS05-5GW23-R05	AS05-5GW23-R06	AS05-5GW23-R07	AS05-5GW24-R05	AS05-5GW24-R06	AS05-5GW24-R07
Sample Date	02/04/02	08/08/00	04/19/01	02/07/02	02/07/02	08/08/00	04/04/01	02/05/02	08/07/00	04/09/01	02/05/02
Chemical Name											
Dimethyl phthalate	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dinoseb	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Diphenylamine	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Disulfoton	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ethyl methanesulfonate	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Famphur	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Fluoranthene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Fluorene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Hexachlorobenzene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Hexachlorobutadiene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Hexachlorocyclopentadiene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Hexachloroethane	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Hexachloropropene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Isodrin	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Isophorone	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Isosafrole	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Methapyrilene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Methyl parathion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
N-Nitrosomorpholine	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
N-Nitrosopiperidine	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Naphthalene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
O,O,O-Triethyl phosphorothioate	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Parathion	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pentachlorobenzene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pentachloronitrobenzene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pentachlorophenol	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Phenacetin	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Phenanthrene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Phenol	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Phorate	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pronamide	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pyrene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pyridine	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Safrole	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sulfotepp	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Thionazin	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
bis(2-Chloroethoxy)methane	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
bis(2-Chloroethyl)ether	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
bis(2-Ethylhexyl)phthalate	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
n-Nitroso-di-n-butylamine	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
n-Nitroso-di-n-propylamine	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
n-Nitroso-n-methylethylamine	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
n-Nitrosodiethylamine	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
n-Nitrosodimethylamine	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
n-Nitrosodiphenylamine	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
n-Nitrosopyrrolidine	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
p-Dimethylaminoazobenzene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
p-Phenylenediamine	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Pesticide/Polychlorinated Biphenyls (UG/L)											
4,4'-DDD	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4,4'-DDE	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4,4'-DDT	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Aldrin	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Aroclor-1016	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Aroclor-1221	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Aroclor-1232	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Aroclor-1242	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Aroclor-1248	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Aroclor-1254	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Aroclor-1260	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dieldrin	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Endosulfan I	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

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Table D-1
Groundwater Analytical Results for Alluvial Wells
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Station ID		5GW22				5GW23			5GW24		
Sample ID	AS05-5GW21-R07	AS05-5GW22-R05	AS05-5GW22-R06	AS05-5GW22-R07	AS05-5GW22P-R07	AS05-5GW23-R05	AS05-5GW23-R06	AS05-5GW23-R07	AS05-5GW24-R05	AS05-5GW24-R06	AS05-5GW24-R07
Sample Date	02/04/02	08/08/00	04/19/01	02/07/02	02/07/02	08/08/00	04/04/01	02/05/02	08/07/00	04/09/01	02/05/02
Chemical Name											
Endosulfan II	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Endosulfan sulfate	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Endrin	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Endrin aldehyde	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Endrin ketone	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Heptachlor	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Heptachlor epoxide	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Methoxychlor	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Toxaphene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
alpha-BHC	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
alpha-Chlordane	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
beta-BHC	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
delta-BHC	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
gamma-BHC (Lindane)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
gamma-Chlordane	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Herbicides (UG/L)											
2,4,5-T	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2,4,5-TP (Silvex)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2,4-D	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2,4-DB	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2,4-DP (Dichloroprop)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dalapon	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Dicamba	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MCPA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MCPP	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Explosives (UG/L)											
1,3,5-Trinitrobenzene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,3-Dinitrobenzene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2,4-Dinitrotoluene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2,6-Dinitrotoluene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Nitrobenzene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total Metals (UG/L)											
Aluminum	88.8 B	6,060	52.6 J	360	567	1,070	NA	387	94.1 B	NA	134 J
Antimony	5 U	4.9 U	3.1 U	5.3 J	5 U	4.9 U	NA	5 U	4.9 U	NA	5 U
Arsenic	5.1 U	3.8 U	2.5 U	5.1 U	5.1 U	3.8 U	NA	5.1 U	5 B	NA	5.1 U
Barium	102 J	233	110 J	89.5 J	107 J	346	NA	733	72.3 J	NA	62.5 J
Beryllium	0.1 U	0.5 B	0.75 B	0.1 U	0.1 U	0.1 B	NA	0.1 U	0.11 B	NA	0.1 U
Boron	17.5 J	NA	50 U	10 U	10 U	NA	NA	17.5 J	NA	NA	26.3 J
Cadmium	1.7 U	0.4 U	0.4 U	1.7 U	1.7 U	0.4 U	NA	1.7 U	0.42 B	NA	1.7 U
Calcium	68,300	44,800	64,000	55,900	62,100	58,400	NA	85,100	124,000	NA	115,000
Chromium	3.2 J	12.2 B	0.8 U	4.4 B	5.1 B	5.1 B	NA	3.8 B	0.96 B	NA	0.92 B
Cobalt	1.3 U	27 J	1 U	2.7 J	2.9 J	2.8 B	NA	1.8 J	1.1 U	NA	1.3 U
Copper	1.5 U	7.5 B	0.8 U	1.5 U	1.5 U	3.2 B	NA	3 J	3.3 B	NA	2.2 J
Cyanide	20	10 U	11	10 U	10 U	10 U	1	10 U	10 U	10 U	10 U
Iron	239	11,900 J	14.7 U	668	1,130	4,590 J	NA	4,400	405 J	NA	261
Lead	2.9 U	14	2.5 U	2.9 U	2.9 U	6.2 B	NA	2.9 U	2.1 B	NA	2.9 U
Magnesium	8,090	7,030	8,670	7,810	8,740	6,860	NA	9,980	21,200	NA	26,800
Manganese	18.8	1,350	65.1	154	177	338	NA	337	44.3	NA	17
Mercury	0.2 U	0.22 B	0.2 U	0.2 U	0.2 U	0.1 U	NA	0.2 U	0.1 U	NA	0.2 U
Molybdenum	10 U	NA	10 R	10 U	10 U	NA	NA	10 U	NA	NA	10 U
Nickel	2.1 U	33 J	2.2 B	4.6 B	5.7 B	15.9 J	NA	2.1 U	2.8 B	NA	2.1 U
Potassium	173 J	1,690 J	372 J	458 J	504 J	1,840 J	NA	877 J	2,980 J	NA	1,150 J
Selenium	4 U	2.2 UL	3.2 U	4 U	4 U	3 B	NA	4 U	2.2 UL	NA	4 U
Silver	0.6 U	0.6 U	1.3 U	0.6 U	0.6 U	0.6 U	NA	0.6 U	0.6 U	NA	0.6 U
Sodium	6,710	5,240	7,450	6,140	6,460	5,680	NA	5,800 J	6,070	NA	5,420 J
Thallium	5 U	2.3 UL	3.9 U	5 U	5 U	4.7 B	NA	5 U	2.3 UL	NA	5 U
Tin	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Vanadium	0.8 U	11.6 J	34.9 U	0.8 U	0.8 U	3.9 B	NA	1.1 J	1 U	NA	0.8 U
Zinc	28.1 B	85.7	46.6 R	20.1 B	22.2 B	63.2	NA	21 B	31.4	NA	22.1 B
Dissolved Metals (UG/L)											

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Table D-1
Groundwater Analytical Results for Alluvial Wells
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Station ID		5GW22				5GW23			5GW24		
Sample ID	AS05-5GW21-R07	AS05-5GW22-R05	AS05-5GW22-R06	AS05-5GW22-R07	AS05-5GW22P-R07	AS05-5GW23-R05	AS05-5GW23-R06	AS05-5GW23-R07	AS05-5GW24-R05	AS05-5GW24-R06	AS05-5GW24-R07
Sample Date	02/04/02	08/08/00	04/19/01	02/07/02	02/07/02	08/08/00	04/04/01	02/05/02	08/07/00	04/09/01	02/05/02
Chemical Name											
Aluminum	NA	19.2 U	52.6 J	NA	NA	19.2 U	30.8 B	NA	19.2 U	26.6 B	NA
Antimony	NA	4.9 U	3.1 U	NA	NA	4.9 U	3.7 J	NA	4.9 U	3.1 U	NA
Arsenic	NA	3.8 U	2.5 U	NA	NA	5.6 B	3.5 K	NA	3.8 U	3.2 B	NA
Barium	NA	82.9 J	110 J	NA	NA	353	380	NA	72.7 J	72.9 B	NA
Beryllium	NA	0.1 U	0.75 B	NA	NA	0.1 U	0.26 B	NA	0.1 U	0.1 U	NA
Boron	NA	NA	50 U	NA	NA	NA	50 U	NA	NA	51.4	NA
Cadmium	NA	0.4 U	0.4 U	NA	NA	0.4 U	0.56 B	NA	0.4 U	0.4 U	NA
Calcium	NA	49,400	64,000	NA	NA	65,200	64,400	NA	132,000	121,000	NA
Chromium	NA	0.96 B	0.8 U	NA	NA	0.7 U	0.8 U	NA	0.7 U	0.8 U	NA
Cobalt	NA	3.4 B	1 U	NA	NA	1.6 B	1.3 J	NA	1.1 U	1 U	NA
Copper	NA	0.7 UL	0.8 U	NA	NA	0.7 UL	1.5 B	NA	0.7 UL	1.4 B	NA
Iron	NA	15.9 U	14.7 U	NA	NA	1,720	3,640	NA	15.9 U	14.7 U	NA
Lead	NA	2 U	2.5 U	NA	NA	2 U	2.5 U	NA	3.5	2.5 U	NA
Magnesium	NA	6,920	8,670	NA	NA	7,390	7,740	NA	22,500	19,800	NA
Manganese	NA	284	65.1	NA	NA	331	294	NA	16.2	2.6 B	NA
Mercury	NA	0.1 U	0.2 U	NA	NA	0.1 U	0.22 L	NA	0.11 B	1.2 L	NA
Molybdenum	NA	NA	10 R	NA	NA	NA	10 U	NA	NA	10 U	NA
Nickel	NA	8.3 B	2.2 B	NA	NA	4.5 B	2.3 J	NA	2 U	1.8 B	NA
Potassium	NA	754 B	372 J	NA	NA	1,320 J	1,220 J	NA	4,330 J	4,160 J	NA
Selenium	NA	2.2 UL	3.2 U	NA	NA	2.2 UL	3.2 U	NA	2.3 B	3.2 U	NA
Silver	NA	0.6 U	1.3 U	NA	NA	0.6 U	1.3 U	NA	0.6 U	1.3 U	NA
Sodium	NA	6,270	7,450	NA	NA	5,630	6,740	NA	6,600	11,400	NA
Thallium	NA	2.3 UL	3.9 U	NA	NA	2.3 UL	5.3 K	NA	2.3 UL	5.5 B	NA
Vanadium	NA	1 U	34.9 U	NA	NA	1 U	34.9 U	NA	1 U	34.9 U	NA
Zinc	NA	29.7	46.6 R	NA	NA	18.4 J	37.1 B	NA	8.9 J	27 B	NA
Wet Chemistry (MG/L)											
Alkalinity	100	83	77	100	98	180	190	220	350	287	230
Ammonia	0.2 U	0.2 U	NA	0.2 U	0.2 U	0.39	0.2 U	0.2 U	0.2 U	NA	0.2 U
BOD-5day (total)	2 U	NA	2.1	2 U	2 U	NA	2 U	7.9	NA	4.5	2 U
Bicarbonate	100	83	77	100	98	180	190	220	340	290	230
Biological oxygen demand	NA	2 U	NA	NA	NA	2 U	NA	NA	2 U	NA	NA
Chemical oxygen demand	5 U	5 U	18	6	5	5 U	41	5 U	5 U	31	5 U
Chloride	34	20	18	17	18	10	13	9	10	28	24
Ethane	0.004 U	1.00E-03 U	0.004 U	0.004 U	0.004 U	1.00E-03 U	0.004 U	0.004 U	1.00E-03 U	0.004	0.004 U
Ethene	0.004 U	1.00E-03 U	0.004 U	0.004 U	0.004 U	1.00E-03 U	0.004 U	0.004 U	1.00E-03 U	0.004	0.004 U
Hardness	200	140	200	170	190	170	200	250	400	380	400
Methane	0.002 U	0.0012	0.002 U	0.002 U	0.002 U	0.001 U	0.002 U	0.011	0.0011	0.02	0.002 U
Nitrate	0.5 U	1.3	NA	0.5 U	0.5 U	0.5 U	NA	0.5 U	1.8	NA	0.5 U
Nitrate/Nitrite	NA	NA	0.55 U	NA	NA	NA	0.55 U	NA	NA	1.5	NA
Nitrite	0.05 U	0.17	NA	0.05 U	0.05 U	0.05 U	NA	0.05 U	0.05 U	NA	0.05 U
Nitrogen	NA	NA	0.2 U	NA	NA	NA	NA	NA	NA	0.2 U	NA
Oil and Grease	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sulfate	80	71	99	110	100	33	50	10	77	88	73
Total dissolved solids (TDS)	1,300	170	260	290	290	200	280 L	340	NA	450	540
Total organic carbon (TOC)	1.2	1 U	1 U	1.7	2.2	1.3	1.5	0.9	1.2	1.1	1.5
Total recoverable phenolics	0.025 U	0.03 U	0.025 U	0.025 U	0.025 U	0.03 U	0.025	0.025 U	0.03 U	0.025 U	0.025 U
Reactivity (MG/L)											
Reactive cyanide	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Reactive sulfide	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

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Table D-2
Groundwater Analytical Results for Bedrock Wells
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Station ID	5GW02				5GW03		
Sample ID	AS05-5GW02-R05	AS05-5GW02-R06	AS05-5GW02-R07	AS05-5GW02P-R07	AS05-5GW03-R05	AS05-5GW03-R06	AS05-5GW03-R07
Sample Date	08/03/00	04/11/01	02/05/02	02/05/02	08/07/00	04/11/01	02/05/02
Chemical Name							
Volatile Organic Compounds (UG/L)							
1,1,1,2-Tetrachloroethane	NA	NA	NA	NA	NA	NA	NA
1,1,1-Trichloroethane	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,1,2,2-Tetrachloroethane	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,1,2-Trichloroethane	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,1-Dichloroethane	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,1-Dichloroethene	1 UJ	1 U	1 U	1 U	1 U	1 U	1 U
1,2,3-Trichloropropane	NA	NA	NA	NA	NA	NA	NA
1,2,4-Trichlorobenzene	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,2-Dibromo-3-chloropropane	1 UJ	1 R	1 U	1 U	1 UJ	1 R	1 U
1,2-Dibromoethane	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,2-Dichlorobenzene	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,2-Dichloroethane	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,2-Dichloroethene (total)	NA	NA	NA	NA	NA	NA	NA
1,2-Dichloropropane	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,3-Dichlorobenzene	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,4-Dichlorobenzene	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,4-Dioxane	NA	NA	NA	NA	NA	NA	NA
2-Butanone	5 R	5 R	5 U	5 U	5 R	5 R	5 U
2-Chloro-1,3-butadiene	NA	NA	NA	NA	NA	NA	NA
2-Hexanone	5 UJ	5 U	5 U	5 U	5 UJ	5 U	5 U
4-Methyl-2-pentanone	5 UJ	5 U	5 U	5 U	5 U	5 U	5 U
Acetone	5 R	23 L	5 U	5 U	5 R	5 R	5 U
Acetonitrile	NA	NA	NA	NA	NA	NA	NA
Acrolein	NA	NA	NA	NA	NA	NA	NA
Acrylonitrile	NA	NA	NA	NA	NA	NA	NA
Allyl chloride	NA	NA	NA	NA	NA	NA	NA
Benzene	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Bromochloromethane	1 UJ	1 U	1 U	1 U	1 U	1 U	1 U
Bromodichloromethane	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Bromoform	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Bromomethane	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Carbon disulfide	1 UJ	1 U	1 U	1 U	1 U	1 U	1 U
Carbon tetrachloride	1 U	0.7 J	1 U	1 U	1 U	1 U	1 U
Chlorobenzene	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Chloroethane	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Chloroform	1 U	1 U	1 U	1 U	1 U	1 U	1 U

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Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Station ID	5GW02				5GW03		
Sample ID	AS05-5GW02-R05	AS05-5GW02-R06	AS05-5GW02-R07	AS05-5GW02P-R07	AS05-5GW03-R05	AS05-5GW03-R06	AS05-5GW03-R07
Sample Date	08/03/00	04/11/01	02/05/02	02/05/02	08/07/00	04/11/01	02/05/02
Chemical Name							
Chloromethane	1 UJ	1 U	1 U	1 U	1 U	1 U	1 U
Dibromochloromethane	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Dibromomethane	NA	NA	NA	NA	NA	NA	NA
Dichlorodifluoromethane(Freon-12)	NA	NA	NA	NA	NA	NA	NA
Ethyl methacrylate	NA	NA	NA	NA	NA	NA	NA
Ethylbenzene	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Hexachlorobutadiene	NA	NA	NA	NA	NA	NA	NA
Iodomethane	NA	NA	NA	NA	NA	NA	NA
Isobutanol	NA	NA	NA	NA	NA	NA	NA
Methacrylonitrile	NA	NA	NA	NA	NA	NA	NA
Methyl methanesulfonate	NA	NA	NA	NA	NA	NA	NA
Methylene chloride	1.1 B	0.5 B	2.7 B	0.7 B	0.7 B	2 U	0.7 B
Pentachloroethane	NA	NA	NA	NA	NA	NA	NA
Propionitrile	NA	NA	NA	NA	NA	NA	NA
Styrene	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Tetrachloroethene	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Toluene	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Trichloroethene	8.2	7.2	7.1	6.5	4.4	6.3	11
Trichlorofluoromethane(Freon-11)	NA	NA	NA	NA	NA	NA	NA
Vinyl acetate	NA	NA	NA	NA	NA	NA	NA
Vinyl chloride	1 UJ	1 U	1 U	1 U	1 U	1 U	1 U
Xylene, total	1 U	NA	NA	NA	1 U	NA	NA
cis-1,2-Dichloroethene	1 J	0.8 J	0.8 J	0.5 J	0.7 J	0.6 J	0.8 J
cis-1,3-Dichloropropene	1 U	1 U	1 U	1 U	1 U	1 U	1 U
m- and p-Xylene	1 U	1 U	1 U	1 U	1 U	1 U	1 U
o-Xylene	1 U	1 U	1 U	1 U	1 U	1 U	1 U
trans-1,2-Dichloroethene	1 U	1 U	1 U	1 U	1 U	1 U	1 U
trans-1,3-Dichloropropene	1 U	1 U	1 U	1 U	1 U	1 U	1 U
trans-1,4-Dichloro-2-butene	NA	NA	NA	NA	NA	NA	NA
Semivolatile Organic Compounds (UG/L)							
1,2,4,5-Tetrachlorobenzene	NA	NA	NA	NA	NA	NA	NA
1,4-Naphthoquinone	NA	NA	NA	NA	NA	NA	NA
1-Naphthylamine	NA	NA	NA	NA	NA	NA	NA
2,2'-Oxybis(1-chloropropane)	NA	NA	NA	NA	NA	NA	NA
2,3,4,6-Tetrachlorophenol	NA	NA	NA	NA	NA	NA	NA
2,4,5-Trichlorophenol	NA	NA	NA	NA	NA	NA	NA
2,4,6-Trichlorophenol	NA	NA	NA	NA	NA	NA	NA
2,4-Dichlorophenol	NA	NA	NA	NA	NA	NA	NA
2,4-Dimethylphenol	NA	NA	NA	NA	NA	NA	NA

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Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Station ID	5GW02				5GW03		
Sample ID	AS05-5GW02-R05	AS05-5GW02-R06	AS05-5GW02-R07	AS05-5GW02P-R07	AS05-5GW03-R05	AS05-5GW03-R06	AS05-5GW03-R07
Sample Date	08/03/00	04/11/01	02/05/02	02/05/02	08/07/00	04/11/01	02/05/02
Chemical Name							
2,4-Dinitrophenol	NA	NA	NA	NA	NA	NA	NA
2,6-Dichlorophenol	NA	NA	NA	NA	NA	NA	NA
2-Acetylaminofluorene	NA	NA	NA	NA	NA	NA	NA
2-Chloronaphthalene	NA	NA	NA	NA	NA	NA	NA
2-Chlorophenol	NA	NA	NA	NA	NA	NA	NA
2-Methyl-5-nitroaniline	NA	NA	NA	NA	NA	NA	NA
2-Methylaniline	NA	NA	NA	NA	NA	NA	NA
2-Methylnaphthalene	NA	NA	NA	NA	NA	NA	NA
2-Methylphenol	NA	NA	NA	NA	NA	NA	NA
2-Naphthylamine	NA	NA	NA	NA	NA	NA	NA
2-Nitroaniline	NA	NA	NA	NA	NA	NA	NA
2-Nitrophenol	NA	NA	NA	NA	NA	NA	NA
2-Picoline	NA	NA	NA	NA	NA	NA	NA
3,3'-Dichlorobenzidine	NA	NA	NA	NA	NA	NA	NA
3,3'-Dimethylbenzidine	NA	NA	NA	NA	NA	NA	NA
3-Methylcholanthrene	NA	NA	NA	NA	NA	NA	NA
3-Nitroaniline	NA	NA	NA	NA	NA	NA	NA
4,6-Dinitro-2-methylphenol	NA	NA	NA	NA	NA	NA	NA
4-Aminobiphenyl	NA	NA	NA	NA	NA	NA	NA
4-Bromophenyl-phenylether	NA	NA	NA	NA	NA	NA	NA
4-Chloro-3-methylphenol	NA	NA	NA	NA	NA	NA	NA
4-Chloroaniline	NA	NA	NA	NA	NA	NA	NA
4-Chlorophenyl-phenylether	NA	NA	NA	NA	NA	NA	NA
4-Methylphenol	NA	NA	NA	NA	NA	NA	NA
4-Nitroaniline	NA	NA	NA	NA	NA	NA	NA
4-Nitrophenol	NA	NA	NA	NA	NA	NA	NA
4-Nitroquinoline-1-oxide	NA	NA	NA	NA	NA	NA	NA
7,12-Dimethylbenz(a)anthracene	NA	NA	NA	NA	NA	NA	NA

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Table D-2
Groundwater Analytical Results for Bedrock Wells
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Station ID	5GW02				5GW03		
Sample ID	AS05-5GW02-R05	AS05-5GW02-R06	AS05-5GW02-R07	AS05-5GW02P-R07	AS05-5GW03-R05	AS05-5GW03-R06	AS05-5GW03-R07
Sample Date	08/03/00	04/11/01	02/05/02	02/05/02	08/07/00	04/11/01	02/05/02
Chemical Name							
Acenaphthene	NA	NA	NA	NA	NA	NA	NA
Acenaphthylene	NA	NA	NA	NA	NA	NA	NA
Acetophenone	NA	NA	NA	NA	NA	NA	NA
Anthracene	NA	NA	NA	NA	NA	NA	NA
Aramite	NA	NA	NA	NA	NA	NA	NA
Benzo(a)anthracene	NA	NA	NA	NA	NA	NA	NA
Benzo(a)pyrene	NA	NA	NA	NA	NA	NA	NA
Benzo(b)fluoranthene	NA	NA	NA	NA	NA	NA	NA
Benzo(g,h,i)perylene	NA	NA	NA	NA	NA	NA	NA
Benzo(k)fluoranthene	NA	NA	NA	NA	NA	NA	NA
Benzoic acid	NA	NA	NA	NA	NA	NA	NA
Benzyl alcohol	NA	NA	NA	NA	NA	NA	NA
Butylbenzylphthalate	NA	NA	NA	NA	NA	NA	NA
Chlorobenzilate	NA	NA	NA	NA	NA	NA	NA
Chrysene	NA	NA	NA	NA	NA	NA	NA
Di-n-butylphthalate	NA	NA	NA	NA	NA	NA	NA
Di-n-octylphthalate	NA	NA	NA	NA	NA	NA	NA
Diallate	NA	NA	NA	NA	NA	NA	NA
Dibenz(a,h)anthracene	NA	NA	NA	NA	NA	NA	NA
Dibenzofuran	NA	NA	NA	NA	NA	NA	NA
Diethylphthalate	NA	NA	NA	NA	NA	NA	NA
Dimethoate	NA	NA	NA	NA	NA	NA	NA
Dimethyl phthalate	NA	NA	NA	NA	NA	NA	NA
Dinoseb	NA	NA	NA	NA	NA	NA	NA
Diphenylamine	NA	NA	NA	NA	NA	NA	NA
Disulfoton	NA	NA	NA	NA	NA	NA	NA
Ethyl methanesulfonate	NA	NA	NA	NA	NA	NA	NA
Famphur	NA	NA	NA	NA	NA	NA	NA
Fluoranthene	NA	NA	NA	NA	NA	NA	NA
Fluorene	NA	NA	NA	NA	NA	NA	NA
Hexachlorobenzene	NA	NA	NA	NA	NA	NA	NA
Hexachlorobutadiene	NA	NA	NA	NA	NA	NA	NA
Hexachlorocyclopentadiene	NA	NA	NA	NA	NA	NA	NA
Hexachloroethane	NA	NA	NA	NA	NA	NA	NA
Hexachloropropene	NA	NA	NA	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	NA	NA	NA	NA	NA	NA	NA
Isodrin	NA	NA	NA	NA	NA	NA	NA
Isophorone	NA	NA	NA	NA	NA	NA	NA
Isosafrole	NA	NA	NA	NA	NA	NA	NA
Methapyrilene	NA	NA	NA	NA	NA	NA	NA

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Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Station ID	5GW02				5GW03		
Sample ID	AS05-5GW02-R05	AS05-5GW02-R06	AS05-5GW02-R07	AS05-5GW02P-R07	AS05-5GW03-R05	AS05-5GW03-R06	AS05-5GW03-R07
Sample Date	08/03/00	04/11/01	02/05/02	02/05/02	08/07/00	04/11/01	02/05/02
Chemical Name							
Methyl parathion	NA	NA	NA	NA	NA	NA	NA
N-Nitrosomorpholine	NA	NA	NA	NA	NA	NA	NA
N-Nitrosopiperidine	NA	NA	NA	NA	NA	NA	NA
Naphthalene	NA	NA	NA	NA	NA	NA	NA
O,O,O-Triethyl phosphorothioate	NA	NA	NA	NA	NA	NA	NA
Parathion	NA	NA	NA	NA	NA	NA	NA
Pentachlorobenzene	NA	NA	NA	NA	NA	NA	NA
Pentachloronitrobenzene	NA	NA	NA	NA	NA	NA	NA
Pentachlorophenol	NA	NA	NA	NA	NA	NA	NA
Phenacetin	NA	NA	NA	NA	NA	NA	NA
Phenanthrene	NA	NA	NA	NA	NA	NA	NA
Phenol	NA	NA	NA	NA	NA	NA	NA
Phorate	NA	NA	NA	NA	NA	NA	NA
Pronamide	NA	NA	NA	NA	NA	NA	NA
Pyrene	NA	NA	NA	NA	NA	NA	NA
Pyridine	NA	NA	NA	NA	NA	NA	NA
Safrole	NA	NA	NA	NA	NA	NA	NA
Sulfotepp	NA	NA	NA	NA	NA	NA	NA
Thionazin	NA	NA	NA	NA	NA	NA	NA
bis(2-Chloroethoxy)methane	NA	NA	NA	NA	NA	NA	NA
bis(2-Chloroethyl)ether	NA	NA	NA	NA	NA	NA	NA
bis(2-Ethylhexyl)phthalate	NA	NA	NA	NA	NA	NA	NA
n-Nitroso-di-n-butylamine	NA	NA	NA	NA	NA	NA	NA
n-Nitroso-di-n-propylamine	NA	NA	NA	NA	NA	NA	NA
n-Nitroso-n-methylethylamine	NA	NA	NA	NA	NA	NA	NA
n-Nitrosodiethylamine	NA	NA	NA	NA	NA	NA	NA
n-Nitrosodimethylamine	NA	NA	NA	NA	NA	NA	NA
n-Nitrosodiphenylamine	NA	NA	NA	NA	NA	NA	NA
n-Nitrosopyrrolidine	NA	NA	NA	NA	NA	NA	NA
p-Dimethylaminoazobenzene	NA	NA	NA	NA	NA	NA	NA
p-Phenylenediamine	NA	NA	NA	NA	NA	NA	NA
Pesticide/Polychlorinated Biphenyls (UG/L)							
4,4'-DDD	NA	NA	NA	NA	NA	NA	NA
4,4'-DDE	NA	NA	NA	NA	NA	NA	NA
4,4'-DDT	NA	NA	NA	NA	NA	NA	NA
Aldrin	NA	NA	NA	NA	NA	NA	NA
Aroclor-1016	NA	NA	NA	NA	NA	NA	NA
Aroclor-1221	NA	NA	NA	NA	NA	NA	NA
Aroclor-1232	NA	NA	NA	NA	NA	NA	NA

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Rocket Center, West Virginia

Station ID	5GW02				5GW03		
Sample ID	AS05-5GW02-R05	AS05-5GW02-R06	AS05-5GW02-R07	AS05-5GW02P-R07	AS05-5GW03-R05	AS05-5GW03-R06	AS05-5GW03-R07
Sample Date	08/03/00	04/11/01	02/05/02	02/05/02	08/07/00	04/11/01	02/05/02
Chemical Name							
Aroclor-1242	NA	NA	NA	NA	NA	NA	NA
Aroclor-1248	NA	NA	NA	NA	NA	NA	NA
Aroclor-1254	NA	NA	NA	NA	NA	NA	NA
Aroclor-1260	NA	NA	NA	NA	NA	NA	NA
Dieldrin	NA	NA	NA	NA	NA	NA	NA
Endosulfan I	NA	NA	NA	NA	NA	NA	NA
Endosulfan II	NA	NA	NA	NA	NA	NA	NA
Endosulfan sulfate	NA	NA	NA	NA	NA	NA	NA
Endrin	NA	NA	NA	NA	NA	NA	NA
Endrin aldehyde	NA	NA	NA	NA	NA	NA	NA
Endrin ketone	NA	NA	NA	NA	NA	NA	NA
Heptachlor	NA	NA	NA	NA	NA	NA	NA
Heptachlor epoxide	NA	NA	NA	NA	NA	NA	NA
Methoxychlor	NA	NA	NA	NA	NA	NA	NA
Toxaphene	NA	NA	NA	NA	NA	NA	NA
alpha-BHC	NA	NA	NA	NA	NA	NA	NA
alpha-Chlordane	NA	NA	NA	NA	NA	NA	NA
beta-BHC	NA	NA	NA	NA	NA	NA	NA
delta-BHC	NA	NA	NA	NA	NA	NA	NA
gamma-BHC (Lindane)	NA	NA	NA	NA	NA	NA	NA
gamma-Chlordane	NA	NA	NA	NA	NA	NA	NA
Herbicides (UG/L)							
2,4,5-T	NA	NA	NA	NA	NA	NA	NA
2,4,5-TP (Silvex)	NA	NA	NA	NA	NA	NA	NA
2,4-D	NA	NA	NA	NA	NA	NA	NA
2,4-DB	NA	NA	NA	NA	NA	NA	NA
2,4-DP (Dichloroprop)	NA	NA	NA	NA	NA	NA	NA
Dalapon	NA	NA	NA	NA	NA	NA	NA
Dicamba	NA	NA	NA	NA	NA	NA	NA
MCPA	NA	NA	NA	NA	NA	NA	NA
MCPP	NA	NA	NA	NA	NA	NA	NA
Explosives (UG/L)							
1,3,5-Trinitrobenzene	NA	NA	NA	NA	NA	NA	NA
1,3-Dinitrobenzene	NA	NA	NA	NA	NA	NA	NA
2,4-Dinitrotoluene	NA	NA	NA	NA	NA	NA	NA
2,6-Dinitrotoluene	NA	NA	NA	NA	NA	NA	NA
Nitrobenzene	NA	NA	NA	NA	NA	NA	NA

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Table D-2
Groundwater Analytical Results for Bedrock Wells
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Station ID	5GW02				5GW03		
Sample ID	AS05-5GW02-R05	AS05-5GW02-R06	AS05-5GW02-R07	AS05-5GW02P-R07	AS05-5GW03-R05	AS05-5GW03-R06	AS05-5GW03-R07
Sample Date	08/03/00	04/11/01	02/05/02	02/05/02	08/07/00	04/11/01	02/05/02
Chemical Name							
Total Metals (UG/L)							
Aluminum	19.2 U	NA	17.2 U	24.4 J	19.2 U	NA	53.2 J
Antimony	4.9 U	NA	5 U	5 U	4.9 U	NA	5 U
Arsenic	3.8 U	NA	5.1 U	5.1 U	3.8 U	NA	5.1 U
Barium	19.3 J	NA	25.5 J	25.9 J	34.8 J	NA	25 J
Beryllium	0.1 U	NA	0.1 U	0.1 U	0.1 U	NA	0.1 U
Boron	207	NA	237	246	NA	NA	70.2
Cadmium	0.4 UL	NA	1.7 U	1.7 U	0.4 U	NA	2.4 J
Calcium	71,900	NA	84,700	85,100	88,800	NA	105,000
Chromium	0.7 UL	NA	1.2 B	1.5 B	0.7 U	NA	1.1 B
Cobalt	8.6 J	NA	6.8 J	5.9 J	1.1 U	NA	1.3 U
Copper	4.8 B	NA	1.5 U	1.7 J	2.7 B	NA	1.5 U
Cyanide	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Iron	1,780	NA	2,280	2,080	168 B	NA	16.9 B
Lead	2 U	NA	2.9 U	2.9 U	2 UL	NA	2.9 U
Magnesium	24,700	NA	29,500	29,900	16,100	NA	26,100
Manganese	1,540	NA	942	885	69.3	NA	554
Mercury	0.1 U	NA	0.2 U	0.2 U	0.1 U	NA	0.2 U
Molybdenum	10 U	NA	10 U	10 U	NA	NA	10 U
Nickel	27.2 J	NA	25.4 J	25.2 J	6 B	NA	90.2
Potassium	3,700 J	NA	3,320 J	3,450 J	2,640 J	NA	2,590 J
Selenium	2.2 U	NA	4 U	4 U	2.2 UL	NA	4 U
Silver	0.6 UL	NA	0.6 U	0.6 U	0.6 U	NA	0.6 U
Sodium	34,500	NA	34,400 J	35,200 J	4,440 J	NA	11,200 J
Thallium	2.3 U	NA	5 U	5 U	2.3 UL	NA	5 U
Tin	NA	NA	NA	NA	NA	NA	NA
Vanadium	1 U	NA	0.8 U	0.8 U	1 U	NA	0.8 U
Zinc	49.7	NA	35.2 B	42.6 B	34.1	NA	42.4 B
Dissolved Metals (UG/L)							
Aluminum	71.6 B	67.4 B	NA	NA	19.2 U	61.5 B	NA
Antimony	4.9 U	3.1 U	NA	NA	4.9 U	3.1 U	NA
Arsenic	3.8 U	2.5 U	NA	NA	6.2 B	3.1 B	NA
Barium	20.4 J	30.3 J	NA	NA	36.1 J	29.6 J	NA
Beryllium	0.1 U	0.34 B	NA	NA	0.1 U	0.5 B	NA
Boron	185	50 U	NA	NA	NA	124	NA
Cadmium	0.4 U	1.2 B	NA	NA	0.4 U	0.86 B	NA
Calcium	76,600	73,600	NA	NA	99,100	99,900	NA
Chromium	0.7 U	0.8 U	NA	NA	0.7 U	1.3 J	NA
Cobalt	9.9 J	6.1 J	NA	NA	1.1 U	1.7 J	NA

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Table D-2
Groundwater Analytical Results for Bedrock Wells
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Station ID	5GW02				5GW03		
Sample ID	AS05-5GW02-R05	AS05-5GW02-R06	AS05-5GW02-R07	AS05-5GW02P-R07	AS05-5GW03-R05	AS05-5GW03-R06	AS05-5GW03-R07
Sample Date	08/03/00	04/11/01	02/05/02	02/05/02	08/07/00	04/11/01	02/05/02
Chemical Name							
Copper	2.3 B	3.6 B	NA	NA	0.7 UL	2.8 J	NA
Iron	2,120	55.7 B	NA	NA	15.9 U	42.1 J	NA
Lead	2 U	2.5 U	NA	NA	2 U	4.6 B	NA
Magnesium	25,900	27,300	NA	NA	17,800	21,600	NA
Manganese	1,620	3,930	NA	NA	7.7 J	71.2	NA
Mercury	0.1 U	0.83 L	NA	NA	0.1 U	0.2 UL	NA
Molybdenum	10 U	10 U	NA	NA	NA	10 U	NA
Nickel	34.1 J	18.1 J	NA	NA	4.4 B	9.2 J	NA
Potassium	3,750 J	4,320 J	NA	NA	4,250 J	3,240 J	NA
Selenium	2.2 B	3.2 U	NA	NA	4.4 B	3.2 U	NA
Silver	0.91 B	1.5 J	NA	NA	0.6 U	1.3 U	NA
Sodium	36,300 J	45,000	NA	NA	5,860	11,700	NA
Thallium	2.3 U	3.9 U	NA	NA	2.3 UL	3.9 B	NA
Vanadium	1 U	34.9 U	NA	NA	1 U	34.9 U	NA
Zinc	33.7 B	45.4 B	NA	NA	18.6 J	44.6 B	NA
Wet Chemistry (MG/L)							
Alkalinity	110	120	130	130	240	180	210
Ammonia	0.2 U	NA	0.2 U	0.2 U	0.2 U	NA	0.2 U
BOD-5day (total)	NA	6.8	2.7	6.3	NA	7.2	7.5
Bicarbonate	110	120	130	130	240	180	210
Biological oxygen demand	2 U	NA	NA	NA	2 U	NA	NA
Chemical oxygen demand	8	42	5 U	5 U	5 U	36	5 U
Chloride	42	36	55	55	5.2	12	19
Ethane	0.001 U	0.004 U	0.004 U	0.004 U	0.001 U	0.004 U	0.004 U
Ethene	0.001 U	0.004 U	0.004 U	0.004 U	0.001 U	0.004 U	0.004 U
Hardness	280	296	330	340	290	338	370
Methane	0.0596	0.002 U	0.007	0.002 U	0.001 U	0.002 U	0.002 U
Nitrate	0.5 U	NA	0.5 U	0.5 U	1.1	NA	2.8
Nitrate/Nitrite	NA	0.55 U	NA	NA	NA	1.5	NA
Nitrite	0.05 U	NA	0.05 U	0.05 U	0.05 U	NA	0.05 U
Nitrogen	NA	0.25	NA	NA	NA	0.2 U	NA
Oil and Grease	NA	NA	NA	NA	NA	NA	NA
Sulfate	190	280	210	210	77	210	140
Total dissolved solids (TDS)	360	560	550	530	NA	460	550
Total organic carbon (TOC)	2.3	4.5	0.84	0.98	1.7	1 U	0.4 U
Total recoverable phenolics	0.03 U	0.025 U	0.025 U	0.025 U	0.03 U	0.025 U	0.025 U
Reactivity (MG/L)							
Reactive cyanide	NA	NA	NA	NA	NA	NA	NA
Reactive sulfide	NA	NA	NA	NA	NA	NA	NA

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Table D-2
Groundwater Analytical Results for Bedrock Wells
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Station ID	5GW06			5GW10			
Sample ID	AS05-5GW06-R05	AS05-5GW06-R06	AS05-5GW06-R07	AS05-5GW10-R05	AS05-5GW10-R06	AS05-5GW10P-R06	AS05-5GW10-R07
Sample Date	08/10/00	04/20/01	02/07/02	08/02/00	04/11/01	04/11/01	02/01/02
Chemical Name							
Volatile Organic Compounds (UG/L)							
1,1,1,2-Tetrachloroethane	NA	NA	NA	NA	NA	NA	NA
1,1,1-Trichloroethane	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,1,2,2-Tetrachloroethane	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,1,2-Trichloroethane	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,1-Dichloroethane	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,1-Dichloroethene	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,2,3-Trichloropropane	NA	NA	NA	NA	NA	NA	NA
1,2,4-Trichlorobenzene	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,2-Dibromo-3-chloropropane	1 UJ	1 R	1 U	1 UJ	1 R	1 R	1 U
1,2-Dibromoethane	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,2-Dichlorobenzene	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,2-Dichloroethane	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,2-Dichloroethene (total)	NA	NA	NA	NA	NA	NA	NA
1,2-Dichloropropane	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,3-Dichlorobenzene	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,4-Dichlorobenzene	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,4-Dioxane	NA	NA	NA	NA	NA	NA	NA
2-Butanone	5 R	5 R	5 U	5 R	5 R	5 R	5 U
2-Chloro-1,3-butadiene	NA	NA	NA	NA	NA	NA	NA
2-Hexanone	5 U	5 U	5 U	5 U	5 U	5 U	5 U
4-Methyl-2-pentanone	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Acetone	5 R	5 R	5 U	5 R	5 R	5 R	5 U
Acetonitrile	NA	NA	NA	NA	NA	NA	NA
Acrolein	NA	NA	NA	NA	NA	NA	NA
Acrylonitrile	NA	NA	NA	NA	NA	NA	NA
Allyl chloride	NA	NA	NA	NA	NA	NA	NA
Benzene	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Bromochloromethane	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Bromodichloromethane	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Bromoform	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Bromomethane	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Carbon disulfide	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Carbon tetrachloride	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Chlorobenzene	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Chloroethane	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Chloroform	1 U	1 U	1 U	1 U	1 U	1 U	1 U

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Table D-2
Groundwater Analytical Results for Bedrock Wells
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Station ID	5GW06			5GW10			
Sample ID	AS05-5GW06-R05	AS05-5GW06-R06	AS05-5GW06-R07	AS05-5GW10-R05	AS05-5GW10-R06	AS05-5GW10P-R06	AS05-5GW10-R07
Sample Date	08/10/00	04/20/01	02/07/02	08/02/00	04/11/01	04/11/01	02/01/02
Chemical Name							
Chloromethane	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Dibromochloromethane	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Dibromomethane	NA	NA	NA	NA	NA	NA	NA
Dichlorodifluoromethane(Freon-12)	NA	NA	NA	NA	NA	NA	NA
Ethyl methacrylate	NA	NA	NA	NA	NA	NA	NA
Ethylbenzene	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Hexachlorobutadiene	NA	NA	NA	NA	NA	NA	NA
Iodomethane	NA	NA	NA	NA	NA	NA	NA
Isobutanol	NA	NA	NA	NA	NA	NA	NA
Methacrylonitrile	NA	NA	NA	NA	NA	NA	NA
Methyl methanesulfonate	NA	NA	NA	NA	NA	NA	NA
Methylene chloride	2 UJ	2 U	0.6 B	2 U	0.5 B	0.6 B	1.7 B
Pentachloroethane	NA	NA	NA	NA	NA	NA	NA
Propionitrile	NA	NA	NA	NA	NA	NA	NA
Styrene	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Tetrachloroethene	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Toluene	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Trichloroethene	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Trichlorofluoromethane(Freon-11)	NA	NA	NA	NA	NA	NA	NA
Vinyl acetate	NA	NA	NA	NA	NA	NA	NA
Vinyl chloride	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Xylene, total	1 U	NA	NA	1 U	NA	NA	NA
cis-1,2-Dichloroethene	1 U	1 U	1 U	1 U	1 U	1 U	1 U
cis-1,3-Dichloropropene	1 U	1 U	1 U	1 U	1 U	1 U	1 U
m- and p-Xylene	1 U	1 U	1 U	1 U	1 U	1 U	1 U
o-Xylene	1 U	1 U	1 U	1 U	1 U	1 U	1 U
trans-1,2-Dichloroethene	1 U	1 U	1 U	1 U	1 U	1 U	1 U
trans-1,3-Dichloropropene	1 U	1 U	1 U	1 U	1 U	1 U	1 U
trans-1,4-Dichloro-2-butene	NA	NA	NA	NA	NA	NA	NA
Semivolatile Organic Compounds (UG/L)							
1,2,4,5-Tetrachlorobenzene	NA	NA	NA	NA	NA	NA	NA
1,4-Naphthoquinone	NA	NA	NA	NA	NA	NA	NA
1-Naphthylamine	NA	NA	NA	NA	NA	NA	NA
2,2'-Oxybis(1-chloropropane)	NA	NA	NA	NA	NA	NA	NA
2,3,4,6-Tetrachlorophenol	NA	NA	NA	NA	NA	NA	NA
2,4,5-Trichlorophenol	NA	NA	NA	NA	NA	NA	NA
2,4,6-Trichlorophenol	NA	NA	NA	NA	NA	NA	NA
2,4-Dichlorophenol	NA	NA	NA	NA	NA	NA	NA
2,4-Dimethylphenol	NA	NA	NA	NA	NA	NA	NA

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Groundwater Analytical Results for Bedrock Wells
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Station ID	5GW06			5GW10			
Sample ID	AS05-5GW06-R05	AS05-5GW06-R06	AS05-5GW06-R07	AS05-5GW10-R05	AS05-5GW10-R06	AS05-5GW10P-R06	AS05-5GW10-R07
Sample Date	08/10/00	04/20/01	02/07/02	08/02/00	04/11/01	04/11/01	02/01/02
Chemical Name							
2,4-Dinitrophenol	NA	NA	NA	NA	NA	NA	NA
2,6-Dichlorophenol	NA	NA	NA	NA	NA	NA	NA
2-Acetylaminofluorene	NA	NA	NA	NA	NA	NA	NA
2-Chloronaphthalene	NA	NA	NA	NA	NA	NA	NA
2-Chlorophenol	NA	NA	NA	NA	NA	NA	NA
2-Methyl-5-nitroaniline	NA	NA	NA	NA	NA	NA	NA
2-Methylaniline	NA	NA	NA	NA	NA	NA	NA
2-Methylnaphthalene	NA	NA	NA	NA	NA	NA	NA
2-Methylphenol	NA	NA	NA	NA	NA	NA	NA
2-Naphthylamine	NA	NA	NA	NA	NA	NA	NA
2-Nitroaniline	NA	NA	NA	NA	NA	NA	NA
2-Nitrophenol	NA	NA	NA	NA	NA	NA	NA
2-Picoline	NA	NA	NA	NA	NA	NA	NA
3,3'-Dichlorobenzidine	NA	NA	NA	NA	NA	NA	NA
3,3'-Dimethylbenzidine	NA	NA	NA	NA	NA	NA	NA
3-Methylcholanthrene	NA	NA	NA	NA	NA	NA	NA
3-Nitroaniline	NA	NA	NA	NA	NA	NA	NA
4,6-Dinitro-2-methylphenol	NA	NA	NA	NA	NA	NA	NA
4-Aminobiphenyl	NA	NA	NA	NA	NA	NA	NA
4-Bromophenyl-phenylether	NA	NA	NA	NA	NA	NA	NA
4-Chloro-3-methylphenol	NA	NA	NA	NA	NA	NA	NA
4-Chloroaniline	NA	NA	NA	NA	NA	NA	NA
4-Chlorophenyl-phenylether	NA	NA	NA	NA	NA	NA	NA
4-Methylphenol	NA	NA	NA	NA	NA	NA	NA
4-Nitroaniline	NA	NA	NA	NA	NA	NA	NA
4-Nitrophenol	NA	NA	NA	NA	NA	NA	NA
4-Nitroquinoline-1-oxide	NA	NA	NA	NA	NA	NA	NA
7,12-Dimethylbenz(a)anthracene	NA	NA	NA	NA	NA	NA	NA

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Table D-2
Groundwater Analytical Results for Bedrock Wells
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Station ID	5GW06			5GW10			
Sample ID	AS05-5GW06-R05	AS05-5GW06-R06	AS05-5GW06-R07	AS05-5GW10-R05	AS05-5GW10-R06	AS05-5GW10P-R06	AS05-5GW10-R07
Sample Date	08/10/00	04/20/01	02/07/02	08/02/00	04/11/01	04/11/01	02/01/02
Chemical Name							
Acenaphthene	NA	NA	NA	NA	NA	NA	NA
Acenaphthylene	NA	NA	NA	NA	NA	NA	NA
Acetophenone	NA	NA	NA	NA	NA	NA	NA
Anthracene	NA	NA	NA	NA	NA	NA	NA
Aramite	NA	NA	NA	NA	NA	NA	NA
Benzo(a)anthracene	NA	NA	NA	NA	NA	NA	NA
Benzo(a)pyrene	NA	NA	NA	NA	NA	NA	NA
Benzo(b)fluoranthene	NA	NA	NA	NA	NA	NA	NA
Benzo(g,h,i)perylene	NA	NA	NA	NA	NA	NA	NA
Benzo(k)fluoranthene	NA	NA	NA	NA	NA	NA	NA
Benzoic acid	NA	NA	NA	NA	NA	NA	NA
Benzyl alcohol	NA	NA	NA	NA	NA	NA	NA
Butylbenzylphthalate	NA	NA	NA	NA	NA	NA	NA
Chlorobenzilate	NA	NA	NA	NA	NA	NA	NA
Chrysene	NA	NA	NA	NA	NA	NA	NA
Di-n-butylphthalate	NA	NA	NA	NA	NA	NA	NA
Di-n-octylphthalate	NA	NA	NA	NA	NA	NA	NA
Diallate	NA	NA	NA	NA	NA	NA	NA
Dibenz(a,h)anthracene	NA	NA	NA	NA	NA	NA	NA
Dibenzofuran	NA	NA	NA	NA	NA	NA	NA
Diethylphthalate	NA	NA	NA	NA	NA	NA	NA
Dimethoate	NA	NA	NA	NA	NA	NA	NA
Dimethyl phthalate	NA	NA	NA	NA	NA	NA	NA
Dinoseb	NA	NA	NA	NA	NA	NA	NA
Diphenylamine	NA	NA	NA	NA	NA	NA	NA
Disulfoton	NA	NA	NA	NA	NA	NA	NA
Ethyl methanesulfonate	NA	NA	NA	NA	NA	NA	NA
Famphur	NA	NA	NA	NA	NA	NA	NA
Fluoranthene	NA	NA	NA	NA	NA	NA	NA
Fluorene	NA	NA	NA	NA	NA	NA	NA
Hexachlorobenzene	NA	NA	NA	NA	NA	NA	NA
Hexachlorobutadiene	NA	NA	NA	NA	NA	NA	NA
Hexachlorocyclopentadiene	NA	NA	NA	NA	NA	NA	NA
Hexachloroethane	NA	NA	NA	NA	NA	NA	NA
Hexachloropropene	NA	NA	NA	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	NA	NA	NA	NA	NA	NA	NA
Isodrin	NA	NA	NA	NA	NA	NA	NA
Isophorone	NA	NA	NA	NA	NA	NA	NA
Isosafrole	NA	NA	NA	NA	NA	NA	NA
Methapyrilene	NA	NA	NA	NA	NA	NA	NA

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Table D-2
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Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Station ID	5GW06			5GW10			
Sample ID	AS05-5GW06-R05	AS05-5GW06-R06	AS05-5GW06-R07	AS05-5GW10-R05	AS05-5GW10-R06	AS05-5GW10P-R06	AS05-5GW10-R07
Sample Date	08/10/00	04/20/01	02/07/02	08/02/00	04/11/01	04/11/01	02/01/02
Chemical Name							
Methyl parathion	NA	NA	NA	NA	NA	NA	NA
N-Nitrosomorpholine	NA	NA	NA	NA	NA	NA	NA
N-Nitrosopiperidine	NA	NA	NA	NA	NA	NA	NA
Naphthalene	NA	NA	NA	NA	NA	NA	NA
O,O,O-Triethyl phosphorothioate	NA	NA	NA	NA	NA	NA	NA
Parathion	NA	NA	NA	NA	NA	NA	NA
Pentachlorobenzene	NA	NA	NA	NA	NA	NA	NA
Pentachloronitrobenzene	NA	NA	NA	NA	NA	NA	NA
Pentachlorophenol	NA	NA	NA	NA	NA	NA	NA
Phenacetin	NA	NA	NA	NA	NA	NA	NA
Phenanthrene	NA	NA	NA	NA	NA	NA	NA
Phenol	NA	NA	NA	NA	NA	NA	NA
Phorate	NA	NA	NA	NA	NA	NA	NA
Pronamide	NA	NA	NA	NA	NA	NA	NA
Pyrene	NA	NA	NA	NA	NA	NA	NA
Pyridine	NA	NA	NA	NA	NA	NA	NA
Safrole	NA	NA	NA	NA	NA	NA	NA
Sulfotepp	NA	NA	NA	NA	NA	NA	NA
Thionazin	NA	NA	NA	NA	NA	NA	NA
bis(2-Chloroethoxy)methane	NA	NA	NA	NA	NA	NA	NA
bis(2-Chloroethyl)ether	NA	NA	NA	NA	NA	NA	NA
bis(2-Ethylhexyl)phthalate	NA	NA	NA	NA	NA	NA	NA
n-Nitroso-di-n-butylamine	NA	NA	NA	NA	NA	NA	NA
n-Nitroso-di-n-propylamine	NA	NA	NA	NA	NA	NA	NA
n-Nitroso-n-methylethylamine	NA	NA	NA	NA	NA	NA	NA
n-Nitrosodiethylamine	NA	NA	NA	NA	NA	NA	NA
n-Nitrosodimethylamine	NA	NA	NA	NA	NA	NA	NA
n-Nitrosodiphenylamine	NA	NA	NA	NA	NA	NA	NA
n-Nitrosopyrrolidine	NA	NA	NA	NA	NA	NA	NA
p-Dimethylaminoazobenzene	NA	NA	NA	NA	NA	NA	NA
p-Phenylenediamine	NA	NA	NA	NA	NA	NA	NA
Pesticide/Polychlorinated Biphenyls (UG/L)							
4,4'-DDD	NA	NA	NA	NA	NA	NA	NA
4,4'-DDE	NA	NA	NA	NA	NA	NA	NA
4,4'-DDT	NA	NA	NA	NA	NA	NA	NA
Aldrin	NA	NA	NA	NA	NA	NA	NA
Aroclor-1016	NA	NA	NA	NA	NA	NA	NA
Aroclor-1221	NA	NA	NA	NA	NA	NA	NA
Aroclor-1232	NA	NA	NA	NA	NA	NA	NA

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Table D-2
Groundwater Analytical Results for Bedrock Wells
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Station ID	5GW06			5GW10			
Sample ID	AS05-5GW06-R05	AS05-5GW06-R06	AS05-5GW06-R07	AS05-5GW10-R05	AS05-5GW10-R06	AS05-5GW10P-R06	AS05-5GW10-R07
Sample Date	08/10/00	04/20/01	02/07/02	08/02/00	04/11/01	04/11/01	02/01/02
Chemical Name							
Aroclor-1242	NA	NA	NA	NA	NA	NA	NA
Aroclor-1248	NA	NA	NA	NA	NA	NA	NA
Aroclor-1254	NA	NA	NA	NA	NA	NA	NA
Aroclor-1260	NA	NA	NA	NA	NA	NA	NA
Dieldrin	NA	NA	NA	NA	NA	NA	NA
Endosulfan I	NA	NA	NA	NA	NA	NA	NA
Endosulfan II	NA	NA	NA	NA	NA	NA	NA
Endosulfan sulfate	NA	NA	NA	NA	NA	NA	NA
Endrin	NA	NA	NA	NA	NA	NA	NA
Endrin aldehyde	NA	NA	NA	NA	NA	NA	NA
Endrin ketone	NA	NA	NA	NA	NA	NA	NA
Heptachlor	NA	NA	NA	NA	NA	NA	NA
Heptachlor epoxide	NA	NA	NA	NA	NA	NA	NA
Methoxychlor	NA	NA	NA	NA	NA	NA	NA
Toxaphene	NA	NA	NA	NA	NA	NA	NA
alpha-BHC	NA	NA	NA	NA	NA	NA	NA
alpha-Chlordane	NA	NA	NA	NA	NA	NA	NA
beta-BHC	NA	NA	NA	NA	NA	NA	NA
delta-BHC	NA	NA	NA	NA	NA	NA	NA
gamma-BHC (Lindane)	NA	NA	NA	NA	NA	NA	NA
gamma-Chlordane	NA	NA	NA	NA	NA	NA	NA
Herbicides (UG/L)							
2,4,5-T	NA	NA	NA	NA	NA	NA	NA
2,4,5-TP (Silvex)	NA	NA	NA	NA	NA	NA	NA
2,4-D	NA	NA	NA	NA	NA	NA	NA
2,4-DB	NA	NA	NA	NA	NA	NA	NA
2,4-DP (Dichloroprop)	NA	NA	NA	NA	NA	NA	NA
Dalapon	NA	NA	NA	NA	NA	NA	NA
Dicamba	NA	NA	NA	NA	NA	NA	NA
MCPA	NA	NA	NA	NA	NA	NA	NA
MCPP	NA	NA	NA	NA	NA	NA	NA
Explosives (UG/L)							
1,3,5-Trinitrobenzene	NA	NA	NA	NA	NA	NA	NA
1,3-Dinitrobenzene	NA	NA	NA	NA	NA	NA	NA
2,4-Dinitrotoluene	NA	NA	NA	NA	NA	NA	NA
2,6-Dinitrotoluene	NA	NA	NA	NA	NA	NA	NA
Nitrobenzene	NA	NA	NA	NA	NA	NA	NA

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Table D-2
Groundwater Analytical Results for Bedrock Wells
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Station ID	5GW06			5GW10			
Sample ID	AS05-5GW06-R05	AS05-5GW06-R06	AS05-5GW06-R07	AS05-5GW10-R05	AS05-5GW10-R06	AS05-5GW10P-R06	AS05-5GW10-R07
Sample Date	08/10/00	04/20/01	02/07/02	08/02/00	04/11/01	04/11/01	02/01/02
Chemical Name							
Total Metals (UG/L)							
Aluminum	19.2 U	45.4 B	93.2 B	60.3 B	NA	NA	17.2 U
Antimony	6.3 B	6.7 J	6.1 J	4.9 U	NA	NA	5 U
Arsenic	3.8 U	3.8 K	5.7 J	3.8 UL	NA	NA	5.1 U
Barium	156 J	198 J	163 J	165 J	NA	NA	200 J
Beryllium	0.22 B	0.8 B	0.1 U	0.1 U	NA	NA	0.1 U
Boron	104	148	85.1	50 R	NA	NA	26.9 J
Cadmium	0.4 UL	0.42 B	1.7 U	0.4 U	NA	NA	1.7 U
Calcium	98,000	114,000	106,000	77,000	NA	NA	82,400
Chromium	12.6	0.8 U	16.7 B	0.7 U	NA	NA	0.6 U
Cobalt	2.8 B	3.3 J	1.8 J	1.1 U	NA	NA	1.3 U
Copper	6.8 J	1.1 J	4.7 J	3.5 B	NA	NA	1.5 U
Cyanide	10 U	11	10 U	10 U	10 U	110	10 U
Iron	5,770 J	83.1 J	3,180	890	NA	NA	939
Lead	2 U	2.5 U	2.9 U	2 U	NA	NA	2.9 U
Magnesium	26,600	30,700	26,500	7,500	NA	NA	7,900
Manganese	129	86.6	93.7	122	NA	NA	131
Mercury	0.1 U	0.2 U	0.2 U	0.1 U	NA	NA	0.2 UL
Molybdenum	10 U	11.9 J	10 U	10 U	NA	NA	10 U
Nickel	21.4 J	13.4 J	22.2 J	2 U	NA	NA	2.1 U
Potassium	4,710 J	6,040 J	3,720 J	371 B	NA	NA	309 J
Selenium	7.1	3.2 U	4 U	2.2 UL	NA	NA	4 U
Silver	0.6 U	1.3 U	0.6 U	0.6 UL	NA	NA	0.6 U
Sodium	12,000	16,100 J	11,500	3,880 B	NA	NA	5,080
Thallium	3.9 B	5 B	5 U	2.3 U	NA	NA	5 U
Tin	NA	NA	NA	NA	NA	NA	NA
Vanadium	1 U	34.9 U	0.8 U	1 U	NA	NA	0.8 U
Zinc	32.7	47 B	23.2 B	30.3 B	NA	NA	11.9 B
Dissolved Metals (UG/L)							
Aluminum	19.2 U	92.8 J	NA	NA	50 B	78.2 B	NA
Antimony	4.9 U	3.1 U	NA	NA	3.1 U	3.1 U	NA
Arsenic	7.1 B	2.7 J	NA	NA	3 B	3.1 B	NA
Barium	177 J	202 E	NA	NA	202	203	NA
Beryllium	0.1 U	0.76 J	NA	NA	0.45 B	0.3 B	NA
Boron	104	50 U	NA	NA	74.4	50 U	NA
Cadmium	0.4 UL	0.4 U	NA	NA	0.4 U	0.4 U	NA
Calcium	103,000	118,000	NA	NA	82,200	81,600	NA
Chromium	3 B	2.2 J	NA	NA	0.8 U	0.8 U	NA
Cobalt	1.7 B	2.7 J	NA	NA	1 U	1 U	NA

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Table D-2
Groundwater Analytical Results for Bedrock Wells
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Station ID	5GW06			5GW10			
Sample ID	AS05-5GW06-R05	AS05-5GW06-R06	AS05-5GW06-R07	AS05-5GW10-R05	AS05-5GW10-R06	AS05-5GW10P-R06	AS05-5GW10-R07
Sample Date	08/10/00	04/20/01	02/07/02	08/02/00	04/11/01	04/11/01	02/01/02
Chemical Name							
Copper	0.7 U	1.3 J	NA	NA	0.98 B	1.4 B	NA
Iron	6,430	2,960	NA	NA	1,000	1,100	NA
Lead	2 U	2.5 U	NA	NA	2.5 U	80.9	NA
Magnesium	30,500	31,600	NA	NA	8,060	8,080	NA
Manganese	138	72.2	NA	NA	134	135	NA
Mercury	0.4 B	0.2 U	NA	NA	0.2 UL	0.2 UL	NA
Molybdenum	10 U	10 R	NA	NA	10 U	10 U	NA
Nickel	10.5 K	5.2 J	NA	NA	1.7 U	1.7 U	NA
Potassium	5,330	6,100	NA	NA	428 J	487 K	NA
Selenium	2.2 U	3.2 U	NA	NA	3.2 U	3.2 U	NA
Silver	0.6 U	1.3 U	NA	NA	1.3 U	1.3 U	NA
Sodium	14,200	16,700	NA	NA	5,750	5,620	NA
Thallium	2.3 UL	3.9 U	NA	NA	4.4 B	3.9 U	NA
Vanadium	1 U	34.9 U	NA	NA	34.9 U	34.9 U	NA
Zinc	13.9 B	39.6	NA	NA	63.5 B	49 B	NA
Wet Chemistry (MG/L)							
Alkalinity	400	360	390	220	210	210	230
Ammonia	0.2 U	NA	0.2 U	0.2 U	NA	NA	0.2 U
BOD-5day (total)	NA	2.4	29	NA	9.4	5.6	2 U
Bicarbonate	400	360	390	220	208	210	230
Biological oxygen demand	10	NA	NA	NA	NA	NA	NA
Chemical oxygen demand	5	14	21	5 U	31	23	5 U
Chloride	3.2	2.9	2.9	4.6	7.3	7.2	4
Ethane	NA	0.004 U	0.004 U	NA	0.004	0.002	0.004 U
Ethene	NA	0.004 U	0.004 U	NA	0.004 U	0.004 U	0.004 U
Hardness	350	430	370	220	238	237	240
Methane	NA	0.02 U	0.002 U	NA	0.008	0.009	0.012 B
Nitrate	0.5 U	NA	0.5 U	0.5 U	NA	NA	0.5 U
Nitrate/Nitrite	NA	0.55 U	NA	NA	0.55 U	0.55 U	NA
Nitrite	0.05 U	NA	0.05 U	NA	NA	NA	0.05 U
Nitrogen	NA	0.2 U	NA	NA	0.2 U	0.2 U	NA
Oil and Grease	NA	NA	NA	NA	NA	NA	NA
Sulfate	50	36	67	16	19	19	13
Total dissolved solids (TDS)	370	450	470	220	280	420	280
Total organic carbon (TOC)	1.5	2.4	7.3	1 U	1 U	1 U	1.1
Total recoverable phenolics	0.03 U	0.025 U	0.025 U	0.025 U	0.025 U	0.025 U	0.025 U
Reactivity (MG/L)							
Reactive cyanide	NA	NA	NA	NA	NA	NA	NA
Reactive sulfide	NA	NA	NA	NA	NA	NA	NA

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Table D-2
Groundwater Analytical Results for Bedrock Wells
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Station ID	5GW14			5GW16		
Sample ID	AS05-5GW14-R05	AS05-5GW14-R06	AS05-5GW14-R07	AS05-5GW16-R05	AS05-5GW16-R06	AS05-5GW16-R07
Sample Date	08/03/00	04/13/01	02/01/02	08/03/00	04/13/01	02/01/02
Chemical Name						
Volatile Organic Compounds (UG/L)						
1,1,1,2-Tetrachloroethane	NA	NA	NA	NA	NA	NA
1,1,1-Trichloroethane	1 U	1 U	1 U	1 U	1 U	1 U
1,1,2,2-Tetrachloroethane	1 U	1 U	1 U	1 U	1 U	1 U
1,1,2-Trichloroethane	1 U	1 U	1 U	1 U	1 U	1 U
1,1-Dichloroethane	1 U	1 U	1 U	1 U	1 U	1 U
1,1-Dichloroethene	1 UJ	1 U	1 U	1 UJ	1 U	1 U
1,2,3-Trichloropropane	NA	NA	NA	NA	NA	NA
1,2,4-Trichlorobenzene	1 U	1 U	1 U	1 U	1 U	1 U
1,2-Dibromo-3-chloropropane	1 UJ	1 R	1 U	1 UJ	1 R	1 U
1,2-Dibromoethane	1 U	1 U	1 U	1 U	1 U	1 U
1,2-Dichlorobenzene	1 U	1 U	1 U	1 U	1 U	1 U
1,2-Dichloroethane	1 U	1 U	1 U	1 U	1 U	1 U
1,2-Dichloroethene (total)	NA	NA	NA	NA	NA	NA
1,2-Dichloropropane	1 U	1 U	1 U	1 U	1 U	1 U
1,3-Dichlorobenzene	1 U	1 U	1 U	1 U	1 U	1 U
1,4-Dichlorobenzene	1 U	1 U	1 U	1 U	1 U	1 U
1,4-Dioxane	NA	NA	NA	NA	NA	NA
2-Butanone	5 R	5 U	5 U	5 R	5 U	5 U
2-Chloro-1,3-butadiene	NA	NA	NA	NA	NA	NA
2-Hexanone	5 UJ	5 U	5 U	5 UJ	5 U	5 U
4-Methyl-2-pentanone	5 UJ	5 U	5 U	5 UJ	5 U	5 U
Acetone	5 R	5 R	5 U	5 R	5 R	5 U
Acetonitrile	NA	NA	NA	NA	NA	NA
Acrolein	NA	NA	NA	NA	NA	NA
Acrylonitrile	NA	NA	NA	NA	NA	NA
Allyl chloride	NA	NA	NA	NA	NA	NA
Benzene	1 U	1 U	1 U	1 U	1 U	1 U
Bromochloromethane	1 UJ	1 U	1 U	1 UJ	1 U	1 U
Bromodichloromethane	1 U	1 U	1 U	1 U	1 U	1 U
Bromoform	1 U	1 U	1 U	1 U	1 U	1 U
Bromomethane	1 U	1 U	1 U	1 U	1 U	1 U
Carbon disulfide	1 UJ	1 U	1 U	1 UJ	1 U	1 U
Carbon tetrachloride	1 U	1 U	1 U	1 U	1 U	1 U
Chlorobenzene	1 U	1 U	1 U	1 U	1 U	1 U
Chloroethane	1 U	1 U	1 U	1 U	1 U	1 U
Chloroform	1 U	1 U	1 U	1 U	1 U	1 U
Chloromethane	1 UJ	1 U	1 U	1 UJ	1 U	1 U
Dibromochloromethane	1 U	1 U	1 U	1 U	1 U	1 U
Dibromomethane	NA	NA	NA	NA	NA	NA

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Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Station ID	5GW14			5GW16		
Sample ID	AS05-5GW14-R05	AS05-5GW14-R06	AS05-5GW14-R07	AS05-5GW16-R05	AS05-5GW16-R06	AS05-5GW16-R07
Sample Date	08/03/00	04/13/01	02/01/02	08/03/00	04/13/01	02/01/02
Chemical Name						
Dichlorodifluoromethane(Freon-12)	NA	NA	NA	NA	NA	NA
Ethyl methacrylate	NA	NA	NA	NA	NA	NA
Ethylbenzene	1 U	1 U	1 U	1 U	1 U	1 U
Hexachlorobutadiene	NA	NA	NA	NA	NA	NA
Iodomethane	NA	NA	NA	NA	NA	NA
Isobutanol	NA	NA	NA	NA	NA	NA
Methacrylonitrile	NA	NA	NA	NA	NA	NA
Methyl methanesulfonate	NA	NA	NA	NA	NA	NA
Methylene chloride	1.4 B	0.6 B	5.2 B	1.3 B	0.5 B	5.1 B
Pentachloroethane	NA	NA	NA	NA	NA	NA
Propionitrile	NA	NA	NA	NA	NA	NA
Styrene	1 U	1 U	1 U	1 U	1 U	1 U
Tetrachloroethene	1 U	1 U	1 U	1 U	1 U	1 U
Toluene	1 U	1 U	1 U	1 U	1 U	1 U
Trichloroethene	1 U	1 U	1 U	1 U	1 U	1 U
Trichlorofluoromethane(Freon-11)	NA	NA	NA	NA	NA	NA
Vinyl acetate	NA	NA	NA	NA	NA	NA
Vinyl chloride	1 UJ	1 U	1 U	1 UJ	1 U	1 U
Xylene, total	1 U	NA	NA	1 U	NA	NA
cis-1,2-Dichloroethene	1 U	1 U	1 U	1 U	1 U	1 U
cis-1,3-Dichloropropene	1 U	1 U	1 U	1 U	1 U	1 U
m- and p-Xylene	1 U	1 U	1 U	1 U	1 U	1 U
o-Xylene	1 U	1 U	1 U	1 U	1 U	1 U
trans-1,2-Dichloroethene	1 U	1 U	1 U	1 U	1 U	1 U
trans-1,3-Dichloropropene	1 U	1 U	1 U	1 U	1 U	1 U
trans-1,4-Dichloro-2-butene	NA	NA	NA	NA	NA	NA
Semivolatile Organic Compounds (UG/L)						
1,2,4,5-Tetrachlorobenzene	NA	NA	NA	NA	NA	NA
1,4-Naphthoquinone	NA	NA	NA	NA	NA	NA
1-Naphthylamine	NA	NA	NA	NA	NA	NA
2,2'-Oxybis(1-chloropropane)	NA	NA	NA	NA	NA	NA
2,3,4,6-Tetrachlorophenol	NA	NA	NA	NA	NA	NA
2,4,5-Trichlorophenol	NA	NA	NA	NA	NA	NA
2,4,6-Trichlorophenol	NA	NA	NA	NA	NA	NA
2,4-Dichlorophenol	NA	NA	NA	NA	NA	NA
2,4-Dimethylphenol	NA	NA	NA	NA	NA	NA

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Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Station ID	5GW14			5GW16		
Sample ID	AS05-5GW14-R05	AS05-5GW14-R06	AS05-5GW14-R07	AS05-5GW16-R05	AS05-5GW16-R06	AS05-5GW16-R07
Sample Date	08/03/00	04/13/01	02/01/02	08/03/00	04/13/01	02/01/02
Chemical Name						
2,4-Dinitrophenol	NA	NA	NA	NA	NA	NA
2,6-Dichlorophenol	NA	NA	NA	NA	NA	NA
2-Acetylaminofluorene	NA	NA	NA	NA	NA	NA
2-Chloronaphthalene	NA	NA	NA	NA	NA	NA
2-Chlorophenol	NA	NA	NA	NA	NA	NA
2-Methyl-5-nitroaniline	NA	NA	NA	NA	NA	NA
2-Methylaniline	NA	NA	NA	NA	NA	NA
2-Methylnaphthalene	NA	NA	NA	NA	NA	NA
2-Methylphenol	NA	NA	NA	NA	NA	NA
2-Naphthylamine	NA	NA	NA	NA	NA	NA
2-Nitroaniline	NA	NA	NA	NA	NA	NA
2-Nitrophenol	NA	NA	NA	NA	NA	NA
2-Picoline	NA	NA	NA	NA	NA	NA
3,3'-Dichlorobenzidine	NA	NA	NA	NA	NA	NA
3,3'-Dimethylbenzidine	NA	NA	NA	NA	NA	NA
3-Methylcholanthrene	NA	NA	NA	NA	NA	NA
3-Nitroaniline	NA	NA	NA	NA	NA	NA
4,6-Dinitro-2-methylphenol	NA	NA	NA	NA	NA	NA
4-Aminobiphenyl	NA	NA	NA	NA	NA	NA
4-Bromophenyl-phenylether	NA	NA	NA	NA	NA	NA
4-Chloro-3-methylphenol	NA	NA	NA	NA	NA	NA
4-Chloroaniline	NA	NA	NA	NA	NA	NA
4-Chlorophenyl-phenylether	NA	NA	NA	NA	NA	NA
4-Methylphenol	NA	NA	NA	NA	NA	NA
4-Nitroaniline	NA	NA	NA	NA	NA	NA
4-Nitrophenol	NA	NA	NA	NA	NA	NA
4-Nitroquinoline-1-oxide	NA	NA	NA	NA	NA	NA
7,12-Dimethylbenz(a)anthracene	NA	NA	NA	NA	NA	NA

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Groundwater Analytical Results for Bedrock Wells
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Station ID	5GW14			5GW16		
Sample ID	AS05-5GW14-R05	AS05-5GW14-R06	AS05-5GW14-R07	AS05-5GW16-R05	AS05-5GW16-R06	AS05-5GW16-R07
Sample Date	08/03/00	04/13/01	02/01/02	08/03/00	04/13/01	02/01/02
Chemical Name						
Acenaphthene	NA	NA	NA	NA	NA	NA
Acenaphthylene	NA	NA	NA	NA	NA	NA
Acetophenone	NA	NA	NA	NA	NA	NA
Anthracene	NA	NA	NA	NA	NA	NA
Aramite	NA	NA	NA	NA	NA	NA
Benzo(a)anthracene	NA	NA	NA	NA	NA	NA
Benzo(a)pyrene	NA	NA	NA	NA	NA	NA
Benzo(b)fluoranthene	NA	NA	NA	NA	NA	NA
Benzo(g,h,i)perylene	NA	NA	NA	NA	NA	NA
Benzo(k)fluoranthene	NA	NA	NA	NA	NA	NA
Benzoic acid	NA	NA	NA	NA	NA	NA
Benzyl alcohol	NA	NA	NA	NA	NA	NA
Butylbenzylphthalate	NA	NA	NA	NA	NA	NA
Chlorobenzilate	NA	NA	NA	NA	NA	NA
Chrysene	NA	NA	NA	NA	NA	NA
Di-n-butylphthalate	NA	NA	NA	NA	NA	NA
Di-n-octylphthalate	NA	NA	NA	NA	NA	NA
Diallate	NA	NA	NA	NA	NA	NA
Dibenz(a,h)anthracene	NA	NA	NA	NA	NA	NA
Dibenzofuran	NA	NA	NA	NA	NA	NA
Diethylphthalate	NA	NA	NA	NA	NA	NA
Dimethoate	NA	NA	NA	NA	NA	NA
Dimethyl phthalate	NA	NA	NA	NA	NA	NA
Dinoseb	NA	NA	NA	NA	NA	NA
Diphenylamine	NA	NA	NA	NA	NA	NA
Disulfoton	NA	NA	NA	NA	NA	NA
Ethyl methanesulfonate	NA	NA	NA	NA	NA	NA
Famphur	NA	NA	NA	NA	NA	NA
Fluoranthene	NA	NA	NA	NA	NA	NA
Fluorene	NA	NA	NA	NA	NA	NA
Hexachlorobenzene	NA	NA	NA	NA	NA	NA
Hexachlorobutadiene	NA	NA	NA	NA	NA	NA
Hexachlorocyclopentadiene	NA	NA	NA	NA	NA	NA
Hexachloroethane	NA	NA	NA	NA	NA	NA
Hexachloropropene	NA	NA	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	NA	NA	NA	NA	NA	NA
Isodrin	NA	NA	NA	NA	NA	NA
Isophorone	NA	NA	NA	NA	NA	NA
Isosafrole	NA	NA	NA	NA	NA	NA
Methapyrilene	NA	NA	NA	NA	NA	NA

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Table D-2
Groundwater Analytical Results for Bedrock Wells
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Station ID	5GW14			5GW16		
Sample ID	AS05-5GW14-R05	AS05-5GW14-R06	AS05-5GW14-R07	AS05-5GW16-R05	AS05-5GW16-R06	AS05-5GW16-R07
Sample Date	08/03/00	04/13/01	02/01/02	08/03/00	04/13/01	02/01/02
Chemical Name						
Methyl parathion	NA	NA	NA	NA	NA	NA
N-Nitrosomorpholine	NA	NA	NA	NA	NA	NA
N-Nitrosopiperidine	NA	NA	NA	NA	NA	NA
Naphthalene	NA	NA	NA	NA	NA	NA
O,O,O-Triethyl phosphorothioate	NA	NA	NA	NA	NA	NA
Parathion	NA	NA	NA	NA	NA	NA
Pentachlorobenzene	NA	NA	NA	NA	NA	NA
Pentachloronitrobenzene	NA	NA	NA	NA	NA	NA
Pentachlorophenol	NA	NA	NA	NA	NA	NA
Phenacetin	NA	NA	NA	NA	NA	NA
Phenanthrene	NA	NA	NA	NA	NA	NA
Phenol	NA	NA	NA	NA	NA	NA
Phorate	NA	NA	NA	NA	NA	NA
Pronamide	NA	NA	NA	NA	NA	NA
Pyrene	NA	NA	NA	NA	NA	NA
Pyridine	NA	NA	NA	NA	NA	NA
Safrole	NA	NA	NA	NA	NA	NA
Sulfotepp	NA	NA	NA	NA	NA	NA
Thionazin	NA	NA	NA	NA	NA	NA
bis(2-Chloroethoxy)methane	NA	NA	NA	NA	NA	NA
bis(2-Chloroethyl)ether	NA	NA	NA	NA	NA	NA
bis(2-Ethylhexyl)phthalate	NA	NA	NA	NA	NA	NA
n-Nitroso-di-n-butylamine	NA	NA	NA	NA	NA	NA
n-Nitroso-di-n-propylamine	NA	NA	NA	NA	NA	NA
n-Nitroso-n-methylethylamine	NA	NA	NA	NA	NA	NA
n-Nitrosodiethylamine	NA	NA	NA	NA	NA	NA
n-Nitrosodimethylamine	NA	NA	NA	NA	NA	NA
n-Nitrosodiphenylamine	NA	NA	NA	NA	NA	NA
n-Nitrosopyrrolidine	NA	NA	NA	NA	NA	NA
p-Dimethylaminoazobenzene	NA	NA	NA	NA	NA	NA
p-Phenylenediamine	NA	NA	NA	NA	NA	NA
Pesticide/Polychlorinated Biphenyls (UG/L)						
4,4'-DDD	NA	NA	NA	NA	NA	NA
4,4'-DDE	NA	NA	NA	NA	NA	NA
4,4'-DDT	NA	NA	NA	NA	NA	NA
Aldrin	NA	NA	NA	NA	NA	NA
Aroclor-1016	NA	NA	NA	NA	NA	NA
Aroclor-1221	NA	NA	NA	NA	NA	NA
Aroclor-1232	NA	NA	NA	NA	NA	NA

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Table D-2
Groundwater Analytical Results for Bedrock Wells
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Station ID	5GW14			5GW16		
Sample ID	AS05-5GW14-R05	AS05-5GW14-R06	AS05-5GW14-R07	AS05-5GW16-R05	AS05-5GW16-R06	AS05-5GW16-R07
Sample Date	08/03/00	04/13/01	02/01/02	08/03/00	04/13/01	02/01/02
Chemical Name						
Aroclor-1242	NA	NA	NA	NA	NA	NA
Aroclor-1248	NA	NA	NA	NA	NA	NA
Aroclor-1254	NA	NA	NA	NA	NA	NA
Aroclor-1260	NA	NA	NA	NA	NA	NA
Dieldrin	NA	NA	NA	NA	NA	NA
Endosulfan I	NA	NA	NA	NA	NA	NA
Endosulfan II	NA	NA	NA	NA	NA	NA
Endosulfan sulfate	NA	NA	NA	NA	NA	NA
Endrin	NA	NA	NA	NA	NA	NA
Endrin aldehyde	NA	NA	NA	NA	NA	NA
Endrin ketone	NA	NA	NA	NA	NA	NA
Heptachlor	NA	NA	NA	NA	NA	NA
Heptachlor epoxide	NA	NA	NA	NA	NA	NA
Methoxychlor	NA	NA	NA	NA	NA	NA
Toxaphene	NA	NA	NA	NA	NA	NA
alpha-BHC	NA	NA	NA	NA	NA	NA
alpha-Chlordane	NA	NA	NA	NA	NA	NA
beta-BHC	NA	NA	NA	NA	NA	NA
delta-BHC	NA	NA	NA	NA	NA	NA
gamma-BHC (Lindane)	NA	NA	NA	NA	NA	NA
gamma-Chlordane	NA	NA	NA	NA	NA	NA
Herbicides (UG/L)						
2,4,5-T	NA	NA	NA	NA	NA	NA
2,4,5-TP (Silvex)	NA	NA	NA	NA	NA	NA
2,4-D	NA	NA	NA	NA	NA	NA
2,4-DB	NA	NA	NA	NA	NA	NA
2,4-DP (Dichloroprop)	NA	NA	NA	NA	NA	NA
Dalapon	NA	NA	NA	NA	NA	NA
Dicamba	NA	NA	NA	NA	NA	NA
MCPA	NA	NA	NA	NA	NA	NA
MCPP	NA	NA	NA	NA	NA	NA
Explosives (UG/L)						
1,3,5-Trinitrobenzene	NA	NA	NA	NA	NA	NA
1,3-Dinitrobenzene	NA	NA	NA	NA	NA	NA
2,4-Dinitrotoluene	NA	NA	NA	NA	NA	NA
2,6-Dinitrotoluene	NA	NA	NA	NA	NA	NA
Nitrobenzene	NA	NA	NA	NA	NA	NA

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Table D-2
Groundwater Analytical Results for Bedrock Wells
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Station ID	5GW14			5GW16		
Sample ID	AS05-5GW14-R05	AS05-5GW14-R06	AS05-5GW14-R07	AS05-5GW16-R05	AS05-5GW16-R06	AS05-5GW16-R07
Sample Date	08/03/00	04/13/01	02/01/02	08/03/00	04/13/01	02/01/02
Chemical Name						
Total Metals (UG/L)						
Aluminum	137 B	NA	17.2 U	100 B	NA	17.2 U
Antimony	4.9 U	NA	5 U	4.9 U	NA	5 U
Arsenic	3.8 U	NA	5.1 U	3.8 U	NA	5.1 U
Barium	30.8 J	NA	33 J	23 J	NA	49.9 J
Beryllium	0.1 U	NA	0.1 U	0.1 U	NA	0.1 U
Boron	171	NA	13.5 J	50 U	NA	33.7 J
Cadmium	0.4 UL	NA	1.7 U	0.4 UL	NA	1.7 U
Calcium	65,400	NA	105,000	20,600	NA	160,000
Chromium	0.7 UL	NA	0.74 J	0.7 UL	NA	1.5 J
Cobalt	6.6 J	NA	8.7 J	1.1 U	NA	1.6 J
Copper	0.7 U	NA	1.5 U	0.7 U	NA	1.5 U
Cyanide	10 U	10 U	10 U	10 U	10 U	10 U
Iron	71,300	NA	71,600	2,490	NA	17,200
Lead	2 U	NA	3.2	2 U	NA	2.9 U
Magnesium	24,300	NA	33,400	13,900	NA	31,900
Manganese	1,390	NA	1,680	282	NA	1,170
Mercury	0.36 B	NA	0.2 UL	0.1 U	NA	0.2 UL
Molybdenum	10 U	NA	10 U	10 U	NA	10 U
Nickel	43.1	NA	33.9 J	2 U	NA	2.1 U
Potassium	1,950 J	NA	2,030 J	490 B	NA	636 J
Selenium	2.2 U	NA	4 U	2.2 U	NA	4 U
Silver	0.66 B	NA	0.6 U	0.6 UL	NA	0.6 U
Sodium	10,100	NA	12,800	7,370	NA	11,500
Thallium	18.7 B	NA	5 U	2.3 U	NA	5 U
Tin	NA	NA	NA	NA	NA	NA
Vanadium	1 U	NA	0.8 U	1 U	NA	0.8 U
Zinc	49.4	NA	28.9 B	16.5 B	NA	25.2 B
Dissolved Metals (UG/L)						
Aluminum	90.3 B	25.6 B	NA	89 B	129 B	NA
Antimony	4.9 U	6.5 B	NA	4.9 U	6.6 B	NA
Arsenic	3.8 UL	4 B	NA	3.8 UL	3.8 B	NA
Barium	32.2 J	35.6 J	NA	25 J	34.3 J	NA
Beryllium	0.1 U	0.65 B	NA	0.1 U	0.61 B	NA
Boron	50 U	50 U	NA	50 U	153	NA
Cadmium	0.4 U	0.4 U	NA	0.4 U	0.4 U	NA
Calcium	78,700	96,200	NA	22,600	172,000	NA
Chromium	0.7 U	0.8 U	NA	0.7 U	0.86 J	NA
Cobalt	6.9 J	9.9 B	NA	1.1 U	2.6 J	NA

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Table D-2
Groundwater Analytical Results for Bedrock Wells
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Station ID	5GW14			5GW16		
Sample ID	AS05-5GW14-R05	AS05-5GW14-R06	AS05-5GW14-R07	AS05-5GW16-R05	AS05-5GW16-R06	AS05-5GW16-R07
Sample Date	08/03/00	04/13/01	02/01/02	08/03/00	04/13/01	02/01/02
Chemical Name						
Copper	0.7 UL	3.4 B	NA	0.7 UL	1.7 J	NA
Iron	79,800	111,000	NA	748	29,700	NA
Lead	2.4 B	2.5 U	NA	2 U	2.5 U	NA
Magnesium	26,400	33,400	NA	15,100	33,800	NA
Manganese	1,620	2,360	NA	288	1,130	NA
Mercury	0.1 U	0.2 U	NA	0.1 U	0.2 U	NA
Molybdenum	10 U	10 U	NA	12.7 J	10 U	NA
Nickel	15.4 J	24.8 K	NA	2 U	1.7 U	NA
Potassium	2,320 J	2,470 J	NA	556 B	888 J	NA
Selenium	14.9 B	3.9 J	NA	3.3 B	3.2 U	NA
Silver	2.9 B	1.6 B	NA	1 B	1.3 U	NA
Sodium	12,900 J	15,900	NA	9,100 J	12,600	NA
Thallium	2.3 U	3.9 U	NA	2.3 U	3.9 U	NA
Vanadium	1.2 B	34.9 U	NA	1 U	34.9 U	NA
Zinc	25.7 B	38.9 B	NA	9.7 B	20 B	NA
Wet Chemistry (MG/L)						
Alkalinity	180	200	180	55	310	260
Ammonia	0.21	NA	0.2 U	0.38	NA	0.2 U
BOD-5day (total)	NA	16	4.5	NA	16	2 U
Bicarbonate	180	200	180	55	320	260
Biological oxygen demand	2 U	NA	NA	2 U	NA	NA
Chemical oxygen demand	15	25	10	5 U	29	5 U
Chloride	31	22	44	19	22	32
Ethane	0.001 U	0.004 U	0.004 U	0.001 U	0.093	0.004 U
Ethene	0.001 U	0.004 U	0.004 U	0.001 U	0.004 U	0.004 U
Hardness	260	378	400	110	569	530
Methane	0.336 U	0.34	1.7 J	0.0212 U	0.334	0.4
Nitrate	0.71	NA	0.5 U	0.5 U	NA	0.5 U
Nitrate/Nitrite	NA	0.55 U	NA	NA	0.55 U	NA
Nitrite	0.05 U	NA	0.05 U	0.05 U	NA	0.05 U
Nitrogen	NA	0.54	NA	NA	0.35	NA
Oil and Grease	NA	NA	NA	NA	NA	NA
Sulfate	140	160	220	54	130	220
Total dissolved solids (TDS)	360	520	590	150	300	670
Total organic carbon (TOC)	1	1 U	4.2	1 U	2	1.2
Total recoverable phenolics	0.03 U	0.025 U	0.025 U	0.03 U	0.025 U	0.025 U
Reactivity (MG/L)						
Reactive cyanide	NA	NA	NA	NA	NA	NA
Reactive sulfide	NA	NA	NA	NA	NA	NA

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Table D-3
Surface Water Analytical Results
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Station ID	5SD-1/5SW-1					5SD-2/5SW-2			
Sample ID	AS05-5SW01-AP	AS05-5SW01-R05	AS05-5SW01-R06	AS05-5SW01-R07	AS05-5SW01P-R07	AS05-5SW02-AP	AS05-5SW02-R05	AS05-5SW02P-R05	AS05-5SW02-R06
Sample Date	12/03/99	08/03/00	06/20/01	02/26/02	02/26/02	12/03/99	08/03/00	08/03/00	06/20/01
Chemical Name									
Volatile Organic Compounds (UG/L)									
1,1,1-Trichloroethane	NA	1 U	1 U	1 U	1 U	NA	1 U	1 U	1 U
1,1,2,2-Tetrachloroethane	NA	1 U	1 U	1 U	1 U	NA	1 U	1 U	1 U
1,1,2-Trichloroethane	NA	1 U	1 U	1 U	1 U	NA	1 U	1 U	1 U
1,1-Dichloroethane	NA	1 U	1 U	1 U	1 U	NA	1 U	1 U	1 U
1,1-Dichloroethene	NA	1 U	1 U	1 U	1 U	NA	1 U	1 U	1 U
1,2,4-Trichlorobenzene	NA	1 U	1 U	1 U	1 U	NA	1 U	1 U	1 U
1,2-Dibromo-3-chloropropane	NA	1 UJ	1 R	1 U	1 U	NA	1 UJ	1 UJ	1 R
1,2-Dibromoethane	NA	1 U	1 U	1 U	1 U	NA	1 U	1 U	1 U
1,2-Dichlorobenzene	NA	1 U	1 U	1 U	1 U	NA	1 U	1 U	1 U
1,2-Dichloroethane	NA	1 U	1 U	1 U	1 U	NA	1 U	1 U	1 U
1,2-Dichloropropane	NA	1 U	1 U	1 U	1 U	NA	1 U	1 U	1 U
1,3-Dichlorobenzene	NA	1 U	1 U	1 U	1 U	NA	1 U	1 U	1 U
1,4-Dichlorobenzene	NA	1 U	1 U	1 U	1 U	NA	1 U	1 U	1 U
2-Butanone	NA	5 R	5 R	5 R	5 R	NA	5 R	5 R	5 R
2-Hexanone	NA	5 UJ	5 R	5 UJ	5 UJ	NA	5 UJ	5 UJ	5 R
4-Methyl-2-pentanone	NA	5 UJ	5 U	5 UJ	5 UJ	NA	5 UJ	5 UJ	5 U
Acetone	NA	5 R	5 R	5 R	5 R	NA	5 R	5 R	5 R
Benzene	NA	1 U	1 U	1 U	1 U	NA	1 U	1 U	1 U
Bromochloromethane	NA	1 U	1 U	1 U	1 U	NA	1 U	1 U	1 U
Bromodichloromethane	NA	1 U	1 U	1 U	1 U	NA	1 U	1 U	1 U
Bromoform	NA	1 U	1 U	1 U	1 U	NA	1 U	1 U	1 U
Bromomethane	NA	1 UJ	1 U	1 U	1 U	NA	1 UJ	1 UJ	1 U
Carbon disulfide	NA	1 U	1 U	1 U	1 U	NA	1 U	1 U	1 U
Carbon tetrachloride	NA	1 U	1 U	1 U	1 U	NA	1 U	1 U	1 U
Chlorobenzene	NA	1 U	1 U	1 U	1 U	NA	1 U	1 U	1 U
Chloroethane	NA	1 U	1 U	1 U	1 U	NA	1 U	1 U	1 U
Chloroform	NA	1 U	1 U	1 U	1 U	NA	1 U	1 U	1 U
Chloromethane	NA	1 UJ	1 U	1 U	1 U	NA	1 UJ	1 UJ	1 U
Dibromochloromethane	NA	1 U	1 U	1 U	1 U	NA	1 U	1 U	1 U
Ethylbenzene	NA	1 U	1 U	1 U	1 U	NA	1 U	1 U	1 U
Methylene chloride	NA	1.1 B	2 U	2 U	2 U	NA	1.3 B	1.3 B	2 U
Styrene	NA	1 U	1 U	1 U	1 U	NA	1 U	1 U	1 U
Tetrachloroethene	NA	1 U	1 U	1 U	1 U	NA	1 U	1 U	1 U
Toluene	NA	1 U	1 U	1 U	1 U	NA	1 U	1 U	1 U
Trichloroethene	NA	1 U	1 U	1 U	1 U	NA	1 U	1 U	1 U
Vinyl chloride	NA	1 U	1 U	1 U	1 U	NA	1 U	1 U	1 U
Xylene, total	NA	1 U	1 U	1 U	1 U	NA	1 U	1 U	1 U
cis-1,2-Dichloroethene	NA	1 U	1 U	1 U	1 U	NA	1 U	1 U	1 U
cis-1,3-Dichloropropene	NA	1 U	1 U	1 U	1 U	NA	1 U	1 U	1 U

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Table D-3
Surface Water Analytical Results
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Station ID	5SD-1/5SW-1					5SD-2/5SW-2			
Sample ID	AS05-5SW01-AP	AS05-5SW01-R05	AS05-5SW01-R06	AS05-5SW01-R07	AS05-5SW01P-R07	AS05-5SW02-AP	AS05-5SW02-R05	AS05-5SW02P-R05	AS05-5SW02-R06
Sample Date	12/03/99	08/03/00	06/20/01	02/26/02	02/26/02	12/03/99	08/03/00	08/03/00	06/20/01
Chemical Name									
m- and p-Xylene	NA	1 U	NA	NA	NA	NA	1 U	1 U	NA
o-Xylene	NA	1 U	1 U	1 U	1 U	NA	1 U	1 U	1 U
trans-1,2-Dichloroethene	NA	1 U	1 U	1 U	1 U	NA	1 U	1 U	1 U
trans-1,3-Dichloropropene	NA	1 U	1 U	1 U	1 U	NA	1 U	1 U	1 U
Explosives (UG/L)									
Perchlorate	5 U	NA	NA	NA	NA	5 U	NA	NA	NA

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Table D-3
Surface Water Analytical Results
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Station ID	5SD-1/5SW-1					5SD-2/5SW-2			
Sample ID	AS05-5SW01-AP	AS05-5SW01-R05	AS05-5SW01-R06	AS05-5SW01-R07	AS05-5SW01P-R07	AS05-5SW02-AP	AS05-5SW02-R05	AS05-5SW02P-R05	AS05-5SW02-R06
Sample Date	12/03/99	08/03/00	06/20/01	02/26/02	02/26/02	12/03/99	08/03/00	08/03/00	06/20/01
Chemical Name									
Total Metals (UG/L)									
Aluminum	NA	405	171 J	147 J	149 J	NA	408 B	339 B	204
Antimony	NA	5.53 B	3.7 U	5 U	5 U	NA	7.2 B	4.9 U	3.7 U
Arsenic	NA	3.8 U	5 U	5.1 U	5.1 U	NA	3.8 U	3.8 U	5 U
Barium	NA	44.5 B	51.8 J	64.1 J	64.2 J	NA	46 J	45 J	52.6 J
Beryllium	NA	0.15 B	0.1 U	0.1 U	0.1 U	NA	0.14 B	0.12 B	0.1 U
Cadmium	NA	0.4 U	3 U	1.7 U	1.7 U	NA	0.4 U	0.42 B	3 U
Calcium	NA	53,574	50,700	55,900	55,600	NA	54,500	54,800	52,100
Chromium	NA	0.7 U	5 U	1.1 J	0.6 U	NA	0.7 UL	0.7 UL	5 U
Cobalt	NA	2.23 B	1.8 U	1.3 J	1.4 J	NA	2.5 J	1.2 J	1.8 U
Copper	NA	2.04 B	2.2 U	1.5 U	1.5 U	NA	1.7 B	1.5 B	2.2 U
Cyanide	NA	10 U	10 U	10 U	NA	NA	10 U	10 U	10 U
Iron	NA	749	281	117	139	NA	970	636	308
Lead	NA	2 U	3 U	3.4	2.9 U	NA	3.2 K	4.8 K	3 U
Magnesium	NA	12,403	13,400	11,500	11,500	NA	12,600	12,600	13,800
Manganese	NA	210	177	278	277	NA	221	214	177
Mercury	NA	0.12 B	0.2 U	0.2 U	0.2 U	NA	0.1 U	0.1 U	0.39
Nickel	NA	2.35 B	5.4 J	7.6 J	7.7 J	NA	2 U	4.4 B	5.8 J
Potassium	NA	3,558 B	3,030 J	3,560 J	3,650 J	NA	3,510 J	3,490 J	3,130 J
Selenium	NA	2.68 B	5 U	4 U	4 U	NA	2.2 U	2.2 U	5 U
Silver	NA	0.6 U	5 U	0.6 U	0.6 U	NA	0.6 UL	0.6 UL	5 U
Sodium	NA	26,807	28,100	37,500 J	37,800 J	NA	26,000 J	26,000 J	28,800
Thallium	NA	2.3 U	5.7 U	5 U	5 U	NA	4.5 B	2.3 U	5.7 U
Vanadium	NA	1 U	3.2 U	1.4 B	1.4 B	NA	1 U	1 U	3.2 U
Zinc	NA	37.5	20.5	36 B	31.2 B	NA	30 B	29.6 B	25.6
Dissolved Metals (UG/L)									
Aluminum	NA	NA	93.8 B	NA	NA	NA	NA	NA	75.8 B
Antimony	NA	NA	8.9 U	NA	NA	NA	NA	NA	8.9 U
Arsenic	NA	NA	6.2 U	NA	NA	NA	NA	NA	6.2 U
Barium	NA	NA	54.8 J	NA	NA	NA	NA	NA	54 J
Beryllium	NA	NA	0.11 J	NA	NA	NA	NA	NA	0.1 U
Cadmium	NA	NA	0.6 U	NA	NA	NA	NA	NA	0.6 U
Calcium	NA	NA	54,700	NA	NA	NA	NA	NA	53,800
Chromium	NA	NA	0.6 U	NA	NA	NA	NA	NA	0.6 U
Cobalt	NA	NA	0.9 U	NA	NA	NA	NA	NA	0.9 U
Copper	NA	NA	3.4 B	NA	NA	NA	NA	NA	3.5 B
Iron	NA	NA	15.8 U	NA	NA	NA	NA	NA	44.8 J
Lead	NA	NA	3 U	NA	NA	NA	NA	NA	3 U
Magnesium	NA	NA	14,400	NA	NA	NA	NA	NA	14,400

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E - Exceedance - Interference

J - Reported value is estimated
K - Biased high
L - Biased low
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Table D-3
Surface Water Analytical Results
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Station ID	5SD-1/5SW-1					5SD-2/5SW-2			
Sample ID	AS05-5SW01-AP	AS05-5SW01-R05	AS05-5SW01-R06	AS05-5SW01-R07	AS05-5SW01P-R07	AS05-5SW02-AP	AS05-5SW02-R05	AS05-5SW02P-R05	AS05-5SW02-R06
Sample Date	12/03/99	08/03/00	06/20/01	02/26/02	02/26/02	12/03/99	08/03/00	08/03/00	06/20/01
Chemical Name									
Manganese	NA	NA	7.6 B	NA	NA	NA	NA	NA	7.1 B
Mercury	NA	NA	0.2 U	NA	NA	NA	NA	NA	0.2 U
Nickel	NA	NA	4.4 B	NA	NA	NA	NA	NA	5.3 B
Potassium	NA	NA	3,640 J	NA	NA	NA	NA	NA	3,520 J
Selenium	NA	NA	1.6 U	NA	NA	NA	NA	NA	1.6 U
Silver	NA	NA	1.7 U	NA	NA	NA	NA	NA	1.7 U
Sodium	NA	NA	29,900	NA	NA	NA	NA	NA	30,100
Thallium	NA	NA	4.3 U	NA	NA	NA	NA	NA	4.3 U
Vanadium	NA	NA	1.2 U	NA	NA	NA	NA	NA	1.2 U
Zinc	NA	NA	39.9	NA	NA	NA	NA	NA	30.2
Wet Chemistry (MG/L)									
Hardness	NA	NA	180	NA	NA	NA	NA	NA	190

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Table D-3
Surface Water Analytical Results
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Station ID	5SD-2/5SW-2		5SD-3/5SW-3			5SD-4/5SW-4		
Sample ID	AS05-5SW02P-R06	AS05-5SW02-R07	AS05-5SW03-R05	AS05-5SW03-R06	AS05-5SW03-R07	AS05-5SW04-R05	AS05-5SW04-R06	AS05-5SW04-R07
Sample Date	06/20/01	02/25/02	08/03/00	06/20/01	02/26/02	08/03/00	06/20/01	02/25/02
Chemical Name								
Volatile Organic Compounds (UG/L)								
1,1,1-Trichloroethane	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,1,2,2-Tetrachloroethane	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,1,2-Trichloroethane	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,1-Dichloroethane	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,1-Dichloroethene	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,2,4-Trichlorobenzene	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,2-Dibromo-3-chloropropane	1 R	1 U	1 UJ	1 R	1 U	1 UJ	1 R	1 U
1,2-Dibromoethane	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,2-Dichlorobenzene	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,2-Dichloroethane	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,2-Dichloropropane	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,3-Dichlorobenzene	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,4-Dichlorobenzene	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
2-Butanone	5 R	5 R	5 R	5 R	5 R	5 R	5 R	5 R
2-Hexanone	5 R	5 UJ	5 UJ	5 R	5 UJ	5 UJ	5 R	5 UJ
4-Methyl-2-pentanone	5 U	5 UJ	5 UJ	5 U	5 UJ	5 UJ	5 U	5 UJ
Acetone	5 R	5 R	5 R	5 R	5 R	5 R	5 R	5 R
Benzene	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Bromochloromethane	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Bromodichloromethane	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Bromoform	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Bromomethane	1 U	1 U	1 UJ	1 U	1 U	1 UJ	1 U	1 U
Carbon disulfide	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Carbon tetrachloride	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Chlorobenzene	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Chloroethane	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Chloroform	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Chloromethane	1 U	1 U	1 UJ	1 U	1 U	1 UJ	1 U	1 U
Dibromochloromethane	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Ethylbenzene	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Methylene chloride	2 U	2 U	1.4 B	2 U	2 U	1.4 B	2 U	2 U
Styrene	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Tetrachloroethene	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Toluene	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Trichloroethene	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Vinyl chloride	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Xylene, total	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
cis-1,2-Dichloroethene	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
cis-1,3-Dichloropropene	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U

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J - Reported value is estimated
K - Biased high
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Table D-3
Surface Water Analytical Results
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Station ID	5SD-2/5SW-2		5SD-3/5SW-3			5SD-4/5SW-4		
Sample ID	AS05-5SW02P-R06	AS05-5SW02-R07	AS05-5SW03-R05	AS05-5SW03-R06	AS05-5SW03-R07	AS05-5SW04-R05	AS05-5SW04-R06	AS05-5SW04-R07
Sample Date	06/20/01	02/25/02	08/03/00	06/20/01	02/26/02	08/03/00	06/20/01	02/25/02
Chemical Name								
m- and p-Xylene	NA	NA	1 U	NA	NA	1 U	NA	NA
o-Xylene	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
trans-1,2-Dichloroethene	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
trans-1,3-Dichloropropene	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Explosives (UG/L)								
Perchlorate	NA	NA	NA	NA	NA	NA	NA	NA

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Table D-3
Surface Water Analytical Results
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Station ID	5SD-2/5SW-2		5SD-3/5SW-3			5SD-4/5SW-4		
Sample ID	AS05-5SW02P-R06	AS05-5SW02-R07	AS05-5SW03-R05	AS05-5SW03-R06	AS05-5SW03-R07	AS05-5SW04-R05	AS05-5SW04-R06	AS05-5SW04-R07
Sample Date	06/20/01	02/25/02	08/03/00	06/20/01	02/26/02	08/03/00	06/20/01	02/25/02
Chemical Name								
Total Metals (UG/L)								
Aluminum	208	148 J	419	214	170 J	414 B	192 J	246
Antimony	3.7 U	5 U	4.9 U	3.7 U	5 U	4.9 U	3.7 U	5 U
Arsenic	5 U	5.1 U	3.8 U	5 U	5.1 U	3.8 U	5 U	5.1 J
Barium	59.4 J	63.1 J	50.4 J	55.8 J	65.9 J	45.6 J	54.8 J	65.8 J
Beryllium	0.1 U	0.1 U	0.12 B	0.1 U	0.1 U	0.16 B	0.1 U	0.1 U
Cadmium	3 U	1.7 U	0.4 U	3 U	1.7 U	0.4 U	3 U	1.7 U
Calcium	58,600	53,000	60,600	54,000	56,000	53,700	54,300	55,900
Chromium	5 U	0.6 U	0.7 UL	5 U	0.6 U	0.7 UL	5 U	1.3 J
Cobalt	1.8 U	1.3 U	1.7 J	1.8 U	2 J	2.4 J	1.8 U	2.2 J
Copper	2.2 U	1.5 U	2.2 B	2.2 U	1.5 U	1.7 B	2.2 U	1.5 U
Cyanide	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Iron	278	132	878	383	219	801	310	355
Lead	3 U	2.9 U	2.4 K	3 U	4	3.9 K	3 U	2.9 U
Magnesium	15,600	11,000	14,000	14,400	11,600	12,300	14,500	11,700
Manganese	198	269	238	229	376	235	189	305
Mercury	0.38	0.2 U	0.1 U	0.2 U	0.2 U	0.1 U	0.2 U	0.2 U
Nickel	6.7 J	7 J	3 B	5.5 J	8.1 J	3.4 B	5.8 J	9.3 J
Potassium	3,570 J	3,640 J	4,010 J	3,180 J	3,670 J	3,530 J	3,280 J	3,850 J
Selenium	5 U	4 U	2.2 U	5 U	4 U	2.2 U	5 U	4 U
Silver	5 U	0.6 U	0.6 UL	5 U	0.6 U	0.6 UL	5 U	0.6 U
Sodium	32,700	38,600 J	29,400 J	29,700	37,300 J	26,300 J	30,500	40,300 J
Thallium	5.7 U	5 U	2.3 U	5.7 U	5 U	2.3 U	5.7 U	5 U
Vanadium	3.2 U	1.4 B	1 U	3.2 U	1.8 B	1 U	3.2 U	2.1 B
Zinc	33.6	32.8	39.4 B	18.2 J	39.2 B	34.7 B	17.8 J	47.7
Dissolved Metals (UG/L)								
Aluminum	76.6 B	NA	NA	73.7 B	NA	NA	93.5 B	NA
Antimony	8.9 U	NA	NA	8.9 U	NA	NA	8.9 U	NA
Arsenic	6.2 U	NA	NA	6.2 U	NA	NA	6.2 U	NA
Barium	52.5 J	NA	NA	51.6 J	NA	NA	52 J	NA
Beryllium	0.1 U	NA	NA	0.1 U	NA	NA	0.1 U	NA
Cadmium	0.6 U	NA	NA	0.6 U	NA	NA	0.6 U	NA
Calcium	52,500	NA	NA	52,000	NA	NA	53,800	NA
Chromium	1.7 J	NA	NA	0.69 J	NA	NA	1.4 J	NA
Cobalt	0.9 U	NA	NA	0.9 U	NA	NA	0.9 U	NA
Copper	4 J	NA	NA	3.2 B	NA	NA	3.4 B	NA
Iron	61.1 B	NA	NA	28.6 J	NA	NA	21.6 B	NA
Lead	3 U	NA	NA	3 U	NA	NA	3 U	NA
Magnesium	14,000	NA	NA	13,900	NA	NA	14,400	NA

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Table D-3
Surface Water Analytical Results
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Station ID	5SD-2/5SW-2		5SD-3/5SW-3			5SD-4/5SW-4		
Sample ID	AS05-5SW02P-R06	AS05-5SW02-R07	AS05-5SW03-R05	AS05-5SW03-R06	AS05-5SW03-R07	AS05-5SW04-R05	AS05-5SW04-R06	AS05-5SW04-R07
Sample Date	06/20/01	02/25/02	08/03/00	06/20/01	02/26/02	08/03/00	06/20/01	02/25/02
Chemical Name								
Manganese	8.4 B	NA	NA	8.2 B	NA	NA	5.9 B	NA
Mercury	0.2 U	NA	NA	0.2 U	NA	NA	0.2 U	NA
Nickel	6.9 B	NA	NA	4.5 B	NA	NA	6.6 B	NA
Potassium	3,420 J	NA	NA	3,330 J	NA	NA	3,470 J	NA
Selenium	1.6 U	NA	NA	1.6 U	NA	NA	1.6 U	NA
Silver	1.7 U	NA	NA	1.7 U	NA	NA	1.7 U	NA
Sodium	29,200	NA	NA	28,300	NA	NA	29,300	NA
Thallium	4.3 U	NA	NA	4.3 U	NA	NA	4.3 U	NA
Vanadium	1.2 U	NA	NA	1.2 U	NA	NA	1.2 U	NA
Zinc	36.2	NA	NA	27.9	NA	NA	29.6	NA
Wet Chemistry (MG/L)								
Hardness	210	NA	NA	190	NA	NA	200	NA

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Table D-4
Sediment Analytical Results
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Station ID	5SD-1/5SW-1							5SD-1A	5SD-1B	5SD-2/5SW-2						
Sample ID	AS05-5SD01-R01	AS05-5SD01-R04	AS05-5SD1P-R04	AS05-5SD01-R05	AS05-5SD01-R06	AS05-5SD01-R07	AS05-5SD01P-R07	AS05-5SD01A	AS05-5SD01B	AS05-5SD02-R01	AS05-5SD02P-R01	AS05-5SD02-R04	AS05-5SD02P-R04	AS05-5SD02-R05	AS05-5SD02P-R05	AS05-5SD02-R06
Sample Date	05/08/98	10/28/99	10/28/99	08/03/00	06/20/01	02/26/02	02/26/02	02/27/02	02/27/02	05/08/98	05/08/98	10/28/99	10/28/99	08/03/00	08/03/00	06/20/01
Chemical Name																
Volatile Organic Compounds (UG/KG)																
1,1,1-Trichloroethane	15 U	15 U	NA	15 UJ	14 B	27 U	30 U	NA	NA	17 U	18 U	19 U	18 U	23 UJ	21 UJ	11 B
1,1,2,2-Tetrachloroethane	15 U	15 U	NA	15 UJ	19 U	27 U	30 U	NA	NA	17 U	18 UJ	19 U	18 U	23 UJ	21 UJ	17 U
1,1,2-Trichloro-1,2,2-trifluoroethane(Freon-113)	NA	NA	NA	NA	19 U	27 U	30 U	NA	NA	NA	NA	NA	NA	NA	NA	17 U
1,1,2-Trichloroethane	15 U	15 U	NA	15 UJ	19 U	27 U	30 U	NA	NA	17 U	18 U	19 U	18 U	23 UJ	21 UJ	17 U
1,1-Dichloroethane	15 U	15 U	NA	15 UJ	19 U	27 U	30 U	NA	NA	17 U	18 U	19 U	18 U	23 UJ	21 UJ	17 U
1,1-Dichloroethene	15 U	15 U	NA	15 UJ	19 U	27 U	30 U	NA	NA	17 U	18 U	19 U	18 U	23 UJ	21 UJ	17 U
1,2,4-Trichlorobenzene	440 U	500 U	NA	510 U	19 U	27 U	30 U	NA	NA	600 UJ	NA	630 U	600 U	760 U	710 U	17 U
1,2-Dibromo-3-chloropropane	NA	NA	NA	NA	19 U	27 U	30 U	NA	NA	NA	NA	NA	NA	NA	NA	17 U
1,2-Dibromoethane	NA	NA	NA	NA	19 U	27 U	30 U	NA	NA	NA	NA	NA	NA	NA	NA	17 U
1,2-Dichlorobenzene	440 U	500 U	NA	510 U	19 U	27 U	30 U	NA	NA	600 U	NA	630 U	600 U	760 U	710 U	17 U
1,2-Dichloroethane	15 U	15 U	NA	15 UJ	19 U	27 U	30 U	NA	NA	17 U	18 U	19 U	18 U	23 UJ	21 UJ	17 U
1,2-Dichloroethene (total)	15 U	NA	NA	NA	NA	NA	NA	NA	NA	17 U	18 U	NA	NA	NA	NA	NA
1,2-Dichloropropane	15 U	15 U	NA	15 UJ	19 U	27 U	30 U	NA	NA	17 U	18 U	19 U	18 U	23 UJ	21 UJ	17 U
1,3-Dichlorobenzene	440 U	500 U	NA	510 U	19 U	27 U	30 U	NA	NA	600 U	NA	630 U	600 U	760 U	710 U	17 U
1,4-Dichlorobenzene	440 U	500 U	NA	510 U	19 U	27 U	30 U	NA	NA	600 UJ	NA	630 U	600 U	760 U	710 U	17 U
2-Butanone	15 U	15 U	NA	15 UJ	19 U	27 U	30 U	NA	NA	17 U	18 U	19 U	18 U	23 UJ	21 UJ	17 U
2-Hexanone	15 U	15 U	NA	15 UJ	19 U	27 U	30 U	NA	NA	17 U	18 UJ	19 U	18 U	23 UJ	21 UJ	17 U
4-Methyl-2-pentanone	15 U	15 U	NA	15 UJ	19 U	27 U	30 U	NA	NA	17 U	18 UJ	19 U	18 U	23 UJ	21 UJ	17 U
Acetone	15 U	33	NA	15 UJ	19 U	27 U	30 U	NA	NA	17 U	18 U	25	18 J	23 UJ	21 UJ	17 U
Benzene	15 U	15 U	NA	15 UJ	19 U	27 U	30 U	NA	NA	17 U	18 U	19 U	18 U	23 UJ	21 UJ	17 U
Bromodichloromethane	15 U	15 U	NA	15 UJ	19 U	27 U	30 U	NA	NA	17 U	18 U	19 U	18 U	23 UJ	21 UJ	17 U
Bromoform	15 U	15 U	NA	15 UJ	19 U	27 U	30 U	NA	NA	17 U	18 U	19 U	18 U	23 UJ	21 UJ	17 U
Bromomethane	15 U	15 U	NA	15 UJ	19 U	27 U	30 U	NA	NA	17 U	18 U	19 U	18 U	23 UJ	21 UJ	17 U
Carbon disulfide	15 U	15 U	NA	15 UJ	19 U	27 U	30 U	NA	NA	17 U	18 U	19 U	18 U	23 UJ	21 UJ	17 U
Carbon tetrachloride	15 U	15 U	NA	15 UJ	19 U	27 U	30 U	NA	NA	17 U	18 U	19 U	18 U	23 UJ	21 UJ	17 U
Chlorobenzene	15 U	15 U	NA	15 UJ	19 U	27 U	30 U	NA	NA	17 U	18 UJ	19 U	18 U	23 UJ	21 UJ	17 U
Chloroethane	15 U	15 U	NA	15 UJ	19 U	27 U	30 U	NA	NA	17 U	18 U	19 U	18 U	23 UJ	21 UJ	17 U
Chloroform	15 U	15 U	NA	15 UJ	19 U	27 U	30 U	NA	NA	17 U	18 U	19 U	18 U	23 UJ	21 UJ	17 U
Chloromethane	15 U	15 U	NA	15 UJ	19 U	27 U	30 U	NA	NA	17 U	18 UJ	19 U	18 U	23 UJ	21 UJ	17 U
Cumene	NA	NA	NA	NA	19 U	27 U	30 U	NA	NA	NA	NA	NA	NA	NA	NA	17 U
Cyclohexane	NA	NA	NA	NA	19 U	27 U	30 U	NA	NA	NA	NA	NA	NA	NA	NA	17 U
Dibromochloromethane	15 U	15 U	NA	15 UJ	19 U	27 U	30 U	NA	NA	17 U	18 U	19 U	18 U	23 UJ	21 UJ	17 U
Dichlorodifluoromethane(Freon-12)	NA	NA	NA	NA	19 U	27 U	30 U	NA	NA	NA	NA	NA	NA	NA	NA	17 U
Ethylbenzene	15 U	15 U	NA	15 UJ	19 U	27 U	30 U	NA	NA	17 U	18 UJ	19 U	18 U	23 UJ	21 UJ	17 U
Methyl acetate	NA	NA	NA	NA	19 U	27 U	30 U	NA	NA	NA	NA	NA	NA	NA	NA	17 U
Methyl-tert-butyl ether (MTBE)	NA	NA	NA	NA	19 U	27 U	30 U	NA	NA	NA	NA	NA	NA	NA	NA	17 U
Methylcyclohexane	NA	NA	NA	NA	19 U	27 U	30 U	NA	NA	NA	NA	NA	NA	NA	NA	17 U
Methylene chloride	15 U	1.8 J	NA	6.7 B	5.2 B	27 U	7.7 B	NA	NA	17 U	32	3.3 J	2.5 J	23 UJ	7.4 B	4.5 B
Styrene	15 U	15 U	NA	15 UJ	19 U	27 U	30 U	NA	NA	17 U	18 UJ	19 U	18 U	23 UJ	21 UJ	17 U
Tetrachloroethene	15 U	15 U	NA	15 UJ	19 U	27 U	30 U	NA	NA	17 U	18 UJ	19 U	18 U	23 UJ	21 UJ	17 U
Toluene	15 U	15 U	NA	15 UJ	19 U	27 U	30 U	NA	NA	17 U	18 UJ	19 U	18 U	23 UJ	21 UJ	17 U
Trichloroethene	15 U	15 U	NA	15 UJ	19 U	27 U	30 U	NA	NA	17 U	18 U	19 U	18 U	23 UJ	21 UJ	17 U
Trichlorofluoromethane(Freon-11)	NA	NA	NA	NA	19 U	27 U	30 U	NA	NA	NA	NA	NA	NA	NA	NA	17 U
Vinyl chloride	15 U	15 U	NA	15 UJ	19 U	27 U	30 U	NA	NA	17 U	18 U	19 U	18 U	23 UJ	21 UJ	17 U
Xylene, total	15 U	NA	NA	15 UJ	19 U	27 U	30 U	NA	NA	17 U	18 UJ	NA	NA	23 UJ	21 UJ	17 U
cis-1,2-Dichloroethene	NA	15 U	NA	15 UJ	19 U	27 U	30 U	NA	NA	NA	NA	19 U	18 U	23 UJ	21 UJ	17 U
cis-1,3-Dichloropropene	15 U	15 U	NA	15 UJ	19 U	27 U	30 U	NA	NA	17 U	18 U	19 U	18 U	23 UJ	21 UJ	17 U
m- and p-Xylene	NA	15 U	NA	15 UJ	NA	NA	NA	NA	NA	NA	NA	19 U	18 U	23 UJ	21 UJ	NA
o-Xylene	NA	15 U	NA	15 UJ	19 U	27 U	30 U	NA	NA	NA	NA	19 U	18 U	23 UJ	21 UJ	17 U
trans-1,2-Dichloroethene	NA	15 U	NA	15 UJ	19 U	27 U	30 U	NA	NA	NA	NA	19 U	18 U	23 UJ	21 UJ	17 U
trans-1,3-Dichloropropene	15 U	15 U	NA	15 UJ	19 U	27 U	30 U	NA	NA	17 U	18 U	19 U	18 U	23 UJ	21 UJ	17 U
Semivolatile Organic Compounds (UG/KG)																
1,1-Biphenyl	NA	NA	NA	NA	620 U	890 U	960 U	NA	NA	NA	NA	NA	NA	NA	NA	570 U
1-Methylnaphthalene	NA	NA	NA	NA	NA	20	NA	7.10	4.00	NA	NA	NA	NA	NA	NA	NA
2,2'-Oxybis(1-chloropropane)	440 U	500 U	NA	510 U	620 U	890 U	960 U	NA	NA	600 U	NA	630 U	600 U	760 U	710 U	570 U
2,4,5-Trichlorophenol	1,100 U	1,200 U	NA	1,300 U	1,500 U	2,200 U	2,400 U	NA	NA	1,500 U	NA	1,500 U	1,500 U	1,900 U	1,800 U	1,400 U
2,4,6-Trichlorophenol	440 U	500 U	NA	510 U	620 U	890 U	960 U	NA	NA	600 U	NA	630 U	600 U	760 U	710 U	570 U
2,4-Dichlorophenol	440 U	500 U	NA	510 U	620 U	890 U	960 U	NA	NA	600 U	NA	630 U	600 U	760 U	710 U	570 U
2,4-Dimethylphenol	440 U	500 U	NA	510 U	620 U	890 U	960 U	NA	NA	600 U	NA	630 U	600 U	760 U	710 U	570 U
2,4-Dinitrophenol	1,100 U	1,200 U	NA	1,300 UJ	1,500 U	2,200 U	2,400 U	NA	NA	1,500 U	NA	1,500 U	1,500 U	1,900 UJ	1,800 UJ	1,400 U

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Table D-4
Sediment Analytical Results
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Station ID	5SD-1/5SW-1							5SD-1A	5SD-1B	5SD-2/5SW-2						
Sample ID	AS05-5SD01-R01	AS05-5SD01-R04	AS05-5SD1P-R04	AS05-5SD01-R05	AS05-5SD01-R06	AS05-5SD01-R07	AS05-5SD01P-R07	AS05-5SD01A	AS05-5SD01B	AS05-5SD02-R01	AS05-5SD02P-R01	AS05-5SD02-R04	AS05-5SD02P-R04	AS05-5SD02-R05	AS05-5SD02P-R05	AS05-5SD02-R06
Sample Date	05/08/98	10/28/99	10/28/99	08/03/00	06/20/01	02/26/02	02/26/02	02/27/02	02/27/02	05/08/98	05/08/98	10/28/99	10/28/99	08/03/00	08/03/00	06/20/01
Chemical Name																
2-Chloronaphthalene	440 U	500 U	NA	510 U	620 U	890 U	960 U	NA	NA	600 U	NA	630 U	600 U	760 U	710 U	570 U
2-Chlorophenol	440 U	500 U	NA	510 U	620 U	890 U	960 U	NA	NA	600 UJ	NA	630 U	600 U	760 U	710 U	570 U
2-Methylnaphthalene	52	500 U	NA	510 U	620 U	22	960 U	17.0	7.70	79	NA	630 U	600 U	760 U	710 U	570 U
2-Methylphenol	440 U	500 U	NA	510 U	620 U	890 U	960 U	NA	NA	600 U	NA	630 U	600 U	760 U	710 U	570 U
2-Nitroaniline	1,100 U	1,200 U	NA	1,300 U	1,500 U	2,200 U	2,400 U	NA	NA	1,500 U	NA	1,500 U	1,500 U	1,900 U	1,800 U	1,400 U
2-Nitrophenol	440 U	500 U	NA	510 U	620 U	890 U	960 U	NA	NA	600 U	NA	630 U	600 U	760 U	710 U	570 U
3,3'-Dichlorobenzidine	440 U	500 U	NA	510 U	620 U	890 U	960 U	NA	NA	600 U	NA	630 U	600 U	760 U	710 U	570 U
3- and 4-Methylphenol	NA	500 U	NA	510 U	620 U	NA	NA	NA	NA	NA	NA	630 U	600 U	760 U	710 U	570 U
3-Nitroaniline	1,100 U	1,200 U	NA	1,300 U	1,500 U	2,200 U	2,400 U	NA	NA	1,500 U	NA	1,500 U	1,500 U	1,900 U	1,800 U	1,400 U
4,6-Dinitro-2-methylphenol	1,100 U	1,200 U	NA	1,300 U	1,500 U	2,200 U	2,400 U	NA	NA	1,500 U	NA	1,500 U	1,500 U	1,900 U	1,800 U	1,400 U
4-Bromophenyl-phenylether	440 U	500 U	NA	510 U	620 U	890 U	960 U	NA	NA	600 U	NA	630 U	600 U	760 U	710 U	570 U
4-Chloro-3-methylphenol	440 U	500 U	NA	510 U	620 U	890 U	960 U	NA	NA	600 UJ	NA	630 U	600 U	760 U	710 U	570 U
4-Chloroaniline	440 U	500 U	NA	510 U	620 U	890 U	960 U	NA	NA	600 U	NA	630 U	600 U	760 U	710 U	570 U
4-Chlorophenyl-phenylether	440 U	500 U	NA	510 U	620 U	890 U	960 U	NA	NA	600 U	NA	630 U	600 U	760 U	710 U	570 U
4-Methylphenol	440 U	NA	NA	NA	NA	190 J	500 J	NA	NA	600 U	NA	NA	NA	NA	NA	NA
4-Nitroaniline	1,100 U	1,200 U	NA	1,300 U	1,500 U	2,200 U	2,400 U	NA	NA	1,500 U	NA	1,500 U	1,500 U	1,900 U	1,800 U	1,400 U
4-Nitrophenol	1,100 U	1,200 U	NA	1,300 U	1,500 U	2,200 U	2,400 U	NA	NA	1,500 UJ	NA	1,500 U	1,500 U	1,900 U	1,800 U	1,400 U
Acenaphthene	440 U	500 U	NA	510 U	620 U	89 J	960 U	2.30 J	1.80 J	600 UJ	NA	630 U	600 U	760 U	710 U	570 U
Acenaphthylene	440 U	500 U	NA	510 U	620 U	9.1	960 U	1.30 J	2.10 J	600 U	NA	630 U	600 U	760 U	710 U	570 U
Acetophenone	NA	NA	NA	NA	620 U	890 U	960 U	NA	NA	NA	NA	NA	NA	NA	NA	570 U
Anthracene	440 U	500 U	NA	510 U	620 U	25	960 U	1.90 J	3.50	600 U	NA	630 U	600 U	760 U	710 U	570 U
Atrazine	NA	NA	NA	NA	620 U	890 U	960 U	NA	NA	NA	NA	NA	NA	NA	NA	570 U
Benzaldehyde	NA	NA	NA	NA	620 U	1,400	1,400	NA	NA	NA	NA	NA	NA	NA	NA	570 U
Benzo(a)anthracene	63	500 U	NA	510 U	620 U	110	960 U	8.70	25.0	85	NA	630 U	600 U	760 U	710 U	570 U
Benzo(a)pyrene	49	500 U	NA	510 U	620 U	120	960 UJ	7.50	27.0	62	NA	630 U	600 U	760 U	710 U	570 U
Benzo(b)fluoranthene	110	500 U	NA	510 U	620 U	140 J	150 J	10.0	27.0	140	NA	630 U	600 U	760 U	710 U	570 U
Benzo(g,h,i)perylene	440 U	500 U	NA	510 U	620 U	96	960 UJ	5.80	21.0	600 U	NA	630 U	600 U	760 U	710 U	570 U
Benzo(k)fluoranthene	440 U	500 U	NA	510 U	620 U	120	960 UJ	7.30	26.0	600 U	NA	630 U	600 U	760 U	710 U	570 U
Butylbenzylphthalate	440 U	500 U	NA	510 U	620 U	890 U	960 U	NA	NA	600 U	NA	630 U	600 U	760 U	710 U	570 U
Caprolactam	NA	NA	NA	NA	71 L	890 U	960 U	NA	NA	NA	NA	NA	NA	NA	NA	570 R
Carbazole	440 U	500 U	NA	510 U	620 U	890 U	960 U	NA	NA	600 U	NA	630 U	600 U	760 U	710 U	570 U
Chrysene	100	500 U	NA	510 U	79 J	180 J	160 J	11.0	28.0	150	NA	630 U	600 U	760 U	710 U	570 U
Di-n-butylphthalate	440 U	500 U	NA	100 J	330 J	890 U	960 U	NA	NA	600 U	NA	630 U	600 U	760 U	120 J	570 U
Di-n-octylphthalate	440 U	500 U	NA	510 U	620 U	890 UJ	960 UJ	NA	NA	600 U	NA	630 U	600 U	760 U	710 U	570 U
Dibenz(a,h)anthracene	440 U	500 U	NA	510 U	620 U	30	960 UJ	3.20	7.70	600 U	NA	630 U	600 U	760 U	710 U	570 U
Dibenzofuran	440 U	500 U	NA	510 U	620 U	890 U	960 U	NA	NA	600 U	NA	630 U	600 U	760 U	710 U	570 U
Diethylphthalate	440 U	500 U	NA	510 U	160 J	260 J	200 J	NA	NA	600 U	NA	630 U	600 U	760 U	710 U	570 U
Dimethyl phthalate	440 U	500 U	NA	510 U	620 U	890 U	960 U	NA	NA	600 U	NA	630 U	600 U	760 U	710 U	570 U
Fluoranthene	110	500 U	NA	510 U	170 J	160	160 J	11.0	36.0	160	NA	630 U	600 U	760 U	710 U	570 U
Fluorene	440 U	500 U	NA	510 U	620 U	22	960 U	6.20	5.30	600 U	NA	630 U	600 U	760 U	710 U	570 U
Hexachlorobenzene	440 U	500 U	NA	510 U	620 U	890 U	960 U	NA	NA	600 U	NA	630 U	600 U	760 U	710 U	570 U
Hexachlorobutadiene	440 U	500 U	NA	510 U	620 U	890 U	960 U	NA	NA	600 U	NA	630 U	600 U	760 U	710 U	570 U
Hexachlorocyclopentadiene	440 U	500 U	NA	510 U	620 U	890 U	960 U	NA	NA	600 U	NA	630 U	600 U	760 U	710 U	570 U
Hexachloroethane	440 U	500 U	NA	510 U	620 U	890 U	960 U	NA	NA	600 U	NA	630 U	600 U	760 U	710 U	570 U
Indeno(1,2,3-cd)pyrene	440 U	500 U	NA	510 U	620 U	81	960 UJ	5.50	19.0	600 U	NA	630 U	600 U	760 U	710 U	570 U
Isophorone	440 U	500 U	NA	510 U	620 U	890 U	960 U	NA	NA	600 U	NA	630 U	600 U	760 U	710 U	570 U
Naphthalene	440 U	500 U	NA	510 U	620 U	14	960 U	7.90	5.30	600 U	NA	630 U	600 U	760 U	710 U	570 U
Pentachlorophenol	1,100 U	1,200 U	NA	1,300 U	1,500 U	2,200 U	2,400 U	NA	NA	1,500 UJ	NA	1,500 U	1,500 U	1,900 U	1,800 U	1,400 U
Phenanthrene	140	500 U	NA	510 U	63 J	160 J	170 J	22.0	22.0	250	NA	630 U	600 U	760 U	710 U	570 U
Phenol	440 U	500 U	NA	510 U	64 J	890 U	960 U	NA	NA	600 UJ	NA	630 U	600 U	760 U	710 U	570 U
Pyrene	88	500 U	NA	510 U	130 J	250 J	280 J	12.0	44.0	140 J	NA	630 U	600 U	760 U	710 U	570 U
bis(2-Chloroethoxy)methane	440 U	500 U	NA	510 U	620 U	890 U	960 U	NA	NA	600 U	NA	630 U	600 U	760 U	710 U	570 U
bis(2-Chloroethyl)ether	440 U	500 U	NA	510 U	620 U	890 U	960 U	NA	NA	600 U	NA	630 U	600 U	760 U	710 U	570 U
bis(2-Ethylhexyl)phthalate	72	500 U	NA	510 U	620 U	670 B	330 B	NA	NA	83	NA	630 U	600 U	760 U	710 U	570 U
n-Nitroso-di-n-propylamine	440 U	500 U	NA	510 U	620 U	890 U	960 U	NA	NA	600 UJ	NA	630 U	600 U	760 U	710 U	570 U
n-Nitrosodiphenylamine	440 U	500 U	NA	510 U	620 U	890 U	960 U	NA	NA	600 U	NA	630 U	600 U	760 U	710 U	570 U
Explosives (UG/KG)																
2,4-Dinitrotoluene	440 U	500 U	NA	510 U	620 U	890 U	960 U	NA	NA	600 UJ	NA	630 U	600 U	760 U	710 U	570 U
2,6-Dinitrotoluene	440 U	500 U	NA	510 U	620 U	890 U	960 U	NA	NA	600 U	NA	630 U	600 U	760 U	710 U	570 U
Nitrobenzene	440 U	500 U	NA	510 U	620 U	890 U	960 U	NA	NA	600 U	NA	630 U	600 U	760 U	710 U	570 U

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Table D-4
Sediment Analytical Results
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Station ID	5SD-1/5SW-1							5SD-1A	5SD-1B	5SD-2/5SW-2						
Sample ID	AS05-5SD01-R01	AS05-5SD01-R04	AS05-5SD1P-R04	AS05-5SD01-R05	AS05-5SD01-R06	AS05-5SD01-R07	AS05-5SD01P-R07	AS05-5SD01A	AS05-5SD01B	AS05-5SD02-R01	AS05-5SD02P-R01	AS05-5SD02-R04	AS05-5SD02P-R04	AS05-5SD02-R05	AS05-5SD02P-R05	AS05-5SD02-R06
Sample Date	05/08/98	10/28/99	10/28/99	08/03/00	06/20/01	02/26/02	02/26/02	02/27/02	02/27/02	05/08/98	05/08/98	10/28/99	10/28/99	08/03/00	08/03/00	06/20/01
Chemical Name																
Total Metals (MG/KG)																
Aluminum	7,820 J	6,160	6,195	3,990	6,520	9,670	11,100	4,910	4,410	13,700 J	NA	8,270	8,840	8,290	8,460	10,400
Antimony	1.1 L	1.5 U	1.52 U	1.5 U	1.4 U	2.7 U	2.9 U	0.76 UL	1.00 L	0.73 UL	NA	1.9 U	1.8 U	2.2 U	2.1 U	1.6 J
Arsenic	9.4	9.9	9.67	6.1	10.2	16.1	17.5	7.30	9.10	24.1	NA	15.4	15.1	16.4	12.7	16.3
Barium	128 J	57.3 B	57.5 B	70.4	152	182	195	62.8	54.1 J	149 J	NA	121	118	117	111	144
Beryllium	2.2	2	2.03	1.3 J	1.7 J	2.5 J	2.7 J	1.10 J	1.20 J	2.9	NA	2.6	2.7	2.3 J	2.2	2.4
Boron	NA	15.2 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	19.2 U	17.6 U	NA	NA	NA
Cadmium	0.08 U	0.3 U	0.3 U	0.12 U	1.1 U	0.93 U	1 U	0.068 U	0.083 U	0.09 U	NA	0.38 U	0.35 U	0.55 B	0.77 B	1 U
Calcium	4,210 J	1,610	1,615	3,470	4,760	7,520	7,580	2,250	1,190 J	4,780 J	NA	79,500	71,500	64,000	94,100	3,640
Chromium	15.6	13.7	13.6	7.1	14.7	17.2	16.9	8.90	12.2	31	NA	49.9	50.3	54.3	80.9	23.5
Cobalt	44.2	26.8 E	26.8	31.7	44.3	66.3	73.4	25.4	27.6	28	NA	39.9 E	40.6 E	46.2	47.9	39.2
Copper	38.9	45.8	46.0	22.3	30.7	50.2	51	14.0	18.4	67.5	NA	64.7	65.7	60.6	62.8	46.5
Cyanide	NA	NA	NA	1.7	0.93 U	1.4 U	1.5 U	NA	NA	NA	NA	NA	NA	1.1 U	1.1 U	0.86 U
Iron	34,800 J	26,800	26,879	18,600	27,200	34,900	33,700	23,600 J	29,900 J	47,100 J	NA	26,400	26,400	22,900	20,700	30,700
Lead	36	35 E	35.0	24.3	37.9	35.9	39.8	15.0 K	22.8 K	43.6	NA	29.5 E	22.2 E	32.3	26.3	32.5
Magnesium	1,240 J	727 B	728 B	797 J	1,130 J	1,870 J	2,150 J	836 J	559 J	1,040 J	NA	2,600	2,450	2,600	3,620	1,050 J
Manganese	941 J	342 E	343	1,190	1,130	1,240	1,160	1,050 K	482 K	603 J	NA	746 E	734 E	1,050	1,020	1,110
Mercury	0.07 U	0.2	0.2	0.21 B	0.17 U	0.38 L	0.46 L	0.039 U	0.046 U	0.24 B	NA	1.7	1.6	4.8	1.7	0.17 U
Nickel	63.7	53.8 E	54.1	50	70.6	117	132	45.9	49.9	48.8	NA	72.3 E	72.6 E	76.4	85.2	64.9
Potassium	948 J	677 B	680 B	532 J	849 J	854 J	1,090 J	775 J	726 J	843 J	NA	686 B	771 B	650 J	801 J	953 J
Selenium	1 U	3.6 N	3.07	0.68 U	2.1	2.4 J	2.3 U	0.71 U	0.77 U	1.1 U	NA	1.9 UN	1.8 N	1 U	1.1 B	1.7 U
Silver	2.4 B	0.54 B	0.46 B	0.18 UL	1.8 U	0.33 U	0.52 J	0.22 UL	0.27 UL	3.1 B	NA	0.82 B	0.84 B	0.27 UL	0.25 UL	1.7 U
Sodium	59.1 B	213 B	214 B	299 B	181 U	298 J	476 J	171 J	179 J	114 B	NA	1,850 B	1,660 B	1,190 J	1,890 J	168 U
Thallium	0.48 U	2.1 U	2.12 U	3.4 B	2.1 U	2.7 U	2.9 U	1.30 J	1.50 J	1.1 J	NA	2.7 U	2.5 U	1 U	0.97 U	2 U
Vanadium	23.8	15.5	15.5	11.3 J	16.7 J	26.3 J	29.4	14.7	15.4 J	28	NA	14 B	14.7 B	16.4 J	14.4 J	19.3
Zinc	221 J	178 E	178	141	203	337	388	120 J	153 J	209 J	NA	263 E	281 E	299	343	227
Wet Chemistry (MG/KG)																
% Solids	NA	NA	NA	NA	NA	35.7	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total organic carbon (TOC)	NA	NA	NA	NA	NA	78,000	NA	16,000	20,000	NA	NA	NA	NA	NA	NA	NA
pH	NA	NA	NA	NA	NA	6.9	NA	7.30	7.20	NA	NA	NA	NA	NA	NA	NA
Acid Volatile Sulfide/Simultaneously Extractable Metals (UMOLE/G)																
Acid Volatile Sulfide	NA	NA	NA	NA	NA	32	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cadmium	NA	NA	NA	NA	NA	0.0089	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Copper	NA	NA	NA	NA	NA	0.16	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Lead	NA	NA	NA	NA	NA	0.19	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Mercury	NA	NA	NA	NA	NA	7.40E-05 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Nickel	NA	NA	NA	NA	NA	0.57	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
SEM/AVS Ratio	NA	NA	NA	NA	NA	0.14	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Simul-ExtractMetal	NA	NA	NA	NA	NA	4.6	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Zinc	NA	NA	NA	NA	NA	3.7	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

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Table D-4
Sediment Analytical Results
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Station ID	5SD-2/5SW-2		5SD-2A	5SD-2B	5SD-3/5SW-3			5SD-3A	5SD-3B	5SD-4/5SW-4			5SD-5		5SD-5A	5SD-6	5SD-6A	5SD-7	5SD-7A
Sample ID	AS05-5SD02P-R06	AS05-5SD02-R07	AS05-5SD02A	AS05-5SD02B	AS05-5SD03-R05	AS05-5SD03-R06	AS05-5SD03-R07	AS05-5SD03A	AS05-5SD03B	AS05-5SD04-R05	AS05-5SD04-R06	AS05-5SD04-R07	AS05-5SD05	AS05-5SD05P	AS05-5SD05A	AS05-5SD06	AS05-5SD06A	AS05-5SD07	AS05-5SD07A
Sample Date	06/20/01	02/25/02	02/27/02	02/27/02	08/03/00	06/20/01	02/26/02	02/27/02	02/27/02	08/03/00	06/20/01	02/25/02	02/25/02	02/25/02	02/27/02	02/25/02	02/27/02	02/25/02	02/27/02
Chemical Name																			
Volatile Organic Compounds (UG/KG)																			
1,1,1-Trichloroethane	11 B	18 U	NA	NA	50 UJ	8 B	19 U	NA	NA	13 UJ	10 B	33 U	NA	NA	NA	NA	NA	NA	NA
1,1,2,2-Tetrachloroethane	17 U	18 U	NA	NA	50 UJ	25 U	19 U	NA	NA	13 UJ	15 U	33 U	NA	NA	NA	NA	NA	NA	NA
1,1,2-Trichloro-1,2,2-trifluoroethane(Freon-113)	17 U	18 U	NA	NA	NA	25 U	19 U	NA	NA	NA	15 U	33 U	NA	NA	NA	NA	NA	NA	NA
1,1,2-Trichloroethane	17 U	18 U	NA	NA	50 UJ	25 U	19 U	NA	NA	13 UJ	15 U	33 U	NA	NA	NA	NA	NA	NA	NA
1,1-Dichloroethane	17 U	18 U	NA	NA	50 UJ	25 U	19 U	NA	NA	13 UJ	15 U	33 U	NA	NA	NA	NA	NA	NA	NA
1,1-Dichloroethene	17 U	18 U	NA	NA	50 UJ	25 U	19 U	NA	NA	13 UJ	15 U	33 U	NA	NA	NA	NA	NA	NA	NA
1,2,4-Trichlorobenzene	17 U	18 U	NA	NA	1,700 U	25 U	19 U	NA	NA	420 U	15 U	33 U	NA	NA	NA	NA	NA	NA	NA
1,2-Dibromo-3-chloropropane	17 U	18 U	NA	NA	NA	25 U	19 U	NA	NA	NA	15 U	33 U	NA	NA	NA	NA	NA	NA	NA
1,2-Dibromoethane	17 U	18 U	NA	NA	NA	25 U	19 U	NA	NA	NA	15 U	33 U	NA	NA	NA	NA	NA	NA	NA
1,2-Dichlorobenzene	17 U	18 U	NA	NA	1,700 U	25 U	19 U	NA	NA	420 U	15 U	33 U	NA	NA	NA	NA	NA	NA	NA
1,2-Dichloroethane	17 U	18 U	NA	NA	50 UJ	25 U	19 U	NA	NA	13 UJ	15 U	33 U	NA	NA	NA	NA	NA	NA	NA
1,2-Dichloroethene (total)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2-Dichloropropane	17 U	18 U	NA	NA	50 UJ	25 U	19 U	NA	NA	13 UJ	15 U	33 U	NA	NA	NA	NA	NA	NA	NA
1,3-Dichlorobenzene	17 U	18 U	NA	NA	1,700 U	25 U	19 U	NA	NA	420 U	15 U	33 U	NA	NA	NA	NA	NA	NA	NA
1,4-Dichlorobenzene	17 U	18 U	NA	NA	1,700 U	25 U	19 U	NA	NA	420 U	15 U	33 U	NA	NA	NA	NA	NA	NA	NA
2-Butanone	17 U	18 U	NA	NA	50 UJ	25 U	19 U	NA	NA	13 UJ	15 U	33 U	NA	NA	NA	NA	NA	NA	NA
2-Hexanone	17 U	18 U	NA	NA	50 UJ	25 U	19 U	NA	NA	13 UJ	15 U	33 U	NA	NA	NA	NA	NA	NA	NA
4-Methyl-2-pentanone	17 U	18 U	NA	NA	50 UJ	25 U	19 U	NA	NA	13 UJ	15 U	33 U	NA	NA	NA	NA	NA	NA	NA
Acetone	17 U	18 U	NA	NA	50 UJ	25 U	19 U	NA	NA	13 UJ	15 U	33 U	NA	NA	NA	NA	NA	NA	NA
Benzene	17 U	18 U	NA	NA	50 UJ	25 U	19 U	NA	NA	13 UJ	15 U	33 U	NA	NA	NA	NA	NA	NA	NA
Bromodichloromethane	17 U	18 U	NA	NA	50 UJ	25 U	19 U	NA	NA	13 UJ	15 U	33 U	NA	NA	NA	NA	NA	NA	NA
Bromoform	17 U	18 U	NA	NA	50 UJ	25 U	19 U	NA	NA	13 UJ	15 U	33 U	NA	NA	NA	NA	NA	NA	NA
Bromomethane	17 U	18 U	NA	NA	50 UJ	25 U	19 U	NA	NA	13 UJ	15 U	33 U	NA	NA	NA	NA	NA	NA	NA
Carbon disulfide	17 U	18 U	NA	NA	50 UJ	25 U	19 U	NA	NA	13 UJ	15 U	33 U	NA	NA	NA	NA	NA	NA	NA
Carbon tetrachloride	17 U	18 U	NA	NA	50 UJ	25 U	19 U	NA	NA	13 UJ	15 U	33 U	NA	NA	NA	NA	NA	NA	NA
Chlorobenzene	17 U	18 U	NA	NA	50 UJ	25 U	19 U	NA	NA	13 UJ	15 U	33 U	NA	NA	NA	NA	NA	NA	NA
Chloroethane	17 U	18 U	NA	NA	50 UJ	25 U	19 U	NA	NA	13 UJ	15 U	33 U	NA	NA	NA	NA	NA	NA	NA
Chloroform	17 U	18 U	NA	NA	50 UJ	25 U	19 U	NA	NA	13 UJ	15 U	33 U	NA	NA	NA	NA	NA	NA	NA
Chloromethane	17 U	18 U	NA	NA	50 UJ	25 U	19 U	NA	NA	13 UJ	15 U	33 U	NA	NA	NA	NA	NA	NA	NA
Cumene	17 U	18 U	NA	NA	NA	25 U	19 U	NA	NA	NA	15 U	33 U	NA	NA	NA	NA	NA	NA	NA
Cyclohexane	17 U	18 U	NA	NA	NA	25 U	19 U	NA	NA	NA	15 U	33 U	NA	NA	NA	NA	NA	NA	NA
Dibromochloromethane	17 U	18 U	NA	NA	50 UJ	25 U	19 U	NA	NA	13 UJ	15 U	33 U	NA	NA	NA	NA	NA	NA	NA
Dichlorodifluoromethane(Freon-12)	17 U	18 U	NA	NA	NA	25 U	19 U	NA	NA	NA	15 U	33 U	NA	NA	NA	NA	NA	NA	NA
Ethylbenzene	17 U	18 U	NA	NA	50 UJ	25 U	19 U	NA	NA	13 UJ	15 U	33 U	NA	NA	NA	NA	NA	NA	NA
Methyl acetate	17 U	18 U	NA	NA	NA	25 U	19 U	NA	NA	NA	15 U	33 U	NA	NA	NA	NA	NA	NA	NA
Methyl-tert-butyl ether (MTBE)	17 U	18 U	NA	NA	NA	25 U	19 U	NA	NA	NA	15 U	33 U	NA	NA	NA	NA	NA	NA	NA
Methylcyclohexane	17 U	18 U	NA	NA	NA	25 U	19 U	NA	NA	NA	15 U	33 U	NA	NA	NA	NA	NA	NA	NA
Methylene chloride	4.7 B	18 U	NA	NA	50 UJ	7.6 B	5.7 B	NA	NA	5 B	4.6 B	7.2 B	NA	NA	NA	NA	NA	NA	NA
Styrene	17 U	18 U	NA	NA	50 UJ	25 U	19 U	NA	NA	13 UJ	15 U	33 U	NA	NA	NA	NA	NA	NA	NA
Tetrachloroethene	17 U	18 U	NA	NA	50 UJ	25 U	19 U	NA	NA	13 UJ	15 U	33 U	NA	NA	NA	NA	NA	NA	NA
Toluene	17 U	18 U	NA	NA	50 UJ	25 U	19 U	NA	NA	13 UJ	15 U	33 U	NA	NA	NA	NA	NA	NA	NA
Trichloroethene	17 U	18 U	NA	NA	50 UJ	25 U	19 U	NA	NA	13 UJ	15 U	33 U	NA	NA	NA	NA	NA	NA	NA
Trichlorofluoromethane(Freon-11)	17 U	18 U	NA	NA	NA	25 U	19 U	NA	NA	NA	15 U	33 U	NA	NA	NA	NA	NA	NA	NA
Vinyl chloride	17 U	18 U	NA	NA	50 UJ	25 U	19 U	NA	NA	13 UJ	15 U	33 U	NA	NA	NA	NA	NA	NA	NA
Xylene, total	17 U	18 U	NA	NA	50 UJ	25 U	19 U	NA	NA	13 UJ	15 U	33 U	NA	NA	NA	NA	NA	NA	NA
cis-1,2-Dichloroethene	17 U	18 U	NA	NA	50 UJ	25 U	19 U	NA	NA	13 UJ	15 U	33 U	NA	NA	NA	NA	NA	NA	NA
cis-1,3-Dichloropropene	17 U	18 U	NA	NA	50 UJ	25 U	19 U	NA	NA	13 UJ	15 U	33 U	NA	NA	NA	NA	NA	NA	NA
m- and p-Xylene	NA	NA	NA	NA	50 UJ	NA	NA	NA	NA	13 UJ	NA	NA	NA	NA	NA	NA	NA	NA	NA
o-Xylene	17 U	18 U	NA	NA	50 UJ	25 U	19 U	NA	NA	13 UJ	15 U	33 U	NA	NA	NA	NA	NA	NA	NA
trans-1,2-Dichloroethene	17 U	18 U	NA	NA	50 UJ	25 U	19 U	NA	NA	13 UJ	15 U	33 U	NA	NA	NA	NA	NA	NA	NA
trans-1,3-Dichloropropene	17 U	18 U	NA	NA	50 UJ	25 U	19 U	NA	NA	13 UJ	15 U	33 U	NA	NA	NA	NA	NA	NA	NA
Semivolatile Organic Compounds (UG/KG)																			
1,1-Biphenyl	560 U	590 U	NA	NA	NA	810 U	650 U	NA	NA	NA	510 U	NA	NA	NA	NA	NA	NA	NA	NA
1-Methylnaphthalene	NA	17	5.20	6.30	NA	NA	22	2.20 J	4.40	NA	NA	28 L	17.0	12.0	6.30	11.0	7.30 L	2.70	1.50 J
2,2'-Oxybis(1-chloropropane)	560 U	590 UJ	NA	NA	1,700 U	810 U	650 U	NA	NA	420 U	510 U	NA	NA	NA	NA	NA	NA	NA	NA
2,4,5-Trichlorophenol	1,400 U	1,500 U	NA	NA	4,200 U	2,000 U	1,600 U	NA	NA	1,100 U	1,300 U	NA	NA	NA	NA	NA	NA	NA	NA
2,4,6-Trichlorophenol	560 U	590 U	NA	NA	1,700 U	810 U	650 U	NA	NA	420 U	510 U	NA	NA	NA	NA	NA	NA	NA	NA
2,4-Dichlorophenol	560 U	590 U	NA	NA	1,700 U	810 U	650 U	NA	NA	420 U	510 U	NA	NA	NA	NA	NA	NA	NA	NA
2,4-Dimethylphenol	560 U	590 U	NA	NA	1,700 U	810 U	650 U	NA	NA	420 U	510 U	NA	NA	NA	NA	NA	NA	NA	NA
2,4-Dinitrophenol	1,400 U	1,500 U	NA	NA	4,200 UJ	2,000 U	1,600 U	NA	NA	1,100 UJ	1,300 U	NA	NA	NA	NA	NA	NA	NA	NA

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Table D-4
Sediment Analytical Results
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Station ID	5SD-2/5SW-2		5SD-2A	5SD-2B	5SD-3/5SW-3			5SD-3A	5SD-3B	5SD-4/5SW-4			5SD-5		5SD-5A	5SD-6	5SD-6A	5SD-7	5SD-7A
Sample ID	AS05-5SD02P-R06	AS05-5SD02-R07	AS05-5SD02A	AS05-5SD02B	AS05-5SD03-R05	AS05-5SD03-R06	AS05-5SD03-R07	AS05-5SD03A	AS05-5SD03B	AS05-5SD04-R05	AS05-5SD04-R06	AS05-5SD04-R07	AS05-5SD05	AS05-5SD05P	AS05-5SD05A	AS05-5SD06	AS05-5SD06A	AS05-5SD07	AS05-5SD07A
Sample Date	06/20/01	02/25/02	02/27/02	02/27/02	08/03/00	06/20/01	02/26/02	02/27/02	02/27/02	08/03/00	06/20/01	02/25/02	02/25/02	02/25/02	02/27/02	02/25/02	02/27/02	02/25/02	02/27/02
Chemical Name																			
2-Chloronaphthalene	560 U	590 U	NA	NA	1,700 U	810 U	650 U	NA	NA	420 U	510 U	NA	NA	NA	NA	NA	NA	NA	NA
2-Chlorophenol	560 U	590 U	NA	NA	1,700 U	810 U	650 U	NA	NA	420 U	510 U	NA	NA	NA	NA	NA	NA	NA	NA
2-Methylnaphthalene	560 U	85 J	12.0	17.0	1,700 U	810 U	110 J	5.50	11.0	420 U	510 U	44 L	26.0	17.0	13.0	20.0	17.0 L	4.10	3.30
2-Methylphenol	560 U	590 U	NA	NA	1,700 U	810 U	650 U	NA	NA	420 U	510 U	NA	NA	NA	NA	NA	NA	NA	NA
2-Nitroaniline	1,400 U	1,500 U	NA	NA	4,200 U	2,000 U	1,600 U	NA	NA	1,100 U	1,300 U	NA	NA	NA	NA	NA	NA	NA	NA
2-Nitrophenol	560 U	590 U	NA	NA	1,700 U	810 U	650 U	NA	NA	420 U	510 U	NA	NA	NA	NA	NA	NA	NA	NA
3,3'-Dichlorobenzidine	560 U	590 U	NA	NA	1,700 U	810 U	650 U	NA	NA	420 U	510 U	NA	NA	NA	NA	NA	NA	NA	NA
3- and 4-Methylphenol	560 U	220 J	NA	NA	1,700 U	7,800	NA	NA	NA	420 U	63 J	NA	NA	NA	NA	NA	NA	NA	NA
3-Nitroaniline	1,400 U	1,500 U	NA	NA	4,200 U	2,000 U	1,600 U	NA	NA	1,100 U	1,300 U	NA	NA	NA	NA	NA	NA	NA	NA
4,6-Dinitro-2-methylphenol	1,400 U	1,500 U	NA	NA	4,200 U	2,000 U	1,600 U	NA	NA	1,100 U	1,300 U	NA	NA	NA	NA	NA	NA	NA	NA
4-Bromophenyl-phenylether	560 U	590 U	NA	NA	1,700 U	810 U	650 U	NA	NA	420 U	510 U	NA	NA	NA	NA	NA	NA	NA	NA
4-Chloro-3-methylphenol	560 U	590 U	NA	NA	1,700 U	810 U	650 U	NA	NA	420 U	510 U	NA	NA	NA	NA	NA	NA	NA	NA
4-Chloroaniline	560 U	590 U	NA	NA	1,700 U	810 U	650 U	NA	NA	420 U	510 U	NA	NA	NA	NA	NA	NA	NA	NA
4-Chlorophenyl-phenylether	560 U	590 U	NA	NA	1,700 U	810 U	650 U	NA	NA	420 U	510 U	NA	NA	NA	NA	NA	NA	NA	NA
4-Methylphenol	NA	NA	NA	NA	NA	NA	330 J	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4-Nitroaniline	1,400 U	1,500 U	NA	NA	4,200 U	2,000 U	1,600 U	NA	NA	1,100 U	1,300 U	NA	NA	NA	NA	NA	NA	NA	NA
4-Nitrophenol	1,400 U	1,500 U	NA	NA	4,200 U	2,000 U	1,600 U	NA	NA	1,100 U	1,300 U	NA	NA	NA	NA	NA	NA	NA	NA
Acenaphthene	560 U	6.6	12.0	2.00 J	1,700 U	810 U	90 J	2.30 U	0.98 J	420 U	510 U	13 L	4.00 J	2.10 J	3.80 J	3.10	2.10 L	0.57 J	2.10 U
Acenaphthylene	560 U	9.7	0.69 J	2.30 J	1,700 U	810 U	15	2.30 U	3.00	420 U	510 U	19 L	5.60	4.50	4.30 J	5.30	1.20 L	0.84 J	2.10 U
Acetophenone	560 U	590 U	NA	NA	NA	810 U	650 U	NA	NA	NA	510 U	NA	NA	NA	NA	NA	NA	NA	NA
Anthracene	560 U	15	25.0	2.80	1,700 U	810 U	31	0.49 J	2.60	420 U	510 U	36 L	12.0	7.30	16.0	8.00	2.50 L	1.00 J	2.10 U
Atrazine	560 U	590 U	NA	NA	NA	810 U	650 U	NA	NA	NA	510 U	NA	NA	NA	NA	NA	NA	NA	NA
Benzaldehyde	560 U	540 J	NA	NA	NA	810 U	680	NA	NA	NA	510 U	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(a)anthracene	560 U	82	43.0	6.60	1,700 U	810 U	200 J	2.50	15.0	420 U	510 U	230 L	64.0	50.0	74.0	45.0	7.10 L	5.70	2.30
Benzo(a)pyrene	560 U	77	43.0	10.0	1,700 U	810 U	170 J	2.50	16.0	420 U	510 U	260 L	72.0	52.0	64.0	51.0	8.70 L	5.40	2.00 J
Benzo(b)fluoranthene	560 U	83	38.0	12.0	1,700 U	810 U	260 J	3.30	18.0	420 U	510 U	240 L	95.0	57.0	64.0	56.0	12.0 L	6.70	2.50
Benzo(g,h,i)perylene	560 U	60	32.0	13.0	1,700 U	810 U	100	1.70 J	13.0	420 U	510 U	170 L	65.0	45.0	45.0	47.0	9.20 L	3.80	1.10 J
Benzo(k)fluoranthene	560 U	76	33.0	9.40	1,700 U	810 U	140	1.60 J	14.0	420 U	510 U	250 L	69.0	54.0	58.0	52.0	8.50 L	4.80	1.00 J
Butylbenzylphthalate	560 U	590 U	NA	NA	1,700 U	810 U	650 U	NA	NA	420 U	510 U	NA	NA	NA	NA	NA	NA	NA	NA
Caprolactam	560 R	590 U	NA	NA	NA	1,600 R	650 U	NA	NA	NA	510 R	NA	NA	NA	NA	NA	NA	NA	NA
Carbazole	560 U	590 U	NA	NA	1,700 U	810 U	650 U	NA	NA	420 U	510 U	NA	NA	NA	NA	NA	NA	NA	NA
Chrysene	560 U	130 J	37.0	7.90	1,700 U	810 U	290 J	3.40	17.0	420 U	510 U	260 L	83.0	57.0	66.0	54.0	15.0 L	6.30	2.00 J
Di-n-butylphthalate	560 U	1,000	NA	NA	260 J	95 J	650 U	NA	NA	110 J	510 U	NA	NA	NA	NA	NA	NA	NA	NA
Di-n-octylphthalate	560 U	590 U	NA	NA	1,700 U	810 U	650 U	NA	NA	420 U	510 U	NA	NA	NA	NA	NA	NA	NA	NA
Dibenz(a,h)anthracene	560 U	20	9.30	5.70	1,700 U	810 U	36	1.80 J	5.30	420 U	510 U	56 L	21.0	15.0	18.0	16.0	3.00 L	2.50	1.50 J
Dibenzofuran	560 U	590 U	NA	NA	1,700 U	810 U	650 U	NA	NA	420 U	510 U	NA	NA	NA	NA	NA	NA	NA	NA
Diethylphthalate	560 U	590 U	NA	NA	1,700 U	810 U	200 J	NA	NA	420 U	510 U	NA	NA	NA	NA	NA	NA	NA	NA
Dimethyl phthalate	560 U	590 U	NA	NA	1,700 U	810 U	650 U	NA	NA	420 U	510 U	NA	NA	NA	NA	NA	NA	NA	NA
Fluoranthene	560 U	190 J	90.0	9.30	1,700 U	810 U	390 J	3.40	17.0	420 U	510 U	330 L	88.0	67.0	140	64.0	14.0 L	8.10	2.80
Fluorene	560 U	17	12.0	4.30	1,700 U	810 U	25	1.60 J	3.40	420 U	510 U	35 L	11.0	6.70	12.0	11.0	6.60 L	1.40 J	1.00 J
Hexachlorobenzene	560 U	590 U	NA	NA	1,700 U	810 U	650 U	NA	NA	420 U	510 U	NA	NA	NA	NA	NA	NA	NA	NA
Hexachlorobutadiene	560 U	590 U	NA	NA	1,700 U	810 U	650 U	NA	NA	420 U	510 U	NA	NA	NA	NA	NA	NA	NA	NA
Hexachlorocyclopentadiene	560 U	590 U	NA	NA	1,700 U	810 U	650 U	NA	NA	420 U	510 U	NA	NA	NA	NA	NA	NA	NA	NA
Hexachloroethane	560 U	590 U	NA	NA	1,700 U	810 U	650 U	NA	NA	420 U	510 U	NA	NA	NA	NA	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	560 U	52	26.0	12.0	1,700 U	810 U	90	2.40	12.0	420 U	510 U	160 L	53.0	39.0	43.0	39.0	7.20 L	4.30	1.90 J
Isophorone	560 U	590 U	NA	NA	1,700 U	810 U	650 U	NA	NA	420 U	510 U	NA	NA	NA	NA	NA	NA	NA	NA
Naphthalene	560 U	14	7.20	8.70	1,700 U	810 U	81 J	2.60	5.10	420 U	510 U	27 L	16.0	11.0	8.90	9.40	9.00 L	2.30	1.90 B
Pentachlorophenol	1,400 U	1,500 U	NA	NA	4,200 U	2,000 U	1,600 U	NA	NA	1,100 U	1,300 U	NA	NA	NA	NA	NA	NA	NA	NA
Phenanthrene	560 U	230 J	94.0	18.0	1,700 U	810 U	380 J	6.50	18.0	420 U	510 U	210 L	80.0	49.0	110	50.0	28.0 L	8.10	3.80
Phenol	560 U	590 U	NA	NA	1,700 U	510 J	650 U	NA	NA	420 U	510 U	NA	NA	NA	NA	NA	NA	NA	NA
Pyrene	560 U	170	110	9.90	1,700 U	810 U	420 J	3.50	21.0	420 U	510 U	340 L	110	88.0	140	74.0	15.0 L	8.50	2.60
bis(2-Chloroethoxy)methane	560 U	590 U	NA	NA	1,700 U	810 U	650 U	NA	NA	420 U	510 U	NA	NA	NA	NA	NA	NA	NA	NA
bis(2-Chloroethyl)ether	560 U	590 U	NA	NA	1,700 U	810 U	650 U	NA	NA	420 U	510 U	NA	NA	NA	NA	NA	NA	NA	NA
bis(2-Ethylhexyl)phthalate	560 U	370 B	NA	NA	1,700 U	95 J	250 B	NA	NA	420 U	510 U	NA	NA	NA	NA	NA	NA	NA	NA
n-Nitroso-di-n-propylamine	560 U	590 U	NA	NA	1,700 U	810 U	650 U	NA	NA	420 U	510 U	NA	NA	NA	NA	NA	NA	NA	NA
n-Nitrosodiphenylamine	560 U	590 U	NA	NA	1,700 U	810 U	650 U	NA	NA	420 U	510 U	NA	NA	NA	NA	NA	NA	NA	NA
Explosives (UG/KG)																			
2,4-Dinitrotoluene	560 U	590 U	NA	NA	1,700 U	810 U	650 U	NA	NA	420 U	510 U	NA	NA	NA	NA	NA	NA	NA	NA
2,6-Dinitrotoluene	560 U	590 U	NA	NA	1,700 U	810 U	650 U	NA	NA	420 U	510 U	NA	NA	NA	NA	NA	NA	NA	NA
Nitrobenzene	560 U	590 U	NA	NA	1,700 U	810 U	650 U	NA	NA	420 U	510 U	NA	NA	NA	NA	NA	NA	NA	NA

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Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Station ID	5SD-2/5SW-2		5SD-2A	5SD-2B	5SD-3/5SW-3			5SD-3A	5SD-3B	5SD-4/5SW-4			5SD-5		5SD-5A	5SD-6	5SD-6A	5SD-7	5SD-7A
Sample ID	AS05-5SD02P-R06	AS05-5SD02-R07	AS05-5SD02A	AS05-5SD02B	AS05-5SD03-R05	AS05-5SD03-R06	AS05-5SD03-R07	AS05-5SD03A	AS05-5SD03B	AS05-5SD04-R05	AS05-5SD04-R06	AS05-5SD04-R07	AS05-5SD05	AS05-5SD05P	AS05-5SD05A	AS05-5SD06	AS05-5SD06A	AS05-5SD07	AS05-5SD07A
Sample Date	06/20/01	02/25/02	02/27/02	02/27/02	08/03/00	06/20/01	02/26/02	02/27/02	02/27/02	08/03/00	06/20/01	02/25/02	02/25/02	02/25/02	02/27/02	02/25/02	02/27/02	02/25/02	02/27/02
Chemical Name																			
Total Metals (MG/KG)																			
Aluminum	11,700	6,750	4,130	5,090	5,780	11,200	6,300	5,370	4,470	3,520	5,870	7,280	5,470	5,150	3,950	2,950	6,580	3,200	5,580
Antimony	1.2 U	1.8 U	0.76 UL	0.77 UL	4.8 U	1.8 U	1.9 U	0.67 UL	0.69 UL	1.2 U	1.1 U	3.3 U	1.40 UL	0.96 UL	0.68 UL	0.81 UL	0.85 UL	0.69 UL	0.67 UL
Arsenic	18.8	14.4	6.60	8.20	9.7 J	16.2	9	6.90	9.10	7.3	10.5	11.6	8.40	7.50	6.40	4.40	11.2	5.30	6.10
Barium	146	139	46.4 J	70.9	111 J	208	66.6 J	63.3	47.9	35.5 J	119	147	60.9 J	60.9 J	41.7 J	31.5 J	65.1	41.0 J	70.2
Beryllium	2.6	1.8	1.10 J	1.10 J	1.8 J	2.6	2	1.30	1.40	1.3	1.5	2 J	1.40 J	1.30 J	1.10 J	0.82 J	1.40 J	0.86 J	1.20
Boron	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cadmium	0.98 U	0.61 U	0.068 U	0.069 U	0.45 B	1.4 U	0.65 U	0.060 U	0.062 U	0.1 U	0.89 U	1.1 U	0.17 J	0.13 J	0.061 U	0.19 J	0.076 U	0.062 U	0.060 U
Calcium	3,590	25,300	1,060 J	2,420	5,890	4,520	2,700	1,480	1,440	908 J	2,720	5,790	2,370	1,890	953 J	1,440	2,320	674 J	4,820
Chromium	24.7	17.9	12.3	11.5	4.5 J	17.6	14	13.3	15.7	7.6	13	12.7	13.1	15.2	12.5	6.60	12.4	9.80	18.7
Cobalt	36.3	36.1	25.9	31.5	51.9	72.6	42.1	29.1	29.6	29.5	39.3	60.1	25.6	23.8	26.8	18.2	31.3	17.5	24.2
Copper	50.7	35.7	15.9	16.2	28.9	40.3	35.7	15.9	19.5	16.1	25.4	34.3	26.3	31.4	17.6	11.2	19.5	10.2	13.7
Cyanide	0.83 U	0.9 U	NA	NA	2.5 U	1.23 U	1 U	NA	NA	0.63 U	0.76 U	1.7 U	NA	NA	NA	NA	NA	NA	NA
Iron	33,600	26,700	28,000 J	28,100 J	20,500	33,900	18,300	35,700 J	40,800 J	22,200	28,100	31,300	21,200 J	21,200 J	30,600 J	10,700 J	32,200 J	19,400 J	38,900 J
Lead	33.8	24.3	26.6 K	14.0 K	27.3	37.2	24	13.7 K	21.2 K	18.5	27.7	31.6	18.4 K	22.5 K	18.9 K	10.1 K	21.0 K	11.9 K	14.7 K
Magnesium	1,050 J	1,220 J	557 J	1,070 J	1,140 J	1,810 J	714 J	661 J	554 J	494 J	896 J	1,330 J	707 J	583 J	469 J	357 J	756 J	599 J	1,590
Manganese	892	1,330	598 K	1,040 K	1,420	1,700	131	1,250 K	686 K	237	916	893	332 K	349 K	458 K	334 K	929 K	239 K	1,340 K
Mercury	0.17 U	0.18 UL	0.048 K	0.042 U	1.4	0.23 U	0.28 L	0.037 U	0.037 U	0.13 B	0.15 U	0.31 UL	0.073 U	0.14 K	0.067 K	0.19 K	0.042 U	0.036 U	0.035 U
Nickel	62.9	61.7	49.7	50.5	78	110	68	45.9	52.9	48.4	60.9	98.3	45.2	43.2	48.9	26.6	57.9	31.6	40.8
Potassium	984 J	651 J	732 J	731 J	657 J	1,320 J	441 J	615 J	668 J	400 J	806 J	766 J	777 J	711 J	639 J	388 J	1,030 J	416 J	554 J
Selenium	1.6 U	1.4 U	0.59 U	0.58 U	2.2 U	2.4 U	1.5 U	0.51 U	0.55 U	0.54 U	1.5 U	2.6 U	1.00 U	0.99 U	0.52 U	0.61 U	2.10	0.53 U	0.51 U
Silver	1.6 U	0.21 U	0.22 UL	0.23 UL	0.59 UL	2.4 U	0.23 U	0.20 UL	0.21 UL	0.15 UL	1.5 U	0.4 U	0.40 UL	0.28 UL	0.20 UL	0.24 UL	0.25 UL	0.21 UL	0.20 UL
Sodium	161 J	414 J	113 J	252 J	899 B	236 U	249 J	360 J	168 J	249 B	145 U	458 J	237 J	149 J	102 J	135 J	184 J	92.7 J	198 J
Thallium	1.9 U	1.8 U	1.10 J	1.90 J	2.3 U	2.7 U	1.9 U	1.30 J	1.80 J	1.9 B	1.7 U	3.3 U	1.90 U	1.40 U	1.30 J	1.10 U	1.90 J	1.20 J	1.40 J
Vanadium	20.9	16.4 J	15.5	15.5	19.4 J	25.1	14.9 J	14.9	17.9	11.1 J	15.5	22.4 J	14.1 J	13.1 J	14.9	7.90 J	17.6	9.10 J	33.2
Zinc	236	184	147 J	143 J	255	334	201	135 J	166 J	149	188	277	149 J	143 J	148 J	76.4 J	157 J	114 J	129 J
Wet Chemistry (MG/KG)																			
% Solids	NA	55.2	NA	NA	NA	NA	47.3	NA	NA	NA	NA	37.2	NA	NA	NA	NA	NA	NA	NA
Total organic carbon (TOC)	NA	100,000	6,400	8,600	NA	NA	67,000	4,900	7,800	NA	NA	91,000	130,000	120,000	7,000	62,000	19,000	9,000	3,700
pH	NA	7.5	7.50	7.30	NA	NA	6.5	7.40	7.40	NA	NA	7	7.30	7.30	7.10	7.10	7.40	7.20	7.60
Acid Volatile Sulfide/Simultaneously Extractable Metals (UMOLE/G)																			
Acid Volatile Sulfide	NA	16	NA	NA	NA	NA	12	NA	NA	NA	NA	43	NA	NA	NA	NA	NA	NA	NA
Cadmium	NA	0.004 B	NA	NA	NA	NA	0.0049 B	NA	NA	NA	NA	0.0059	NA	NA	NA	NA	NA	NA	NA
Copper	NA	0.3	NA	NA	NA	NA	0.23	NA	NA	NA	NA	0.26	NA	NA	NA	NA	NA	NA	NA
Lead	NA	0.077	NA	NA	NA	NA	0.1	NA	NA	NA	NA	0.099	NA	NA	NA	NA	NA	NA	NA
Mercury	NA	4.80E-05 U	NA	NA	NA	NA	5.60E-05 U	NA	NA	NA	NA	7.10E-05 U	NA	NA	NA	NA	NA	NA	NA
Nickel	NA	0.4	NA	NA	NA	NA	0.34	NA	NA	NA	NA	0.72	NA	NA	NA	NA	NA	NA	NA
SEM/AVS Ratio	NA	0.15	NA	NA	NA	NA	0.22	NA	NA	NA	NA	0.088	NA	NA	NA	NA	NA	NA	NA
Simul-ExtractMetal	NA	2.5	NA	NA	NA	NA	2.6	NA	NA	NA	NA	3.8	NA	NA	NA	NA	NA	NA	NA
Zinc	NA	1.7	NA	NA	NA	NA	1.9	NA	NA	NA	NA	2.7	NA	NA	NA	NA	NA	NA	NA

NA - Not analyzed
B - Analyte not detected above associated blank
D - Result came from a diluted sample
E - Exceedance - Interference

J - Reported value is estimated
K - Biased high
L - Biased low
R - Rejected
U - Undetected

Appendix E
DPT Groundwater Analytical Results

Table E-1
DPT Groundwater Analytical Results
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Station ID	AS05-DP01		AS05-DP02		AS05-DP03		AS05-DP04		AS05-DP05		AS05-DP06		AS05-DP07		AS05-DP08		AS05-DP09		AS05-DP10		AS05-DP11		AS05-DP12		AS05-DP14	
Sample ID	AS05-DP01		AS05-DP02		AS05-DP03		AS05-DP04		AS05-DP05		AS05-DP06		AS05-DP07		AS05-DP08		AS05-DP09		AS05-DP10		AS05-DP11		AS05-DP12		AS05-DP14	
Sample Date	05/30/00		05/30/00		05/30/00		05/30/00		05/31/00		05/31/00		05/31/00		05/31/00		05/31/00		06/01/00		06/01/00		06/02/00		06/02/00	
Chemical Name																										
Volatile Organic Compounds (UG/L)																										
1,1,1-Trichloroethane	1.5	U	1.5	U	1.5	U	1.5	U	1.5	U	1.5	U	1.5	U	1.5	U	1.5	U	1.5	U	1.5	U	1.5	U	1.5	U
1,1,2,2-Tetrachloroethane	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U
1,1,2-Trichloroethane	1.6	U	1.6	U	1.6	U	1.6	U	1.6	U	1.6	U	1.6	U	1.6	U	1.6	U	1.6	U	1.6	U	1.6	U	1.6	U
1,1-Dichloroethane	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U
1,1-Dichloroethene	2	U	2	U	2	U	2	U	2	U	2	U	2	U	2	U	2	U	2	U	2	U	2	U	2	U
1,2-Dichlorobenzene	1.6	U	1.6	U	1.6	U	1.6	U	1.6	U	1.6	U	1.6	U	1.6	U	1.6	U	1.6	U	1.6	U	1.6	U	1.6	U
1,2-Dichloroethane	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U
1,2-Dichloropropane	1.9	U	1.9	U	1.9	U	1.9	U	1.9	U	1.9	U	1.9	U	1.9	U	1.9	U	1.9	U	1.9	U	1.9	U	1.9	U
1,3-Dichlorobenzene	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U
1,4-Dichlorobenzene	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U
2-Chloroethyl vinyl ether	1.5	U	1.5	U	1.5	U	1.5	U	1.5	U	1.5	U	1.5	U	1.5	U	1.5	U	1.5	U	1.5	U	1.5	U	1.5	U
Benzene	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U
Bromodichloromethane	1.5	U	1.5	U	1.5	U	1.5	U	1.5	U	1.5	U	1.5	U	1.5	U	1.5	U	1.5	U	1.5	U	1.5	U	1.5	U
Bromoform	1.8	U	1.8	U	1.8	U	1.8	U	1.8	U	1.8	U	1.8	U	1.8	U	1.8	U	1.8	U	1.8	U	1.8	U	1.8	U
Bromomethane	1.8	U	1.8	U	1.8	U	1.8	U	1.8	U	1.8	U	1.8	U	1.8	U	1.8	U	1.8	U	1.8	U	1.8	U	NA	
Carbon tetrachloride	1.3	U	1.3	U	1.3	U	1.3	U	1.3	U	1.3	U	1.3	U	1.3	U	1.3	U	1.3	U	1.3	U	1.3	U	1.3	U
Chlorobenzene	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U
Chloroethane	2.2	U	2.2	U	2.2	U	2.2	U	2.2	U	2.2	U	2.2	U	2.2	U	2.2	U	2.2	U	2.2	U	2.2	U	2.2	U
Chloroform	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U
Chloromethane	2.4	U	2.4	U	2.4	U	2.4	U	2.4	U	2.4	U	2.4	U	2.4	U	2.4	U	2.4	U	2.4	U	2.4	U	NA	
Dibromochloromethane	1.2	U	1.2	U	1.2	U	1.2	U	1.2	U	1.2	U	1.2	U	1.2	U	1.2	U	1.2	U	1.2	U	1.2	U	1.2	U
Ethylbenzene	1.2	U	1.2	U	1.2	U	1.2	U	1.2	U	1.2	U	1.2	U	1.2	U	1.2	U	1.2	U	1.2	U	1.2	U	1.2	U
Methylene chloride	1.9	U	1.9	U	1.9	U	1.9	U	1.9	U	1.9	U	1.9	U	1.9	U	1.9	U	1.9	U	1.9	U	1.9	U	1.9	U
Tetrachloroethene	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U
Toluene	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U
Trichloroethene	1.9	U	63		41		2.2		2.7		1.9	U	1.9	U	1.9	U	2.6		1.9	U	28		1.9	U	1.9	U
Trichlorofluoromethane(Freon-11)	2.4	U	2.4	U	2.4	U	2.4	U	2.4	U	2.4	U	2.4	U	2.4	U	2.4	U	2.4	U	2.4	U	2.4	U	2.4	U
Vinyl chloride	1.9	U	1.9	U	1.9	U	1.9	U	1.9	U	1.9	U	1.9	U	1.9	U	1.9	U	1.9	U	1.9	U	1.9	U	1.9	U
cis-1,3-Dichloropropene	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U
trans-1,2-Dichloroethene	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U
trans-1,3-Dichloropropene	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U

NA - Not analyzed
U - Analyte not detected

Table E-1
DPT Groundwater Analytical Results
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Station ID	AS05-DP15		AS05-DP16		AS05-DP17		AS05-DP18		AS05-DP19		AS05-DP20		AS05-DP21		AS05-DP25		AS05-DP26		AS05-DP27		AS05-DP28		AS05-DP29		AS05-DP30	
Sample ID	AS05-DP15		AS05-DP16		AS05-DP17		AS05-DP18		AS05-DP19		AS05-DP20		AS05-DP21		AS05-DP25		AS05-DP26		AS05-DP27		AS05-DP28		AS05-DP29		AS05-DP30	
Sample Date	06/02/00		06/02/00		06/02/00		06/02/00		06/05/00		06/05/00		06/05/00		06/08/00		06/08/00		06/08/00		06/08/00		06/09/00		06/09/00	
Chemical Name																										
Volatile Organic Compounds (UG/L)																										
1,1,1-Trichloroethane	1.5	U	1.5	U	1.5	U	1.5	U	1.5	U	1.5	U	1.5	U	1.5	U	1.5	U	1.5	U	1.5	U	1.5	U	1.5	U
1,1,2,2-Tetrachloroethane	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U
1,1,2-Trichloroethane	1.6	U	1.6	U	1.6	U	1.6	U	1.6	U	1.6	U	1.6	U	1.6	U	1.6	U	1.6	U	1.6	U	1.6	U	1.6	U
1,1-Dichloroethane	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U
1,1-Dichloroethene	2	U	2	U	2	U	2	U	2	U	2	U	2	U	2	U	2	U	2	U	2	U	2	U	2	U
1,2-Dichlorobenzene	1.6	U	1.6	U	1.6	U	1.6	U	1.6	U	1.6	U	1.6	U	1.6	U	1.6	U	1.6	U	1.6	U	1.6	U	1.6	U
1,2-Dichloroethane	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U
1,2-Dichloropropane	1.9	U	1.9	U	1.9	U	1.9	U	1.9	U	1.9	U	1.9	U	1.9	U	1.9	U	1.9	U	1.9	U	1.9	U	1.9	U
1,3-Dichlorobenzene	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U
1,4-Dichlorobenzene	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U
2-Chloroethyl vinyl ether	1.5	U	1.5	U	1.5	U	1.5	U	1.5	U	1.5	U	1.5	U	1.5	U	1.5	U	1.5	U	1.5	U	1.5	U	1.5	U
Benzene	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U
Bromodichloromethane	1.5	U	1.5	U	1.5	U	1.5	U	1.5	U	1.5	U	1.5	U	1.5	U	1.5	U	1.5	U	1.5	U	1.5	U	1.5	U
Bromoform	1.8	U	1.8	U	1.8	U	1.8	U	1.8	U	1.8	U	1.8	U	1.8	U	1.8	U	1.8	U	1.8	U	1.8	U	1.8	U
Bromomethane	1.8	U	1.8	U	1.8	U	1.8	U	1.8	U	1.8	U	1.8	U	1.8	U	1.8	U	1.8	U	1.8	U	1.8	U	1.8	U
Carbon tetrachloride	1.3	U	1.3	U	1.3	U	1.3	U	1.3	U	1.3	U	1.3	U	1.3	U	1.3	U	1.3	U	1.3	U	1.3	U	1.3	U
Chlorobenzene	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U
Chloroethane	2.2	U	2.2	U	2.2	U	2.2	U	2.2	U	2.2	U	2.2	U	2.2	U	2.2	U	2.2	U	2.2	U	2.2	U	2.2	U
Chloroform	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U
Chloromethane	2.4	U	2.4	U	2.4	U	2.4	U	2.4	U	2.4	U	2.4	U	2.4	U	2.4	U	2.4	U	2.4	U	2.4	U	2.4	U
Dibromochloromethane	1.2	U	1.2	U	1.2	U	1.2	U	1.2	U	1.2	U	1.2	U	1.2	U	1.2	U	1.2	U	1.2	U	1.2	U	1.2	U
Ethylbenzene	1.2	U	1.2	U	1.2	U	1.2	U	1.2	U	1.2	U	1.2	U	1.2	U	1.2	U	1.2	U	1.2	U	1.2	U	1.2	U
Methylene chloride	1.9	U	1.9	U	1.9	U	1.9	U	1.9	U	1.9	U	1.9	U	1.9	U	1.9	U	1.9	U	1.9	U	1.9	U	1.9	U
Tetrachloroethene	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U
Toluene	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	3.1		2.7		1.4	U	1.8		1.4	U	1.4	U	1.4	U	1.4	U
Trichloroethene	14		51		6.6		1.9	U	1.9	U	4.6		57		11		1.9	U	24		1.9	U	1.9	U	14	
Trichlorofluoromethane(Freon-11)	2.4	U	2.4	U	2.4	U	2.4	U	2.4	U	2.4	U	2.4	U	2.4	U	2.4	U	2.4	U	2.4	U	2.4	U	2.4	U
Vinyl chloride	1.9	U	1.9	U	1.9	U	1.9	U	1.9	U	1.9	U	1.9	U	1.9	U	1.9	U	1.9	U	1.9	U	1.9	U	1.9	U
cis-1,3-Dichloropropene	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U
trans-1,2-Dichloroethene	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U
trans-1,3-Dichloropropene	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U

NA - Not analyzed
U - Analyte not detected

Table E-1
DPT Groundwater Analytical Results
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Station ID	AS05-DP32		AS05-DP33		AS05-DP34		AS05-DP36		AS05-DP37	
Sample ID	AS05-DP32		AS05-DP33		AS05-DP34		AS05-DP36		AS05-DP37	
Sample Date	06/12/00		06/12/00		06/12/00		06/12/00		06/12/00	
Chemical Name										
Volatile Organic Compounds (UG/L)										
1,1,1-Trichloroethane	1.5	U	1.5	U	1.5	U	1.5	U	1.5	U
1,1,2,2-Tetrachloroethane	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U
1,1,2-Trichloroethane	1.6	U	1.6	U	1.6	U	1.6	U	1.6	U
1,1-Dichloroethane	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U
1,1-Dichloroethene	2	U	2	U	2	U	2	U	2	U
1,2-Dichlorobenzene	1.6	U	1.6	U	1.6	U	1.6	U	1.6	U
1,2-Dichloroethane	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U
1,2-Dichloropropane	1.9	U	1.9	U	1.9	U	1.9	U	1.9	U
1,3-Dichlorobenzene	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U
1,4-Dichlorobenzene	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U
2-Chloroethyl vinyl ether	1.5	U	1.5	U	1.5	U	1.5	U	1.5	U
Benzene	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U
Bromodichloromethane	1.5	U	1.5	U	1.5	U	1.5	U	1.5	U
Bromoform	1.8	U	1.8	U	1.8	U	1.8	U	1.8	U
Bromomethane	1.8	U	1.8	U	1.8	U	1.8	U	1.8	U
Carbon tetrachloride	1.3	U	1.3	U	1.3	U	1.3	U	1.3	U
Chlorobenzene	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U
Chloroethane	2.2	U	2.2	U	2.2	U	2.2	U	2.2	U
Chloroform	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U
Chloromethane	2.4	U	2.4	U	2.4	U	2.4	U	2.4	U
Dibromochloromethane	1.2	U	1.2	U	1.2	U	1.2	U	1.2	U
Ethylbenzene	1.2	U	1.2	U	1.2	U	1.2	U	1.2	U
Methylene chloride	1.9	U	1.9	U	1.9	U	1.9	U	1.9	U
Tetrachloroethene	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U
Toluene	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U
Trichloroethene	9.6		1.9	U	3.6		1.9	U	1.9	U
Trichlorofluoromethane(Freon-11)	2.4	U	2.4	U	2.4	U	2.4	U	2.4	U
Vinyl chloride	1.9	U	1.9	U	1.9	U	1.9	U	1.9	U
cis-1,3-Dichloropropene	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U
trans-1,2-Dichloroethene	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U
trans-1,3-Dichloropropene	1.4	U	1.4	U	1.4	U	1.4	U	1.4	U

NA - Not analyzed
U - Analyte not detected

Appendix F
Human Health Risk Assessment Tables

TABLE 1

SELECTION OF EXPOSURE PATHWAYS

Site 5, Allegany Ballistics Laboratory

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	On-Site/ Off-Site	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
Current/Future	Surface Water	Surface Water	Site 5 Surface Water	Other Recreational Person	Adult	Dermal Absorption	On-Site	Quant	Recreational users may contact surface water during recreational activities.
						Ingestion	On-site	Quant	Recreational users may ingest surface water during recreational activities.
					Adolescents	Dermal Absorption	On-site	Quant	Recreational users may contact surface water during recreational activities.
						Ingestion	On-site	Quant	Recreational users may ingest surface water during recreational activities.
	Sediment	Sediment	Site 5 Sediment	Other Recreational Person	Adult	Dermal Absorption	On-site	Quant	Recreational users may contact sediment during recreational activities.
						Ingestion	On-site	Quant	Recreational users may ingest sediment during recreational activities.
					Adolescents	Dermal Absorption	On-site	Quant	Recreational users may contact sediment during recreational activities.
						Ingestion	On-site	Quant	Recreational users may ingest sediment during recreational activities.
Future	Groundwater	Groundwater	Alluvial Aquifer-Tap Water	Resident	Adult	Ingestion	On-site	Quant	Although unlikely, groundwater evaluated for use as future potable water supply.
					Child	Dermal Absorption	On-site	Quant	Although unlikely, groundwater evaluated for use as future potable water supply.
						Ingestion	On-site	Quant	Although unlikely, groundwater evaluated for use as future potable water supply.
					Adult/Child	Ingestion	On-site	Quant	Although unlikely, groundwater evaluated for use as future potable water supply. This is for cancer risk only.
			Alluvial Aquifer-Water in Excavation Pit	Construction Worker	Adult	Dermal Absorption	On-site	Quant	Construction workers may contact groundwater while performing construction or excavation activities.
						Ingestion	On-site	None	Ingestion of groundwater during construction activities expected to be minimal.
		Air	Alluvial Aquifer-Water Vapors at Showerhead	Resident	Adult	Inhalation	On-site	Quant	Although unlikely, groundwater evaluated for use as future potable water supply.
					Child	Inhalation	On-site	None	Children are assumed not to shower.
			Alluvial Aquifer-Volatilization from Water in Excavation Pit	Construction Worker	Adult	Inhalation	On-site	Quant	Construction workers may inhale vapors from groundwater while performing construction or excavation activities.
		Groundwater	Bedrock Aquifer-Tap Water	Resident	Adult	Ingestion	On-site	Quant	Although unlikely, groundwater evaluated for use as future potable water supply.
					Child	Dermal Absorption	On-site	Quant	Although unlikely, groundwater evaluated for use as future potable water supply.
						Ingestion	On-site	Quant	Although unlikely, groundwater evaluated for use as future potable water supply.
					Adult/Child	Ingestion	On-site	Quant	Although unlikely, groundwater evaluated for use as future potable water supply. This is for cancer risk only.
		Air	Bedrock Aquifer-Water Vapors at Showerhead	Resident	Adult	Inhalation	On-site	Quant	Although unlikely, groundwater evaluated for use as future potable water supply.
					Child	Inhalation	On-site	None	Children are assumed not to shower.

Table F.2.1

OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN

Site 5, Allegany Ballistics Laboratory

Scenario Timeframe: Current/Future
Medium: Surface Water
Exposure Medium: Surface Water
Exposure Point: Site 5

CAS Number	Chemical	Minimum [1] Concentration	Minimum Qualifier	Maximum [1] Concentration	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration [2] Used for Screening	Background [3] Value	Screening [4] Toxicity Value	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for [5] Contaminant Deletion or Selection
7429-90-5	Aluminum	148	J	419		UG/L	AS05-5SW03-R05	10/12	17.2 - 45.7	419	NA	36,500 N	NA	NA	NO	BSL
7440-38-2	Arsenic	5.1	J	5.1	J	UG/L	AS05-5SW04-R07	1/12	3.8 - 5.1	5.1	NA	0.446 C	NA	NA	YES	ASL
7440-39-3	Barium	45.6	J	65.9	J	UG/L	AS05-5SW03-R07	11/12	0.2 - 2	65.9	NA	2,555 N	NA	NA	NO	BSL
7440-70-2	Calcium	50,700	J	60,600	J	UG/L	AS05-5SW03-R05	12/12	10.7 - 15.9	60,600	NA	NA	NA	NA	NO	NUT
7440-47-3	Chromium	1.1	J	1.3	J	UG/L	AS05-5SW04-R07	2/12	0.6 - 5	1.3	NA	110 N	NA	NA	NO	BSL
7440-48-4	Cobalt	1.4	J	2.5	J	UG/L	AS05-5SW02-R05	6/12	1.1 - 1.8	2.5	NA	730 N	NA	NA	NO	BSL
7439-89-6	Iron	132	J	970	J	UG/L	AS05-5SW02-R05	12/12	7 - 15.9	970	NA	11,000 N	NA	NA	NO	BSL
7439-92-1	Lead	2.4	K	4.8	K	UG/L	AS05-5SW02P-R05	5/12	2 - 3	4.8	NA	15	NA	NA	NO	BSL
7439-95-4	Magnesium	11,000	K	15,600	K	UG/L	AS05-5SW02-R06	12/12	12.3 - 75.9	15,600	NA	NA	NA	NA	NO	NUT
7439-96-5	Manganese	177		376		UG/L	AS05-5SW03-R07	12/12	0.3 - 1.2	376	NA	730 N	NA	NA	NO	BSL
7439-97-6	Mercury	0.39		0.39		UG/L	AS05-5SW02-R06	1/12	0.1 - 0.2	0.39	NA	11.0 N	NA	NA	NO	BSL
7440-02-0	Nickel	5.4	J	9.3	J	UG/L	AS05-5SW04-R07	8/12	2 - 4	9.3	NA	730 N	NA	NA	NO	BSL
7440-09-7	Potassium	3,030	J	4,010	J	UG/L	AS05-5SW03-R05	11/12	21.9 - 49.7	4,010	NA	NA	NA	NA	NO	NUT
7440-23-5	Sodium	26,000	J	40,300	J	UG/L	AS05-5SW04-R07	12/12	308 - 496.6	40,300	NA	NA	NA	NA	NO	NUT
7440-66-6	Zinc	17.8	J	47.7	J	UG/L	AS05-5SW04-R07	7/12	1.5 - 8.5	47.7	NA	10,950 N	NA	NA	NO	BSL

[1] Minimum/Maximum detected concentration. Total metals results used since direct contact with surface water may occur.

[2] Maximum concentration is used for screening.

[3] Background values not available.

[4] Risk-Based Concentration Table, October 9, 2002, U.S. EPA Region III, Jennifer Hubbard.
10xTap water RBC (Cancer benchmark value = 1E-06, adjusted HQ=0.1) per discussion with Dawn Ioven (EPA Region III Toxicologist).
RBC value for Chromium VI used for total chromium.
Lead screening toxicity value is 15 µg/l, the EPA Safe Drinking Water Action Level for lead.
RBC value for manganese-nonfood used as surrogate for manganese.
RBC value for mercuric chloride used as surrogate for mercury.

[5] Rationale Codes

Selection Reason: Above Screening Levels (ASL)

Deletion Reason: No Toxicity Information (NTX)
Essential Nutrient (NUT)
Below Screening Level (BSL)

SQL = Sample Quantification Limit
COPC = Chemical of Potential Concern
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/ To Be Considered
J = Estimated Value
K = Biased High
L = Biased Low
C = Carcinogenic
N = Noncarcinogenic

Table F.2.2

OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN

Site 5, Allegany Ballistics Laboratory

Scenario Timeframe: Current/Future
Medium: Sediment
Exposure Medium: Sediment
Exposure Point: Site 5

CAS Number	Chemical	Minimum [1] Concentration	Minimum Qualifier	Maximum [1] Concentration	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration [2] Used for Screening	Background [3] Value	Screening [4] Toxicity Value	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for [5] Contaminant Deletion or Selection
78-93-3	2-Butanone	0.005	J	0.012	J	MG/KG	5SD-2(94)	2/16	0.013 - 0.05	0.012	NA	46,929 N	NA	NA	NO	BSL
75-09-2	Methylene chloride	0.032		0.032		MG/KG	AS05-5SD02P-R01	1/16	0.013 - 0.05	0.032	NA	852 C	NA	NA	NO	BSL
90-12-0	1-Methylnaphthalene	0.0015	J	0.028	L	MG/KG	AS05-5SD04-R07	16/16	0.0021 - 0.009	0.028	NA	1,564 N	NA	NA	NO	BSL
91-57-6	2-Methylnaphthalene	0.0033		0.11	J	MG/KG	AS05-5SD03-R07	20/28	0.0021 - 1.7	0.11	NA	1,564 N	NA	NA	NO	BSL
-	3- and 4-Methylphenol	0.063	J	7.8		MG/KG	AS05-5SD03-R06	3/9	0.42 - 1.7	7.8	NA	1,564 N	NA	NA	NO	BSL
106-44-5	4-Methylphenol	0.18	J	0.5	J	MG/KG	AS05-5SD01P-R07	4/6	0.44 - 0.96	0.5	NA	391 N	NA	NA	NO	BSL
83-32-9	Acenaphthene	5.70E-04	J	0.09	J	MG/KG	AS05-5SD03-R07	14/28	0.0021 - 1.7	0.09	NA	4,693 N	NA	NA	NO	BSL
208-96-8	Acenaphthylene	6.90E-04	J	0.019	L	MG/KG	AS05-5SD04-R07	14/28	0.0021 - 1.7	0.019	NA	1,564 N	NA	NA	NO	BSL
120-12-7	Anthracene	4.90E-04	J	0.036	L	MG/KG	AS05-5SD04-R07	15/28	0.0021 - 1.7	0.036	NA	23,464 N	NA	NA	NO	BSL
100-52-7	Benzaldehyde	0.54	J	1.4		MG/KG	AS05-5SD01-R07 AS05-5SD01P-R07	3/7	0.51 - 0.96	1.4	NA	7,821 N	NA	NA	NO	BSL
56-55-3	Benzo(a)anthracene	0.0023		0.23	L	MG/KG	AS05-5SD04-R07	19/28	0.0021 - 1.7	0.23	NA	8.75 C	NA	NA	NO	BSL
50-32-8	Benzo(a)pyrene	0.002	J	0.26	L	MG/KG	AS05-5SD04-R07	19/28	0.0021 - 1.7	0.26	NA	0.875 C	NA	NA	NO	BSL
205-99-2	Benzo(b)fluoranthene	0.0025		0.26	J	MG/KG	AS05-5SD03-R07	20/28	0.0021 - 1.7	0.26	NA	8.75 C	NA	NA	NO	BSL
191-24-2	Benzo(g,h,i)perylene	0.0011	J	0.17	L	MG/KG	AS05-5SD04-R07	16/28	0.0021 - 1.7	0.17	NA	2,346 N	NA	NA	NO	BSL
207-08-9	Benzo(k)fluoranthene	1.00E-03	J	0.25	L	MG/KG	AS05-5SD04-R07	17/28	0.0021 - 1.7	0.25	NA	87.5 C	NA	NA	NO	BSL
105-60-2	Caprolactam	0.071	L	0.071	L	MG/KG	AS05-5SD01-R06	1/4	0.59 - 0.96	0.071	NA	39,107 N	NA	NA	NO	BSL
218-01-9	Chrysene	0.002	J	0.29	J	MG/KG	AS05-5SD03-R07	21/28	0.0021 - 1.7	0.29	NA	875 C	NA	NA	NO	BSL
84-74-2	Di-n-butylphthalate	0.095	J	1		MG/KG	AS05-5SD02-R07	7/15	0.42 - 1.7	1	NA	7,821 N	NA	NA	NO	BSL
53-70-3	Dibenz(a,h)anthracene	0.0015	J	0.056	L	MG/KG	AS05-5SD04-R07	16/28	0.0021 - 1.7	0.056	NA	0.875 C	NA	NA	NO	BSL
84-66-2	Diethylphthalate	0.16	J	0.26	J	MG/KG	AS05-5SD01-R07	3/15	0.42 - 1.7	0.26	NA	62,571 N	NA	NA	NO	BSL
206-44-0	Fluoranthene	0.0028		0.39	J	MG/KG	AS05-5SD03-R07	21/28	0.0021 - 1.7	0.39	NA	3,129 N	NA	NA	NO	BSL
86-73-7	Fluorene	1.00E-03	J	0.035	L	MG/KG	AS05-5SD04-R07	16/28	0.0021 - 1.7	0.035	NA	3,129 N	NA	NA	NO	BSL
193-39-5	Indeno(1,2,3-cd)pyrene	0.0019	J	0.16	L	MG/KG	AS05-5SD04-R07	16/28	0.0021 - 1.7	0.16	NA	8.75 C	NA	NA	NO	BSL
91-20-3	Naphthalene	0.0023		0.081	J	MG/KG	AS05-5SD03-R07	16/28	0.0021 - 1.7	0.081	NA	1,564 N	NA	NA	NO	BSL
85-01-8	Phenanthrene	0.0038		0.38	J	MG/KG	AS05-5SD03-R07	21/28	0.0021 - 1.7	0.38	NA	2,346 N	NA	NA	NO	BSL
108-95-2	Phenol	0.064	J	0.51	J	MG/KG	AS05-5SD03-R06	2/15	0.42 - 1.7	0.51	NA	23,000 N	NA	NA	NO	BSL
129-00-0	Pyrene	0.0026		0.42	J	MG/KG	AS05-5SD03-R07	21/28	0.0021 - 1.7	0.42	NA	2,346 N	NA	NA	NO	BSL
117-81-7	bis(2-Ethylhexyl)phthalate	0.072		0.095	J	MG/KG	AS05-5SD03-R06	3/15	0.42 - 1.7	0.095	NA	456 C	NA	NA	NO	BSL
7429-90-5	Aluminum	2,950		13,700	J	MG/KG	AS05-5SD02-R01	28/28	4.87 - 93.9	13,700	NA	78,214 N	NA	NA	NO	BSL
7440-36-0	Antimony	1	L	1.6	J	MG/KG	AS05-5SD02-R06	3/28	0.65 - 28.2	1.6	NA	31.3 N	NA	NA	NO	BSL
7440-38-2	Arsenic	4.4		24.1		MG/KG	AS05-5SD02-R01	28/28	0.65 - 4.7	24.1	NA	4.26 C	NA	NA	YES	ASL
7440-39-3	Barium	31.5	J	208		MG/KG	AS05-5SD03-R06	27/28	0.05 - 93.9	208	NA	5,475 N	NA	NA	NO	BSL
7440-41-7	Beryllium	0.82	J	2.9		MG/KG	AS05-5SD02-R01	28/28	0.03 - 2.3	2.9	NA	156 N	NA	NA	NO	BSL
7440-43-9	Cadmium	0.17	J	1.60		MG/KG	5SD-1(94)	4/28	0.08 - 2.3	1.6	NA	78 N	NA	NA	NO	BSL
7440-70-2	Calcium	674	J	94,100		MG/KG	AS05-5SD02P-R05	28/28	3.24 - 2350	94,100	NA	NA	NA	NA	NO	NUT
7440-47-3	Chromium	4.5	J	80.9		MG/KG	AS05-5SD02P-R05	28/28	0.18 - 4.7	80.9	NA	235 N	NA	NA	NO	BSL

Table F.2.2

OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN

Site 5, Allegany Ballistics Laboratory

Scenario Timeframe: Current/Future
Medium: Sediment
Exposure Medium: Sediment
Exposure Point: Site 5

CAS Number	Chemical	Minimum [1] Concentration	Minimum Qualifier	Maximum [1] Concentration	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration [2] Used for Screening	Background [3] Value	Screening [4] Toxicity Value	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for [5] Contaminant Deletion or Selection
7440-48-4	Cobalt	17.5		73.4		MG/KG	AS05-5SD01P-R07	28/28	0.28 - 23.5	73.4	NA	1,600 N	NA	NA	NO	BSL
7440-50-8	Copper	10.2		67.5		MG/KG	AS05-5SD02-R01	28/28	0.18 - 11.7	67.5	NA	3,129 N	NA	NA	NO	BSL
57-12-5	Cyanide	1.7		1.7		MG/KG	AS05-5SD01-R05	1/14	0.63 - 2.5	1.7	NA	1,564 N	NA	NA	NO	BSL
7439-89-6	Iron	10,700	J	47,100	J	MG/KG	AS05-5SD02-R01	28/28	2.03 - 46.9	47,100	NA	23,000 N	NA	NA	YES	ASL
7439-92-1	Lead	10.1	J	43.6	J	MG/KG	AS05-5SD02-R01	28/28	0.48 - 1.99	43.6	NA	400	NA	NA	NO	BSL
7439-95-4	Magnesium	357	J	3,620		MG/KG	AS05-5SD02P-R05	26/28	3.45 - 2350	3,620	NA	NA	NA	NA	NO	NUT
7439-96-5	Manganese	131		1,700		MG/KG	AS05-5SD03-R06	28/28	0.08 - 7	1,700	NA	1,564 N	NA	NA	YES	ASL
7439-97-6	Mercury	0.048	K	4.8		MG/KG	AS05-5SD02-R05	9/28	5.99E-02 - 0.31	4.8	NA	23.5 N	NA	NA	NO	BSL
7440-02-0	Nickel	26.6	K	132		MG/KG	AS05-5SD01-R07	28/28	0.51 - 18.8	132	NA	1,564 N	NA	NA	NO	BSL
7440-09-7	Potassium	388	J	1,320	J	MG/KG	AS05-5SD03-R06	26/28	6.63 - 2350	1,320	NA	NA	NA	NA	NO	NUT
7782-49-2	Selenium	2.1		2.4	J	MG/KG	AS05-5SD01-R07	3/28	0.54 - 2.6	2.4	NA	391 N	NA	NA	NO	BSL
7440-22-4	Silver	0.52	J	0.52	J	MG/KG	AS05-5SD01P-R07	1/28	0.15 - 4.7	0.52	NA	391 N	NA	NA	NO	BSL
7440-23-5	Sodium	92.7	J	1,890	J	MG/KG	AS05-5SD02P-R05	18/28	22.57 - 2350	1,890	NA	NA	NA	NA	NO	NUT
7440-28-0	Thallium	1.1	J	1.9	J	MG/KG	AS05-5SD02B AS05-5SD06A	11/28	0.48 - 4.7	1.9	NA	5.48 N	NA	NA	NO	BSL
7440-62-2	Vanadium	7.9	J	33.2		MG/KG	AS05-5SD07A	28/28	0.25 - 23.5	33.2	NA	548 N	NA	NA	NO	BSL
7440-66-6	Zinc	76.4	J	388		MG/KG	AS05-5SD01-R07	28/28	0.38 - 9.4	388	NA	23,464 N	NA	NA	NO	BSL

[1] Minimum/Maximum detected concentrations.
[2] Maximum concentration is used for screening.
[3] Background values not available.
[4] Risk-Based Concentration Table, October 9, 2002, U.S. EPA Region III, Jennifer Hubbard.
10xResidential Soil Ingestion RBC (Cancer benchmark value = 1E-06, adjusted HQ=0.1) per discussion with Dawn Ioven (EPA Region III Toxicologist).
RBC value for naphthalene used as surrogate for acenapthylene and 1-methylnaphthalene.
RBC value for 2-methylnaphthalene used as surrogate for 3- and 4-methylphenol.
RBC value for pyrene used as surrogate for phenanthrene and benzo(g,h,i)perylene.
RBC value for Chromium VI used for total chromium.
Lead screening toxicity value is 400 mg/kg, the EPA residential soil screening level for lead.
RBC value for manganese-nonfood used as surrogate for manganese.
RBC value for mercuric chloride used as surrogate for mercury.
[5] Rationale Codes

Selection Reason: Above Screening Levels (ASL)
Deletion Reason: No Toxicity Information (NTX)
Essential Nutrient (NUT)
Below Screening Level (BSL)

SQL = Sample Quantification Limit
COPC = Chemical of Potential Concern
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/ To Be Considered
J = Estimated Value
K = Biased High
L = Biased Low
N = Noncarcinogenic

Table F.2.3

OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN

Site 5, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Alluvial Aquifer - Tap Water

CAS Number	Chemical	Minimum [1] Concentration	Minimum Qualifier	Maximum [1] Concentration	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration [2] Used for Screening	Background [3] Value	Screening [4] Toxicity Value	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for [5] Contaminant Deletion or Selection
79-01-6	Trichloroethene	2		150		UG/L	AS05-5GW22P-R07	9/11	1 - 10	150		0.026 C	5	PMCL	YES	ASL
156-59-2	cis-1,2-Dichloroethene	1.8		24		UG/L	AS05-5GW18-R07	6/11	1 - 1	24		6.08 N	70	PMCL	YES	ASL
7429-90-5	Aluminum	61.4	J	5,260		UG/L	AS05-5GW11-R07	7/11	17.2 - 17.2	5,260	134	3,650 N	50-200	SMCL	YES	ASL
7440-36-0	Antimony	5.3	J	5.3	J	UG/L	AS05-5GW22-R07	1/11	5 - 5	5.3		1.46 N	6	PMCL	YES	ASL
7440-38-2	Arsenic	6.9	J	6.9	J	UG/L	AS05-5GW11-R07	1/11	5.1 - 5.1	6.9		0.0446 C	10	PMCL	YES	ASL
7440-39-3	Barium	25.7	J	733		UG/L	AS05-5GW23-R07	11/11	1.6 - 1.6	733	62.5	256 N	2000	PMCL	YES	ASL
7440-41-7	Beryllium	0.1	J	0.46	J	UG/L	AS05-5GW11-R07	2/11	0.1 - 0.1	0.46		7.3 N	4	PMCL	NO	BSL
7440-42-8	Boron	13.8	J	47.8	J	UG/L	AS05-5GW13-R07	10/11	10 - 10	47.8	26.3	329 N	NA		NO	BSL
7440-70-2	Calcium	25,900		167,000		UG/L	AS05-5GW13-R07	11/11	15.9 - 15.9	167,000	115,000	NA	NA		NO	NUT
7440-47-3	Chromium	1.4	J	3.2	J	UG/L	AS05-5GW21-R07	3/11	0.6 - 0.6	3.2		11.0 N	100	PMCL	NO	BSL
7440-48-4	Cobalt	1.8	J	72.3		UG/L	AS05-5GW09-R07	7/11	1.3 - 1.3	72.3		73 N	NA		NO	BSL
7440-50-8	Copper	2.3	J	39		UG/L	AS05-5GW11-R07	3/11	1.5 - 1.5	39	2.2	146 N	1000	SMCL	NO	BSL
57-12-5	Cyanide	20		20		UG/L	AS05-5GW21-R07	1/11	10 - 10	20		73 N	200	PMCL	NO	BSL
7439-89-6	Iron	218		13,800		UG/L	AS05-5GW11-R07	10/11	12.2 - 12.2	13,800	261	1,100 N	300	SMCL	YES	ASL
7439-92-1	Lead	3.3		17.4		UG/L	AS05-5GW11-R07	3/11	2.9 - 2.9	17.4		15	15	AL	YES	ASL
7439-95-4	Magnesium	5,780		31,300		UG/L	AS05-5GW13-R07	11/11	12.3 - 12.3	31,300	26,800	NA	NA		NO	NUT
7439-96-5	Manganese	18.8		2,840		UG/L	AS05-5GW13-R07	11/11	0.6 - 0.6	2,840	17	73 N	50	SMCL	YES	ASL
7440-02-0	Nickel	3	J	91.8		UG/L	AS05-5GW07-R07	6/11	2.1 - 2.1	91.8		73 N	NA		YES	ASL
7440-09-7	Potassium	173	J	4,820	J	UG/L	AS05-5GW11-R07	11/11	26.9 - 26.9	4,820	1,150	NA	NA		NO	NUT
7440-22-4	Silver	1.3	J	1.3	J	UG/L	AS05-5GW11-R07	1/11	0.6 - 0.6	1.3		18.3 N	100	SMCL	NO	BSL
7440-23-5	Sodium	3,320	J	17,100		UG/L	AS05-5GW07-R07	11/11	496.6 - 496.6	17,100	5,420	NA	NA		NO	NUT
7440-62-2	Vanadium	0.89	J	11.8	J	UG/L	AS05-5GW11-R07	3/11	0.8 - 0.8	11.8		25.6 N	NA		NO	BSL
7440-66-6	Zinc	47.8		47.8		UG/L	AS05-5GW09-R07	1/11	3.2 - 3.2	47.8		1,095 N	5000	SMCL	NO	BSL

Includes sampling results from all alluvial wells.

[1] Minimum/Maximum detected concentrations.

[2] Maximum concentration is used for screening.

[3] Sample results from background well AS05-5GW24-R07.

[4] Risk-Based Concentration Table, October 9, 2002, U.S. EPA Region III, Jennifer Hubbard.
Tap Water RBC (Cancer benchmark value = 1E-06, adjusted HQ=0.1).
RBC value for Chromium VI used for total chromium.
Lead screening toxicity value is 15 µg/l, the EPA Safe Drinking Water Action Level for lead.

[5] RBC value for manganese-nonfood used as surrogate for manganese.

Rationale Co

Selection Reason: Above Screening Levels (ASL)

Deletion Reason: No Toxicity Information (NTX)
Essential Nutrient (NUT)
Below Screening Level (BSL)

SQL = Sample Quantification Limit
COPC = Chemical of Potential Concern
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/ To Be Considered
J = Estimated Value
K = Biased High
L = Biased Low
C = Carcinogenic
N = Noncarcinogenic
PMCL = Maximum Contaminant Level, Primary Drinking Water Staandards
SMCL = Maximum Contaminant Level, Secondary Drinking Water Standards
AL = Action Level, Safe Drinking Water Act

Table F.2.4

OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN

Site 5, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Air
Exposure Point: Alluvial Aquifer - Water in Excavation Pit

CAS Number	Chemical	Minimum [1] Concentration	Minimum Qualifier	Maximum [1] Concentration	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration [2] Used for Screening	Background [3] Value	Screening [4] Toxicity Value	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for [5] Contaminant Deletion or Selection
79-01-6	Trichloroethene	2		150		UG/L	AS05-5GW22P-R07	9/11	1 - 10	150		0.026 C	5	PMCL	YES	ASL
156-59-2	cis-1,2-Dichloroethene	1.8		24		UG/L	AS05-5GW18-R07	6/11	1 - 1	24		6.08 N	70	PMCL	YES	ASL
7429-90-5	Aluminum	61.4	J	5,260		UG/L	AS05-5GW11-R07	7/11	17.2 - 17.2	5260	134	3,650 N	50-200	SMCL	YES	ASL
7440-36-0	Antimony	5.3	J	5.3	J	UG/L	AS05-5GW22-R07	1/11	5 - 5	5.3		1.46 N	6	PMCL	YES	ASL
7440-38-2	Arsenic	6.9	J	6.9	J	UG/L	AS05-5GW11-R07	1/11	5.1 - 5.1	6.9		0.0446 C	10	PMCL	YES	ASL
7440-39-3	Barium	25.7	J	733		UG/L	AS05-5GW23-R07	11/11	1.6 - 1.6	733	62.5	256 N	2000	PMCL	YES	ASL
7440-41-7	Beryllium	0.1	J	0.46	J	UG/L	AS05-5GW11-R07	2/11	0.1 - 0.1	0.46		7.3 N	4	PMCL	NO	BSL
7440-42-8	Boron	13.8	J	47.8	J	UG/L	AS05-5GW13-R07	10/11	10 - 10	47.8	26.3	329 N	NA		NO	BSL
7440-70-2	Calcium	25,900		167,000		UG/L	AS05-5GW13-R07	11/11	15.9 - 15.9	167000	115,000	NA	NA		NO	NUT
7440-47-3	Chromium	1.4	J	3.2	J	UG/L	AS05-5GW21-R07	3/11	0.6 - 0.6	3.2		11.0 N	100	PMCL	NO	BSL
7440-48-4	Cobalt	1.8	J	72.3		UG/L	AS05-5GW09-R07	7/11	1.3 - 1.3	72.3		73 N	NA		NO	BSL
7440-50-8	Copper	2.3	J	39		UG/L	AS05-5GW11-R07	3/11	1.5 - 1.5	39	2.2	146 N	1000	SMCL	NO	BSL
57-12-5	Cyanide	20		20		UG/L	AS05-5GW21-R07	1/11	10 - 10	20		73 N	200	PMCL	NO	BSL
7439-89-6	Iron	218		13,800		UG/L	AS05-5GW11-R07	10/11	12.2 - 12.2	13800	261	1,100 N	300	SMCL	YES	ASL
7439-92-1	Lead	3.3		17.4		UG/L	AS05-5GW11-R07	3/11	2.9 - 2.9	17.4		15	15	AL	YES	ASL
7439-95-4	Magnesium	5,780		31,300		UG/L	AS05-5GW13-R07	11/11	12.3 - 12.3	31300	26,800	NA	NA		NO	NUT
7439-96-5	Manganese	18.8		2,840		UG/L	AS05-5GW13-R07	11/11	0.6 - 0.6	2840	17	73 N	50	SMCL	YES	ASL
7440-02-0	Nickel	3	J	91.8		UG/L	AS05-5GW07-R07	6/11	2.1 - 2.1	91.8		73 N	NA		YES	ASL
7440-09-7	Potassium	173	J	4,820	J	UG/L	AS05-5GW11-R07	11/11	26.9 - 26.9	4820	1,150	NA	NA		NO	NUT
7440-22-4	Silver	1.3	J	1.3	J	UG/L	AS05-5GW11-R07	1/11	0.6 - 0.6	1.3		18.3 N	100	SMCL	NO	BSL
7440-23-5	Sodium	3,320	J	17,100		UG/L	AS05-5GW07-R07	11/11	496.6 - 496.6	17100	5,420	NA	NA		NO	NUT
7440-62-2	Vanadium	0.89	J	11.8	J	UG/L	AS05-5GW11-R07	3/11	0.8 - 0.8	11.8		25.6 N	NA		NO	BSL
7440-66-6	Zinc	47.8		47.8		UG/L	AS05-5GW09-R07	1/11	3.2 - 3.2	47.8		1,095 N	5000	SMCL	NO	BSL

Includes sampling results from all alluvial wells.

[1] Minimum/Maximum detected concentrations.

[2] Maximum concentration is used for screening.

[3] Background values available for a few select constituents.

[4] Risk-Based Concentration Table, October 9, 2002, U.S. EPA Region III, Jennifer Hubbard.
Tap Water RBC (Cancer benchmark value = 1E-06, adjusted HQ=0.1).
RBC value for Chromium VI used for total chromium.
Lead screening toxicity value is 15 µg/l, the EPA Safe Drinking Water Action Level for lead.

[5] RBC value for manganese-nonfood used as surrogate for manganese.

Rationale Co

Selection Reason: Above Screening Levels (ASL)

Deletion Reason: No Toxicity Information (NTX)
Essential Nutrient (NUT)
Below Screening Level (BSL)

SQL = Sample Quantification Limit
COPC = Chemical of Potential Concern
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/ To Be Considered
J = Estimated Value
K = Biased High
L = Biased Low
C = Carcinogenic
N = Noncarcinogenic
PMCL = Maximum Contaminant Level, Primary Drinking Water Staandards
SMCL = Maximum Contaminant Level, Secondary Drinking Water Standards
AL = Action Level, Safe Drinking Water Act

Table F.2.5

OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN

Site 5, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Air
Exposure Point: Alluvial Aquifer - Vapors at Showerhead

CAS Number	Chemical	Minimum [1] Concentration	Minimum Qualifier	Maximum [1] Concentration	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration [2] Used for Screening	Background [3] Value	Screening [4] Toxicity Value	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for [5] Contaminant Deletion or Selection
79-01-6	Trichloroethene	2		150		UG/L	AS05-5GW22P-R07	9/11	1 - 10	150		0.026 C	5	PMCL	YES	ASL
156-59-2	cis-1,2-Dichloroethene	1.8		24		UG/L	AS05-5GW18-R07	6/11	1 - 1	24		6.08 N	70	PMCL	YES	ASL

Includes sampling results from all alluvial wells.

[1] Minimum/Maximum detected concentrations.

[2] Maximum concentration is used for screening.

[3] Background values available for a few select constituents.

[4] Risk-Based Concentration Table, October 9, 2002, U.S. EPA Region III, Jennifer Hubbard.

[5] Rationale Codes
Selection Reason: Above Screening Levels (ASL)
Deletion Reason: No Toxicity Information (NTX)
Essential Nutrient (NUT)
Below Screening Level (BSL)

SQL = Sample Quantification Limit
COPC = Chemical of Potential Concern
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/ To Be Considered
J = Estimated Value
K = Biased High
L = Biased Low
C = Carcinogenic
N = Noncarcinogenic
PMCL = Maximum Contaminant Level, Primary Drinking Water Staandards
SMCL = Maximum Contaminant Level, Secondary Drinking Water Standards
AL = Action Level, Safe Drinking Water Act

Table F.2.6

OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN

Site 5, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Air
Exposure Point: Alluvial Aquifer-Volatilization from Water in Excavation Pit

CAS Number	Chemical	Minimum [1] Concentration	Minimum Qualifier	Maximum [1] Concentration	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration [2] Used for Screening	Background [3] Value	Screening [4] Toxicity Value	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for [5] Contaminant Deletion or Selection
79-01-6	Trichloroethene	2		150		UG/L	AS05-5GW22P-R07	9/11	1 - 10	150		0.026 C	5	PMCL	YES	ASL
156-59-2	cis-1,2-Dichloroethene	1.8		24		UG/L	AS05-5GW18-R07	6/11	1 - 1	24		6.08 N	70	PMCL	YES	ASL

Includes sampling results from all alluvial wells.

[1] Minimum/Maximum detected concentrations.

[2] Maximum concentration is used for screening.

[3] Background values available for a few select constituents.

[4] Risk-Based Concentration Table, October 9, 2002, U.S. EPA Region III, Jennifer Hubbard.

[5] Rationale Codes
Selection Reason: Above Screening Levels (ASL)
Deletion Reason: No Toxicity Information (NTX)
Essential Nutrient (NUT)
Below Screening Level (BSL)

SQL = Sample Quantification Limit
COPC = Chemical of Potential Concern
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/ To Be Considered
J = Estimated Value
K = Biased High
L = Biased Low
C = Carcinogenic
N = Noncarcinogenic
PMCL = Maximum Contaminant Level, Primary Drinking Water Staandards
SMCL = Maximum Contaminant Level, Secondary Drinking Water Standards
AL = Action Level, Safe Drinking Water Act

Table F.2.7

OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN

Site 5, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Bedrock Aquifer - Tap Water

CAS Number	Chemical	Minimum [1] Concentration	Minimum Qualifier	Maximum [1] Concentration	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration [2] Used for Screening	Background [3] Value	Screening [4] Toxicity Value	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for [5] Contaminant Deletion or Selection
79-01-6	Trichloroethene	7.1		11		UG/L	AS05-5GW03-R07	3/5	1 - 1	11		0.026 C	5	PMCL	YES	ASL
156-59-2	cis-1,2-Dichloroethene	0.8	J	0.8	J	UG/L	AS05-5GW02-R07 AS05-5GW03-R07	3/5	1 - 1	0.8		6.08 N	70	PMCL	NO	BSL
7429-90-5	Aluminum	24.4	J	53.2	J	UG/L	AS05-5GW03-R07	2/5	17.2 - 17.2	53.2		3,650 N	50-200	SMCL	NO	BSL
7440-39-3	Barium	25	J	200	J	UG/L	AS05-5GW10-R07	6/5	1.6 - 1.6	200	163	256 N	2000	PMCL	NO	BSL
7440-42-8	Boron	13.5	J	246		UG/L	AS05-5GW02P-R07	6/5	10 - 10	246	85.1	329 N	NA		NO	BSL
7440-43-9	Cadmium	2.4	J	2.4	J	UG/L	AS05-5GW03-R07	1/5	1.7 - 1.7	2.4		1.83 N	5	PMCL	YES	ASL
7440-70-2	Calcium	82,400		160,000		UG/L	AS05-5GW16-R07	6/5	15.9 - 15.9	160,000	106,000	NA	NA		NO	NUT
7440-47-3	Chromium	0.74	J	1.5	J	UG/L	AS05-5GW16-R07	2/5	0.6 - 0.6	1.5		11.0 N	100	PMCL	NO	BSL
7440-48-4	Cobalt	1.6	J	8.7	J	UG/L	AS05-5GW14-R07	4/5	1.3 - 1.3	8.7	1.8	73 N	NA		NO	BSL
7440-50-8	Copper	1.7	J	1.7	J	UG/L	AS05-5GW02P-R07	1/5	1.5 - 1.5	4.7	4.7	146 N	1000	SMCL	NO	BSL
7439-89-6	Iron	939		71,600		UG/L	AS05-5GW14-R07	5/5	12.2 - 12.2	71,600	3,180	1,100 N	300	SMCL	YES	ASL
7439-92-1	Lead	3.2		3.2		UG/L	AS05-5GW14-R07	1/5	2.9 - 2.9	3.2		15	15	AL	NO	BSL
7439-95-4	Magnesium	7,900		33,400		UG/L	AS05-5GW14-R07	5/5	12.3 - 12.3	33,400	26,500	NA	NA		NO	NUT
7439-96-5	Manganese	131		1,680		UG/L	AS05-5GW14-R07	5/5	0.6 - 0.6	1,680	93.7	73 N	50	SMCL	YES	ASL
7440-02-0	Nickel	25.4	J	90.2		UG/L	AS05-5GW03-R07	3/5	2.1 - 2.1	90.2	22.2	73 N	NA		YES	ASL
7440-09-7	Potassium	309	J	3,450	J	UG/L	AS05-5GW02P-R07	6/5	26.9 - 26.9	3,720	3,720	NA	NA		NO	NUT
7440-23-5	Sodium	5,080		35,200	J	UG/L	AS05-5GW02P-R07	6/5	496.6 - 496.6	35,200	11,500	NA	NA		NO	NUT

Includes samples results from all bedrock wells.

[1] Minimum/Maximum detected concentrations.

[2] Maximum concentration is used for screening.

[3] Background values available for a few select constituents.

[4] Risk-Based Concentration Table, October 9, 2002, U.S. EPA Region III, Jennifer Hubbard.
Tap Water RBC (Cancer benchmark value = 1E-06, adjusted HQ=0.1).
RBC value for cadmium-water used as surrogate for cadmium.
RBC value for Chromium VI used for total chromium.
Lead screening toxicity value is 15 µg/l, the EPA Safe Drinking Water Action Level for lead.

[5] RBC value for manganese-nonfood used as surrogate for manganese.

Rationale Co

Selection Reason: Above Screening Levels (ASL)

Deletion Reason: No Toxicity Information (NTX)
Essential Nutrient (NUT)
Below Screening Level (BSL)

SQL = Sample Quantification Limit
COPC = Chemical of Potential Concern
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/ To Be Considered
J = Estimated Value
K = Biased High
L = Biased Low
C = Carcinogenic
N = Noncarcinogenic
PMCL = Maximum Contaminant Level, Primary Drinking Water Staandards
SMCL = Maximum Contaminant Level, Secondary Drinking Water Standards
AL = Action Level, Safe Drinking Water Act

Table F.2.8

OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN

Site 5, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Air
Exposure Point: Bedrock Aquifer-Water Vapors at Showerhead

CAS Number	Chemical	Minimum [1] Concentration	Minimum Qualifier	Maximum [1] Concentration	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration [2] Used for Screening	Background [3] Value	Screening [4] Toxicity Value	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for [5] Contaminant Deletion or Selection
79-01-6	Trichloroethene	7.1		11		UG/L	AS05-5GW03-R07	3/5	1 - 1	11		0.026 C	5	PMCL	YES	ASL
156-59-2	cis-1,2-Dichloroethene	0.8	J	0.8	J	UG/L	AS05-5GW02-R07 AS05-5GW03-R07	3/5	1 - 1	0.8		6.08 N	70	PMCL	NO	BSL

Includes samples results from all bedrock wells.

[1] Minimum/Maximum detected concentrations.

[2] Maximum concentration is used for screening.

[3] Background values available for a few select constituents.

[4] Risk-Based Concentration Table, October 9, 2002, U.S. EPA Region III, Jennifer Hubbard.
Tap Water RBC (Cancer benchmark value = 1E-06, adjusted HQ=0.1).

[5] Rationale Codes

Selection Reason: Above Screening Levels (ASL)

Deletion Reason: No Toxicity Information (NTX)
Essential Nutrient (NUT)
Below Screening Level (BSL)

SQL = Sample Quantification Limit
COPC = Chemical of Potential Concern
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/
To Be Considered
J = Estimated Value
K = Biased High
L = Biased Low
C = Carcinogenic
N = Noncarcinogenic
PMCL = Maximum Contaminant Level, Primary Drinking Water Staandards
SMCL = Maximum Contaminant Level, Secondary Drinking Water Standards
AL = Action Level, Safe Drinking Water Act

Table 3.1

MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY

Site 5, Allegany Ballistics Laboratory

Scenario Timeframe: Current/Future
Medium: Surface Water
Exposure Medium: Surface Water
Exposure Point: Site 5 Surface Water

Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL of Normal Data	Maximum Detected Concentration	Maximum Qualifier	EPC Units	Reasonable Maximum Exposure			Central Tendency		
							Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale	Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale
Arsenic	UG/L	2.53	2.98	5.10	J	UG/L	2.95	95% UCL-T	W-Test (4)	2.95	95% UCL-T	W-Test (4)

Full statistics for data included in Appendix.

For non-detects, 1/2 sample quantitation limit was used as a proxy concentration; for duplicate sample results, the maximum value was used in the calculation.

W - Test: Developed by Shapiro and Wilk, refer to Supplemental Guidance to RAGS: Calculating the Concentration Term, OSWER Directive 9285.7-081, May 1992.

Options: Maximum Detected Value (Max); 95% UCL of Normal Data (95% UCL-N); 95% UCL of Log-transformed Data (95% UCL-T);

(1) Shapiro-Wilk W Test indicates data are log-normally distributed.

(2) 95% UCL (or mean) exceeds maximum detected concentration. Therefore, maximum concentration used for EPC.

(3) Shapiro-Wilks W Test indicates data are normally distributed.

(4) Shapiro-Wilks W Test inconclusive. Use of 95% UCL (normal or transformed) that best fits the data according to the results of the Shapiro-Wilks W Test for EPC.

(5) Maximum detected concentration used because sample size is less than 5.

(6) Mean value used because sample size is less than 5.

Table 3.2

MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY

Site 5, Allegany Ballistics Laboratory

Scenario Timeframe: Current/Future
Medium: Sediment
Exposure Medium: Sediment
Exposure Point: Site 5 Sediment

Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL of Normal Data	Maximum Detected Concentration	Maximum Qualifier	EPC Units	Reasonable Maximum Exposure			Central Tendency		
							Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale	Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale
Arsenic	MG/KG	10.3	11.7	24.1		MG/KG	11.9	95% UCL-T	W-Test (1)	11.9	95% UCL-T	W-Test (1)
Iron	MG/KG	28,393	30,902	47,100	J	MG/KG	30,902	95% UCL-N	W-Test (4)	30,902	95% UCL-N	W-Test (4)
Manganese	MG/KG	852	986	1,700		MG/KG	986	95% UCL-N	W-Test (3)	986	95% UCL-N	W-Test (3)

Full statistics for data included in Appendix.

For non-detects, 1/2 sample quantitation limit was used as a proxy concentration; for duplicate sample results, the maximum value was used in the calculation.

W - Test: Developed by Shapiro and Wilk, refer to Supplemental Guidance to RAGS: Calculating the Concentration Term, OSWER Directive 9285.7-081, May 1992.

Options: Maximum Detected Value (Max); 95% UCL of Normal Data (95% UCL-N); 95% UCL of Log-transformed Data (95% UCL-T);

(1) Shapiro-Wilk W Test indicates data are log-normally distributed.

(2) 95% UCL (or mean) exceeds maximum detected concentration. Therefore, maximum concentration used for EPC.

(3) Shapiro-Wilks W Test indicates data are normally distributed.

(4) Shapiro-Wilks W Test inconclusive. Use of 95% UCL (normal or transformed) that best fits the data according to the results of the Shapiro-Wilks W Test for EPC.

Table 3.3

MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY

Site 5, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Alluvial Aquifer-Tap Water

Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL of Normal Data	Maximum Detected Concentration	Maximum Qualifier	EPC Units	Reasonable Maximum Exposure			Central Tendency		
							Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale	Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale
Trichloroethene	UG/L	31.7	55.8	150		UG/L	150	Max	W-Test (2)	150	Max	W-Test (2)
cis-1,2-Dichloroethene	UG/L	6.92	12.3	24.0		UG/L	24.0	Max	W-Test (2)	24.0	Max	W-Test (2)
Aluminum	UG/L	642	1,485	5,260		UG/L	5,260	Max	W-Test (2)	5,260	Max	W-Test (2)
Antimony	UG/L	2.75	3.22	5.30	J	UG/L	3.22	95% UCL-N	W-Test (4)	3.22	95% UCL-N	W-Test (4)
Arsenic	UG/L	2.95	3.66	6.90	J	UG/L	3.66	95% UCL-N	W-Test (4)	3.66	95% UCL-N	W-Test (4)
Barium	UG/L	156	268	733		UG/L	348	95% UCL-T	W-Test (1)	348	95% UCL-T	W-Test (1)
Iron	UG/L	4,665	7,495	13,800		UG/L	13,800	Max	W-Test (2)	13,800	Max	W-Test (2)
Lead	UG/L	3.24	5.83	17.4		UG/L	5.36	95% UCL-T	W-Test (4)	5.36	95% UCL-T	W-Test (4)
Manganese	UG/L	731	1,257	2,840		UG/L	2,840	Max	W-Test (2)	2,840	Max	W-Test (2)
Nickel	UG/L	18.9	34.2	91.8		UG/L	91.8	Max	W-Test (2)	91.8	Max	W-Test (2)

Full statistics for data included in Appendix.

For non-detects, 1/2 sample quantitation limit was used as a proxy concentration; for duplicate sample results, the maximum value was used in the calculation.

W - Test: Developed by Shapiro and Wilk, refer to Supplemental Guidance to RAGS: Calculating the Concentration Term, OSWER Directive 9285.7-081, May 1992.

Options: Maximum Detected Value (Max); 95% UCL of Normal Data (95% UCL-N); 95% UCL of Log-transformed Data (95% UCL-T);

(1) Shapiro-Wilk W Test indicates data are log-normally distributed.

(2) 95% UCL (or mean) exceeds maximum detected concentration. Therefore, maximum concentration used for EPC.

(3) Shapiro-Wilks W Test indicates data are normally distributed.

(4) Shapiro-Wilks W Test inconclusive. Use of 95% UCL (normal or transformed) that best fits the data according to the results of the Shapiro-Wilks W Test for EPC.

Table 3.4

MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY

Site 5, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Alluvial Aquifer-Water in Excavation Pit

Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL of Normal Data	Maximum Detected Concentration	Maximum Qualifier	EPC Units	Reasonable Maximum Exposure			Central Tendency		
							Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale	Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale
Trichloroethene	UG/L	31.7	55.8	150		UG/L	150	Max	W-Test (2)	150	Max	W-Test (2)
cis-1,2-Dichloroethene	UG/L	6.92	12.3	24.0		UG/L	24.0	Max	W-Test (2)	24.0	Max	W-Test (2)
Aluminum	UG/L	642	1,485	5,260		UG/L	5,260	Max	W-Test (2)	5,260	Max	W-Test (2)
Antimony	UG/L	2.75	3.22	5.30	J	UG/L	3.22	95% UCL-N	W-Test (4)	3.22	95% UCL-N	W-Test (4)
Arsenic	UG/L	2.95	3.66	6.90	J	UG/L	3.66	95% UCL-N	W-Test (4)	3.66	95% UCL-N	W-Test (4)
Barium	UG/L	156	268	733		UG/L	348	95% UCL-T	W-Test (1)	348	95% UCL-T	W-Test (1)
Iron	UG/L	4,665	7,495	13,800		UG/L	13,800	Max	W-Test (2)	13,800	Max	W-Test (2)
Lead	UG/L	3.24	5.83	17.4		UG/L	5.36	95% UCL-T	W-Test (4)	5.36	95% UCL-T	W-Test (4)
Manganese	UG/L	731	1,257	2,840		UG/L	2,840	Max	W-Test (2)	2,840	Max	W-Test (2)
Nickel	UG/L	18.9	34.2	91.8		UG/L	91.8	Max	W-Test (2)	91.8	Max	W-Test (2)

Full statistics for data included in Appendix.

For non-detects, 1/2 sample quantitation limit was used as a proxy concentration; for duplicate sample results, the maximum value was used in the calculation.

W - Test: Developed by Shapiro and Wilk, refer to Supplemental Guidance to RAGS: Calculating the Concentration Term, OSWER Directive 9285.7-081, May 1992.

Options: Maximum Detected Value (Max); 95% UCL of Normal Data (95% UCL-N); 95% UCL of Log-transformed Data (95% UCL-T);

(1) Shapiro-Wilk W Test indicates data are log-normally distributed.

(2) 95% UCL (or mean) exceeds maximum detected concentration. Therefore, maximum concentration used for EPC.

(3) Shapiro-Wilks W Test indicates data are normally distributed.

(4) Shapiro-Wilks W Test inconclusive. Use of 95% UCL (normal or transformed) that best fits the data according to the results of the Shapiro-Wilks W Test for EPC.

Table 3.5

MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY

Site 5, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Air
Exposure Point: Alluvial Aquifer-Water Vapors at Showerhead

Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL of Normal Data	Maximum Detected Concentration	Maximum Qualifier	EPC Units	Reasonable Maximum Exposure			Central Tendency		
							Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale	Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale
Trichloroethene	UG/L	31.7	55.8	150		UG/L	150	Max	W-Test (2)	150	Max	W-Test (2)
cis-1,2-Dichloroethene	UG/L	6.92	12.3	24.0		UG/L	24.0	Max	W-Test (2)	24.0	Max	W-Test (2)

Full statistics for data included in Appendix.

For non-detects, 1/2 sample quantitation limit was used as a proxy concentration; for duplicate sample results, the maximum value was used in the calculation.

W - Test: Developed by Shapiro and Wilk, refer to Supplemental Guidance to RAGS: Calculating the Concentration Term, OSWER Directive 9285.7-081, May 1992.

Options: Maximum Detected Value (Max); 95% UCL of Normal Data (95% UCL-N); 95% UCL of Log-transformed Data (95% UCL-T);

(1) Shapiro-Wilk W Test indicates data are log-normally distributed.

(2) 95% UCL (or mean) exceeds maximum detected concentration. Therefore, maximum concentration used for EPC.

(3) Shapiro-Wilks W Test indicates data are normally distributed.

(4) Shapiro-Wilks W Test inconclusive. Use of 95% UCL (normal or transformed) that best fits the data according to the results of the Shapiro-Wilks W Test for EPC.

Table 3.6

MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY

Site 5, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Air
Exposure Point: Alluvial Aquifer-Volatilization from Water in Excavation Pit

Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL of Normal Data	Maximum Detected Concentration	Maximum Qualifier	EPC Units	Reasonable Maximum Exposure			Central Tendency		
							Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale	Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale
Trichloroethene	UG/L	31.7	55.8	150		UG/L	150	Max	W-Test (2)	150	Max	W-Test (2)
cis-1,2-Dichloroethene	UG/L	6.92	12.3	24.0		UG/L	24.0	Max	W-Test (2)	24.0	Max	W-Test (2)

Full statistics for data included in Appendix.

For non-detects, 1/2 sample quantitation limit was used as a proxy concentration; for duplicate sample results, the maximum value was used in the calculation.

W - Test: Developed by Shapiro and Wilk, refer to Supplemental Guidance to RAGS: Calculating the Concentration Term, OSWER Directive 9285.7-081, May 1992.

Options: Maximum Detected Value (Max); 95% UCL of Normal Data (95% UCL-N); 95% UCL of Log-transformed Data (95% UCL-T);

(1) Shapiro-Wilk W Test indicates data are log-normally distributed.

(2) 95% UCL (or mean) exceeds maximum detected concentration. Therefore, maximum concentration used for EPC.

(3) Shapiro-Wilks W Test indicates data are normally distributed.

(4) Shapiro-Wilks W Test inconclusive. Use of 95% UCL (normal or transformed) that best fits the data according to the results of the Shapiro-Wilks W Test for EPC.

Table 3.7

MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY

Site 5, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Bedrock Aquifer - Tap Water

Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL of Normal Data	Maximum Detected Concentration	Maximum Qualifier	EPC Units	Reasonable Maximum Exposure			Central Tendency		
							Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale	Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale
Trichloroethene	UG/L	3.92	8.57	11.0		UG/L	8.57	95% UCL-N	W-Test (4)	8.57	95% UCL-N	W-Test (4)
Cadmium	UG/L	1.16	1.82	2.40	J	UG/L	1.82	95% UCL-N	W-Test (4)	1.82	95% UCL-N	W-Test (4)
Iron	UG/L	18,405	47,539	71,600		UG/L	71,600	Max	W-Test (2)	71,600	Max	W-Test (2)
Manganese	UG/L	895	1,458	1,680		UG/L	1,458	95% UCL-N	W-Test (4)	1,458	95% UCL-N	W-Test (4)
Nickel	UG/L	30.3	65.1	90.2		UG/L	65.1	95% UCL-N	W-Test (4)	65.1	95% UCL-N	W-Test (4)

Full statistics for data included in Appendix.

For non-detects, 1/2 sample quantitation limit was used as a proxy concentration; for duplicate sample results, the maximum value was used in the calculation.

W - Test: Developed by Shapiro and Wilk, refer to Supplemental Guidance to RAGS: Calculating the Concentration Term, OSWER Directive 9285.7-081, May 1992.

Options: Maximum Detected Value (Max); 95% UCL of Normal Data (95% UCL-N); 95% UCL of Log-transformed Data (95% UCL-T);

(1) Shapiro-Wilk W Test indicates data are log-normally distributed.

(2) 95% UCL (or mean) exceeds maximum detected concentration. Therefore, maximum concentration used for EPC.

(3) Shapiro-Wilks W Test indicates data are normally distributed.

(4) Shapiro-Wilks W Test inconclusive. Use of 95% UCL (normal or transformed) that best fits the data according to the results of the Shapiro-Wilks W Test for EPC.

Table 3.8

MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY

Site 5, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Bedrock Aquifer-Water Vapors at Showerhead

Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL of Normal Data	Maximum Detected Concentration	Maximum Qualifier	EPC Units	Reasonable Maximum Exposure			Central Tendency		
							Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale	Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale
Trichloroethene	UG/L	3.92	8.57	11.0		UG/L	8.57	95% UCL-N	W-Test (4)	8.57	95% UCL-N	W-Test (4)

Full statistics for data included in Appendix.

For non-detects, 1/2 sample quantitation limit was used as a proxy concentration; for duplicate sample results, the maximum value was used in the calculation.

W - Test: Developed by Shapiro and Wilk, refer to Supplemental Guidance to RAGS: Calculating the Concentration Term, OSWER Directive 9285.7-081, May 1992.

Options: Maximum Detected Value (Max); 95% UCL of Normal Data (95% UCL-N); 95% UCL of Log-transformed Data (95% UCL-T);

(1) Shapiro-Wilk W Test indicates data are log-normally distributed.

(2) 95% UCL (or mean) exceeds maximum detected concentration. Therefore, maximum concentration used for EPC.

(3) Shapiro-Wilks W Test indicates data are normally distributed.

(4) Shapiro-Wilks W Test inconclusive. Use of 95% UCL (normal or transformed) that best fits the data according to the results of the Shapiro-Wilks W Test for EPC.

TABLE 4.1

VALUES USED FOR DAILY INTAKE CALCULATIONS

Site 5, Allegany Ballistics Laboratory

Scenario Timeframe: Current/Future
Medium: Surface Water
Exposure Medium: Surface Water
Exposure Point: Site 5 Surface Water
Receptor Population: Other Recreational Person
Receptor Age: Adult

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/ Model Name
Ingestion	CSW	Chemical Concentration in Surface Water	µg/l	see Table ----	- -	see Table ----	- -	Chronic Daily Intake (CDI) (mg/kg-day) =
	IR-SW	Ingestion Rate of Surface Water	l/hour	0.01	EPA, 1996	0.01	EPA, 1996	CSW x IR-SW x ET x EF x ED x CF1 x
	ET	Exposure Time	hr/day	2.6	EPA, 1989	2.6	EPA, 1989	1/BW x 1/AT
	EF	Exposure Frequency	days/year	52	(1)	26	(1)	
	ED	Exposure Duration	years	24	EPA, 1991	9	EPA, 1991	
	CF1	Conversion Factor 1	mg/µg	0.001	- -	0.001	- -	
	BW	Body Weight	kg	70	EPA, 1991	70	EPA, 1991	
	AT-C	Averaging Time (Cancer)	days	25,550	EPA, 1989	25,550	EPA, 1989	
	AT-N	Averaging Time (Non-Cancer)	days	8,760	EPA, 1989	3,285	EPA, 1989	
Dermal Absorption	CSW	Chemical Concentration in Surface Water	µg/l	see Table ----	- -	see Table ----	- -	CDI (mg/kg-day) =
	SA	Skin Surface Area Available for Contact	cm^2	20,000	EPA, 1997, [3]	17,000	EPA, 1997, [3]	CSW x SA x PC x CF1 x ET x EF x ED x CF2 x 1/BW x 1/AT
	PC	Permeability Constant	cm/hr	chem specific	EPA, 1992	chem specific	EPA, 1992	
	CF1	Conversion Factor 1	mg/µg	0.001	- -	0.001	- -	
	ET	Exposure Time	hr/day	2.6	EPA, 1989	2.6	(2)	
	EF	Exposure Frequency	days/year	52	(1)	26	(1)	
	ED	Exposure Duration	years	24	EPA, 1991	9	EPA, 1991	
	CF2	Conversion Factor 2	l/cm^3	0.001	- -	0.001	- -	
	BW	Body Weight	kg	70	EPA, 1991	70	EPA, 1991	
	AT-C	Averaging Time (Cancer)	days	25,550	EPA, 1989	25,550	EPA, 1989	
	AT-N	Averaging Time (Non-Cancer)	days	8,760	EPA, 1989	3,285	EPA, 1989	

(1) Professional Judgement assuming 1 day per week for 52 weeks per year for the RME and 1/2 the RME value for the CT.

(2) Not available, used RME value.

[3] SA: Skin surface area in contact with surface water are based on ranges. For total adult male surface area ranges from 17,000 to 23,000 cm^2, with a mean of 20,000 cm^2; the mean value of 20,000 cm^2 is used for the RME value and 17,000 cm^2 is used for the CT value.

Sources:

EPA, 1989: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual, Part A. OERR. EPA/540/1-89/002.

EPA, 1991: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual - Supplemental Guidance, Standard Default Exposure Factors. Interim Final. OSWER Directive 9285.6-03.

EPA, 1992: Dermal Exposure Assessment: Principals and Applications. ORD. EPA/600/8-91/011B.

EPA, 1993: Superfund's Standard Default Exposure Factors for the Central Tendency and Reasonable Maximum Exposure.

EPA, 1996: Supplemental Guidance to RAGS: Region 4 Bulletins

EPA, 1997: Exposure Factors Handbook. EPA/600/P-95/002Fa.

TABLE 4.2

VALUES USED FOR DAILY INTAKE CALCULATIONS

Site 5, Allegany Ballistics Laboratory

Scenario Timeframe: Current/Future
Medium: Surface Water
Exposure Medium: Surface Water
Exposure Point: Site 5 Surface Water
Receptor Population: Other Recreational Person
Receptor Age: Adolescents

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/ Model Name
Ingestion	CSW	Chemical Concentration in Surface Water	µg/l	see Table ----	- -	see Table ----	- -	Chronic Daily Intake (CDI) (mg/kg-day) =
	IR-SW	Ingestion Rate of Surface Water	l/hour	0.01	EPA, 1996	0.01	EPA, 1996	CSW x IR-SW x ET x EF x ED x CF1 x
	ET	Exposure Time	hr/day	2.6	EPA, 1989	2.6	EPA, 1989	1/BW x 1/AT
	EF	Exposure Frequency	days/year	52	(1)	26	(1)	
	ED	Exposure Duration	years	9	[3]	9	[3]	
	CF1	Conversion Factor 1	mg/µg	0.001	- -	0.001	- -	
	BW	Body Weight	kg	51	EPA, 1997	51	EPA, 1997	
	AT-C	Averaging Time (Cancer)	days	25,550	EPA, 1989	25,550	EPA, 1989	
	AT-N	Averaging Time (Non-Cancer)	days	3,285	EPA, 1989	2,190	EPA, 1989	
Dermal Absorption	CSW	Chemical Concentration in Surface Water	µg/l	see Table ----	- -	see Table ----	- -	CDI (mg/kg-day) =
	SA	Skin Surface Area Available for Contact	cm^2	15,000	EPA, 1997, [4]	12,000	EPA, 1997, [4]	CSW x SA x PC x CF1 x ET x EF x ED x CF2 x 1/BW x 1/AT
	PC	Permeability Constant	cm/hr	chem specific	EPA, 1992	chem specific	EPA, 1992	
	CF1	Conversion Factor 1	mg/µg	0.001	- -	0.001	- -	
	ET	Exposure Time	hr/day	2.6	EPA, 1989	2.6	(2)	
	EF	Exposure Frequency	days/year	52	(1)	26	(1)	
	ED	Exposure Duration	years	9	[3]	9	[3]	
	CF2	Conversion Factor 2	l/cm^3	0.001	- -	0.001	- -	
	BW	Body Weight	kg	51	EPA, 1997	51	EPA, 1997	
	AT-C	Averaging Time (Cancer)	days	25,550	EPA, 1989	25,550	EPA, 1989	
	AT-N	Averaging Time (Non-Cancer)	days	3,285	EPA, 1989	2,190	EPA, 1989	

(1) Professional Judgement assuming 1 day per week for 52 weeks per year for the RME and 1/2 the RME value for the CT.

(2) Not available, used RME value.

(3) Professional Judgement assuming adolescents from 9 to 18 years of age.

[4] SA: Surface area in contact with surface water (while showering or bathing) are based on ranges. For the adolescent recreational person, the total body surface area ranges from 12,000 to 19,000 cm^2 of a 12- to 15-year-old male; the mean value of 15,000 cm^2 is used for the RME and 12,000 cm^2 is used for the CT value.

Sources:

EPA, 1989: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual, Part A. OERR. EPA/540/1-89/002.

EPA, 1991: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual - Supplemental Guidance, Standard Default Exposure Factors. Interim Final. OSWER Directive 9285.6-03.

EPA, 1992: Dermal Exposure Assessment: Principals and Applications. ORD. EPA/600/8-91/011B.

EPA, 1993: Superfund's Standard Default Exposure Factors for the Central Tendency and Reasonable Maximum Exposure.

EPA, 1996: Supplemental Guidance to RAGS: Region 4 Bulletins

EPA, 1997: Exposure Factors Handbook. EPA/600/P-95/002Fa.

TABLE 4.3

VALUES USED FOR DAILY INTAKE CALCULATIONS

Site 5, Allegany Ballistics Laboratory

Scenario Timeframe: Current/Future
Medium: Sediment
Exposure Medium: Sediment
Exposure Point: Site 5 Sediment
Receptor Population: Other Recreational Person
Receptor Age: Adult

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/ Model Name
Ingestion	CSed	Chemical Concentration in Sediment	mg/kg	see Table ----	- -	see Table ----	- -	Chronic Daily Intake (CDI) (mg/kg-day) =
	IR-Sed	Ingestion Rate of Sediment	mg/day	50	(1)	25	(1)	CSed x IR-Sed x EF x ED x CF3 x 1/BW x 1/AT
	EF	Exposure Frequency	days/year	52	(2)	26	(2)	
	ED	Exposure Duration	years	24	EPA, 1991	9	EPA, 1991	
	CF3	Conversion Factor 3	kg/mg	0.000001	- -	0.000001	- -	
	BW	Body Weight	kg	70	EPA, 1991	70	EPA, 1991	
	AT-C	Averaging Time (Cancer)	days	25,550	EPA, 1989	25,550	EPA, 1989	
	AT-N	Averaging Time (Non-Cancer)	days	8,760	EPA, 1989	3,285	EPA, 1989	
Dermal Absorption	CSed	Chemical Concentration in Sediment	mg/kg	see Table ----	- -	see Table ----	- -	CDI (mg/kg-day) =
	SA	Skin Surface Area Available for Contact	cm^2	5,170	EPA, 1997, [3]	1,960	EPA, 1997, [3]	CSed x SA x SSAF x NOE x DABS x CF3 x EF x
	SSAF	Soil to Skin Adherence Factor	mg/cm^2-event	0.08	EPA,1997 [4]	0.08	EPA,1997 [4]	ED x 1/BW x 1/AT
	NOE	Number of Events	events/day	1	[5]	1	[5]	
	DABS	Dermal Absorption Factor Solids	--	chem specific	EPA, 1995b	chem specific	EPA, 1995b	
	CF3	Conversion Factor 3	kg/mg	0.000001	- -	0.000001	- -	
	EF	Exposure Frequency	days/year	52	(2)	26	(2)	
	ED	Exposure Duration	years	24	EPA, 1991	9	EPA, 1991	
	BW	Body Weight	kg	70	EPA, 1991	70	EPA, 1991	
	AT-C	Averaging Time (Cancer)	days	25,550	EPA, 1989	25,550	EPA, 1989	
	AT-N	Averaging Time (Non-Cancer)	days	8,760	EPA, 1989	3,285	EPA, 1989	

(1) Professional Judgement assuming 1/2 the default value for the residential soil scenario per comment from EPA Region III, June 16, 1998, and 1/2 the RME value for the CT.

(2) Professional Judgement assuming 2 days per week for 6 months per year for the RME and 1/2 the RME value for the CT.

(3) RME SA is the sum of the mean surface areas (for a male) of the hands, forearms, feet, and lower legs. CT SA is the sum of the mean surface areas (for a male) of the feet and hands.

(4) Soil to skin adherence factor is based on maximum adherence factor for Garderner No.1, calculations presented in Table 4.3.A.

(5) Professional judgement assuming 1 event/day.

NA - Not available, used RME value.

Sources:

EPA, 1989: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual, Part A. OERR. EPA/540/1-89/002.

EPA, 1991: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual - Supplemental Guidance, Standard Default Exposure Factors. Interim Final. OSWER Directive 9285.6-03.

EPA, 1992: Dermal Exposure Assessment: Principals and Applications. ORD. EPA/600/8-91/011B.

EPA, 1995b: Assessing Dermal Exposure from Soil. EPA Region III. EPA/903-K-95-003.

EPA, 1997: Exposure Factors Handbook. EPA/600/P-95/002Fa.

DABS: Based on Region III Technical Guidance "Assessing Dermal Exposure from Soil, December 1995", for constituents not listed used volatile organics value of 20%, semi-volatile organics value of 10%, and Inorganics value of 1%.

Table 4.3.A
Calculation of Soil to Skin Adherence Factor
Site 5, Allegany Balistics Laboratory

Body Part (cm^2/s)	50th% Total SA (cm^2)		Average 50th% Total SA Combined Male & Female	Adherence Factor per Body Part (mg/cm^2)		Soil to Skin Adherence Factor (SSAF) ($mg\text{-}cm^2$/event)
	Male	Female		Garderner No.1	Adherence Factor * SA	
Feet	1310	1140	1225	0.17	208.25	**0.08**
Hands	990	817	903.5	0.2	180.7	
Forearms	1310	1035	1172.5	0.05	58.625	
Lower Legs	2560	2180	2370	0.072	N/A	
Total			**5671**		**448**	

Assumed forearm-to-arm ratio is 0.45 to account for only mean surface area of arms available for females. EFH Table 6-4.
Assumed face-to-head ratio is 3 to account for only mean adherence factor of face available. EFH Table 6-12

TABLE 4.4

VALUES USED FOR DAILY INTAKE CALCULATIONS

Site 5, Allegany Ballistics Laboratory

Scenario Timeframe: Current/Future
Medium: Sediment
Exposure Medium: Sediment
Exposure Point: Site 5 Sediment
Receptor Population: Other Recreational Person
Receptor Age: Adolescents

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/ Model Name
Ingestion	CSed	Chemical Concentration in Sediment	mg/kg	see Table	- -	see Table	- -	Chronic Daily Intake (CDI) (mg/kg-day) =
	IR-Sed	Ingestion Rate of Sediment	mg/day	50	(1)	25	(1)	CSed x IR-Sed x EF x ED x CF3 x 1/BW x 1/AT
	EF	Exposure Frequency	days/year	52	(2)	26	(2)	
	ED	Exposure Duration	years	9	[5]	9	[5]	
	CF3	Conversion Factor 3	kg/mg	0.000001	- -	0.000001	- -	
	BW	Body Weight	kg	51	EPA, 1991	51	EPA, 1991	
	AT-C	Averaging Time (Cancer)	days	25,550	EPA, 1989	25,550	EPA, 1989	
	AT-N	Averaging Time (Non-Cancer)	days	3,285	EPA, 1989	2,190	EPA, 1989	
Dermal Absorption	CSed	Chemical Concentration in Sediment	mg/kg	see Table	- -	see Table	- -	CDI (mg/kg-day) =
	SA	Skin Surface Area Available for Contact	cm^2	1,550	EPA, 1997, [3]	588	EPA, 1997, [3]	CSed x SA x SSAF x NOE x DABS x CF3 x EF x
	SSAF	Soil to Skin Adherence Factor	mg/cm^2-event	0.08	EPA,1997 [4]	0.08	EPA,1997 [4]	ED x 1/BW x 1/AT
	NOE	Number of Events	events/day	1	[6]	1	[6]	
	DABS	Dermal Absorption Factor Solids	--	chem specific	EPA, 1995b	chem specific	EPA, 1995b	
	CF3	Conversion Factor 3	kg/mg	0.000001	- -	0.000001	- -	
	EF	Exposure Frequency	days/year	52	(4)	26	(4)	
	ED	Exposure Duration	years	9	[5]	9	[5]	
	BW	Body Weight	kg	51	EPA, 1991	51	EPA, 1991	
	AT-C	Averaging Time (Cancer)	days	25,550	EPA, 1989	25,550	EPA, 1989	
	AT-N	Averaging Time (Non-Cancer)	days	3,285	EPA, 1989	2,190	EPA, 1989	

(1) Professional Judgement assuming 1/2 the default value for the residential soil scenario per comment from EPA Region III, June 16, 1998, and 1/2 the RME value for the CT.

(2) Professional Judgement assuming 2 days per week for 6 months per year for the RME and 1/2 the RME value for the CT.

(3) RME SA is 30 percent of the sum of the mean surface areas (for a male) of the hands, forearms, feet, and lower legs. CT SA is 30 percent of the sum of the mean surface areas (for a male) of the feet and hands.

(4) Soil to skin adherence factor is based on maximum adherence factor for Garderner No.1, calculations presented in Table 4.4.A.

(5) Professional Judgement assuming adolescents from 9 to 18 years of age.

(6) Professional judgement assuming 1 event/day.

NA - Not available, used RME value.

Sources:

EPA, 1989: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual, Part A. OERR. EPA/540/1-89/002.

EPA, 1991: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual - Supplemental Guidance, Standard Default Exposure Factors. Interim Final. OSWER Directive 9285.6-03. (soil exposure factors used for sediment, and 1/2 the RME value for the CT).

EPA, 1992: Dermal Exposure Assessment: Principals and Applications. ORD. EPA/600/8-91/011B.

EPA, 1995b: Assessing Dermal Exposure from Soil. EPA Region III. EPA/903-K-95-003.

EPA, 1997: Exposure Factors Handbook. EPA/600/P-95/002Fa.

DABS: Based on Region III Technical Guidance "Assessing Dermal Exposure from Soil, December 1995", for constituents not listed used volatile organics value of 20%, semi-volatile organics value of 10%, and Inorganics value of 1%.

Table 4.4.A
Calculation of Soil to Skin Adherence Factor
Site 5, Allegany Balistics Laboratory

Body Part (cm^2/s)	50th% Total SA (cm^2)		Average 50th% Total SA Combined Male & Female	Adherence Factor per Body Part (mg/cm^2)		Soil to Skin Adherence Factor (SSAF)
	Male	Female		Gardener No.1	Adherence Factor * SA	($mg\text{-}cm^2$/event)
Feet	1310	1140	1225	0.17	208.25	
Hands	990	817	903.5	0.2	180.7	**0.08**
Forearms	1310	1035	1172.5	0.05	58.625	
Lower Legs	2560	2180	2370	0.072	N/A	
Total			**5671**		**448**	

Assumed forearm-to-arm ratio is 0.45 to account for only mean surface area of arms available for females. EFH Table 6-4.
Assumed face-to-head ratio is 3 to account for only mean adherence factor of face available. EFH Table 6-12

TABLE 4.5

VALUES USED FOR DAILY INTAKE CALCULATIONS

Site 5, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Alluvial Aquifer-Tap Water
Receptor Population: Resident
Receptor Age: Adult

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/ Model Name
Ingestion	CW	Chemical Concentration in Water	µg/l	see Table ----		see Table ----		Chronic Daily Intake (CDI) (mg/kg-day) =
	IR-W	Ingestion Rate of Water	liters/day	2	EPA, 1997a	1.4	EPA, 1993	CW x IR-W x EF x ED x CF1 x 1/BW x 1/AT
	EF	Exposure Frequency	days/year	350	EPA, 1991	234	EPA, 1993	
	ED	Exposure Duration	years	24	EPA, 1991	9	EPA, 1993	
	CF1	Conversion Factor 1	mg/µg	0.001	- -	0.001	- -	
	BW	Body Weight	kg	70	EPA, 1991	70	EPA, 1991	
	AT-C	Averaging Time (Cancer)	days	25,550	EPA, 1989	25,550	EPA, 1989	
	AT-N	Averaging Time (Non-Cancer)	days	8,760	EPA, 1989	3,285	EPA, 1989	

Sources:

EPA, 1989: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual, Part A. OERR. EPA/540/1-89/002.

EPA, 1991: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual - Supplemental Guidance, Standard Default Exposure Factors. Interim Final. OSWER Directive 9285.6-03.

EPA, 1992: Dermal Exposure Assessment: Principals and Applications. ORD. EPA/600/8-91/011B.

EPA, 1993: Superfund's Standard Default Exposure Factors for the Central Tendency and Reasonable Maximum Exposure.

EPA, 1997a: Exposure Factors Handbook. EPA/600/P-95/002Fa.

EPA, 1997b: Risk Assessment Guidance for Superfund. Vol.1: Supplemental guidance, Dermal Risk Assessment Guidance. Interim Guidance. NCEA-W-0364.

TABLE 4.6

VALUES USED FOR DAILY INTAKE CALCULATIONS

Site 5, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Alluvial Aquifer-Tap Water
Receptor Population: Resident
Receptor Age: Child

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/ Model Name
Ingestion	CW	Chemical Concentration in Water	µg/L	see Table ----		see Table ----		Chronic Daily Intake (CDI) (mg/kg-day) =
	IR-W	Ingestion Rate of Water	L/day	1.29	EPA, 1997a, [2]	0.74	EPA, 1997a, [2]	CW x IR-W x EF x ED x CF3 x 1/BW x 1/AT
	EF	Exposure Frequency	days/year	350	EPA, 1991	234	EPA, 1993	
	ED	Exposure Duration	years	6	EPA, 1991	2	EPA, 1993	
	CF3	Conversion Factor 3	mg/µg	0.001	- -	0.001	- -	
	BW	Body Weight	kg	16.6	EPA, 1997a, [3]	16.6	EPA, 1997a, [3]	
	AT-C	Averaging Time (Cancer)	days	25,550	EPA, 1989	25,550	EPA, 1989	
	AT-N	Averaging Time (Non-Cancer)	days	2,190	EPA, 1989	730	EPA, 1989	
Dermal Absorption	CW	Chemical Concentration in Water	µg/l	see Table ---		see Table ---		CDI (mg/kg-day) =
	DAevent	Dermally Absorbed Dose per Event	mg/cm^2-event	calculated	EPA, 1992	calculated	EPA, 1992	DAevent x SA x EF x ED x 1/BW x 1/AT
	CF1	Conversion Factor 1	mg/µg	0.001	- -	0.001	- -	Inorganics: DAevent (mg/cm2-event) =
	PC	Permeability Constant	cm/hr	chem specific	EPA, 1992	chem specific	EPA, 1992	PC x CW x ET x CF1 x CF2
	t	Lag Time	hours	chem specific	EPA, 1992	chem specific	EPA, 1992	
	ET	Exposure Time	hr/day	0.33	EPA, 1992	0.17	EPA, 1997a	Organics :
	CF2	Conversion Factor 2	l/cm^3	0.001	- -	0.001	- -	ET<t*: DAevent (mg/cm2-event) =
	SA	Skin Surface Area Available for Contact	cm^2	7,213	EPA, 1997a,[1]	7,213	EPA, 1997a,[1]	2 x PC x CW x (sqrt((6 x t x ET)/3.1415))
	EF	Exposure Frequency	days/year	350	EPA, 1991	234	EPA, 1993	x CF1 x CF2
	ED	Exposure Duration	years	6	EPA, 1991	2	EPA, 1993	
	BW	Body Weight	kg	16.6	EPA, 1997a, [3]	16.6	EPA, 1997a, [3]	ET>t*: DAevent (mg/cm2-event) =
	AT-C	Averaging Time (Cancer)	days	25,550	EPA, 1989	25,550	EPA, 1989	PC x CW x (ET/(1+B) + 2 x t x ((1 + 3xB)/(1+B))
	AT-N	Averaging Time (Non-Cancer)	days	2,190	EPA, 1989	730	EPA, 1989	x CF1 x CF2

(1) Surface area is the average of child surface area for ages 1-6 years.
(2) RME Ingestion Rate is the 90th percentile drinking water intake rates of age group 1-10 years; CT ingestion rate is the mean drinking water intake rates of age group 1-10 years, Table 3-6, EFH 1997.
(3) Body weight is the average of mean weight of boys and girls for ages 1-6 years, Table 7-3, EFH 1997.

Sources:

EPA, 1989: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual, Part A. OERR. EPA/540/1-89/002.

EPA, 1991: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual - Supplemental Guidance, Standard Default Exposure Factors. Interim Final. OSWER Directive 9285.6-03.

EPA, 1992: Dermal Exposure Assessment: Principals and Applications. ORD. EPA/600/8-91/011B.

EPA, 1993: Superfund's Standard Default Exposure Factors for the Central Tendency and Reasonable Maximum Exposure.

EPA, 1995: Assessing Dermal Exposure from Soil. EPA Region III. EPA/903-K-95-003.

EPA, 1997a: Exposure Factors Handbook. EPA/600/P-95/002Fa.

EPA, 1997b: Risk Assessment Guidance for Superfund. Vol.1: Supplemental guidance, Dermal Risk Assessment Guidance. Interim Guidance. NCEA-W-0364.

DABS: Based on Region III Technical Guidance "Assessing Dermal Exposure from Soil, December 1995", for constituents not listed used volatile organics value of 20%, semi-volatile organics value of 10%, and Inorganics value of 1%.

TABLE 4.7

VALUES USED FOR DAILY INTAKE CALCULATIONS

Site 5, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Alluvial Aquifer-Tap Water
Receptor Population: Resident
Receptor Age: Adult/Child

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/ Model Name
Ingestion	CW	Chemical Concentration in Water	µg/l	see Table ---	--	see Table ---	--	Chronic Daily Intake (CDI) (mg/kg-day) =
	IR-W-A	Ingestion Rate of Water, Adult	liters/day	2	EPA, 1997a	1.4	EPA, 1993	CW x IR-W-Adj x EF x CF1 x 1/AT
	IR-W-C	Ingestion Rate of Water, Child	liters/day	1.29	EPA, 1997a	0.74	EPA, 1997a	
	IR-W-Adj	Ingestion Rate of Water, Age-adjusted	liter-year/kg-day	1.15	calculated	0.27	calculated	IR-W-Adj (liter-year/kg-day) =
	EF	Exposure Frequency	days/year	350	EPA, 1991	234	EPA, 1993	(ED-C x IR-W-C / BW-C) + (ED-A x IR-W-A / BW-A)
	ED-A	Exposure Duration, Adult	years	24	EPA, 1991	9	EPA, 1993	
	ED-C	Exposure Duration, Child	years	6	EPA, 1991	2	EPA, 1993	
	CF1	Conversion Factor 1	mg/µg	0.001	- -	0.001	- -	
	BW-A	Body Weight , Adult	kg	70	EPA, 1991	70	EPA, 1991	
	BW-C	Body Weight, Child	kg	16.6	EPA, 1997	16.6	EPA, 1997	
	AT-C	Averaging Time (Cancer)	days	25,550	EPA, 1989	25,550	EPA, 1989	

(1) Not available, used RME value.

Sources:

EPA, 1989: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual, Part A. OERR. EPA/540/1-89/002.

EPA, 1991: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual - Supplemental Guidance, Standard Default Exposure Factors. Interim Final. OSWER Directive 9285.6-03.

EPA, 1992: Dermal Exposure Assessment: Principals and Applications. ORD. EPA/600/8-91/011B.

EPA, 1993: Superfund's Standard Default Exposure Factors for the Central Tendency and Reasonable Maximum Exposure.

EPA, 1997a: Exposure Factors Handbook. EPA/600/P-95/002Fa.

EPA, 1997b: Risk Assessment Guidance for Superfund. Vol.1: Supplemental guidance, Dermal Risk Assessment Guidance. Interim Guidance. NCEA-W-0364.

TABLE 4.8

VALUES USED FOR DAILY INTAKE CALCULATIONS

Site 5, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Alluvial Aquifer-Water in Excavation Pit
Receptor Population: Construction Worker
Receptor Age: Adult

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/ Model Name
Dermal Absorption	CW	Chemical Concentration in Water	µg/l	see Table ----	chem specific	see Table ----	chem specific	CDI (mg/kg-day) =
	DAevent	Dermally Absorbed Dose per Event	mg/cm^2-event	calculated	EPA, 1992	calculated	EPA, 1992	DAevent x SA x EF x ED x 1/BW x 1/AT
	CF1	Conversion Factor 1	mg/µg	0.001	- -	0.001	- -	
	PC	Permeability Constant	cm/hr	chem specific	EPA, 1992	chem specific	EPA, 1992	Inorganics: DAevent (mg/cm2-event) =
	t	Lag Time	hours	chem specific	EPA, 1992	chem specific	EPA, 1992	PC x CW x ET x CF1 x CF2
	t*	Time to Reach Steady-state	hours	chem specific	EPA, 1992	chem specific	EPA, 1992	
	B	Ratio of Permeability of Stratum Corneum to Epidermis	dimensionless	chem specific	EPA, 1992	chem specific	EPA, 1992	Organics :
	ET	Exposure Time	hr/day	8	(1)	8	(1)	ET<t*: DAevent (mg/cm2-event) =
	CF2	Conversion Factor 2	l/cm^3	0.001	- -	0.001	- -	2 x PC x CW x (sqrt((6 x t x ET)/3.1415))
	SA	Skin Surface Area Available for Contact	cm^2	6,000	EPA, 1997 (2)	5,100	EPA, 1997 (2)	x CF1 x CF2
	EF	Exposure Frequency	days/year	250	EPA, 1993	219	EPA, 1993	
	ED	Exposure Duration	years	1	EPA, 1991	1	EPA, 1991	ET>t*: DAevent (mg/cm2-event) =
	BW	Body Weight	kg	70	EPA, 1991	70	EPA, 1991	PC x CW x (ET/(1+B) + 2 x t x ((1 + 3xB)/(1+B))
	AT-C	Averaging Time (Cancer)	days	25,550	EPA, 1989	25,550	EPA, 1989	x CF1 x CF2
	AT-N	Averaging Time (Non-Cancer)	days	365	EPA, 1989	365	EPA, 1989	

(1) Professional Judgement based on construction activities that would result in contact with the groundwater for 8 hrs per day.

(2) Skin surface area in contact with groundwater based on contact during construction activities. Assumed 30 percent of total surface area of male. 'For total adult male surface area ranges from 17,000 to 23,000 cm2, with a mean of 20,000 cm2; 30% of the mean value of 20,000 cm^2 is used for the RME value and 30% of 17,000 cm^2 is used for the CT value.

Sources:

EPA, 1989: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual, Part A. OERR. EPA/540/1-89/002.

EPA, 1991: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual - Supplemental Guidance, Standard Default Exposure Factors. Interim Final. OSWER Directive 9285.6-03.

EPA, 1992: Dermal Exposure Assessment: Principals and Applications. ORD. EPA/600/8-91/011B.

EPA, 1993: Superfund's Standard Default Exposure Factors for the Central Tendency and Reasonable Maximum Exposure.

EPA, 1997: Exposure Factors Handbook. EPA/600/P-95/002Fa.

TABLE 4.9

VALUES USED FOR DAILY INTAKE CALCULATIONS

Site 5, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Air
Exposure Point: Alluvial Aquifer-Water Vapors at Showerhead
Receptor Population: Resident
Receptor Age: Adult

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/ Model Name
Inhalation	InhExp	Inhalation Exposure per Shower	mg/kg-shower	see Table ----		see Table ----		Foster & Chrostowski Shower Inhalation Model for InhExp
	EF	Exposure Frequency	days/year	350	EPA, 1991	234	EPA, 1993	
	ED	Exposure Duration	years	24	EPA, 1991	9	EPA, 1993	Chronic Daily Intake (CDI) (mg/kg-day) =
	AT-C	Averaging Time (Cancer)	days	25,550	EPA, 1989	25,550	EPA, 1989	InhExp x EF x ED x 1/AT
	AT-N	Averaging Time (Non-Cancer)	days	8,760	EPA. 1989	3,285	EPA. 1989	

Sources:

EPA, 1989: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual, Part A. OERR. EPA/540/1-89/002.

EPA, 1991: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual - Supplemental Guidance, Standard Default Exposure Factors. Interim Final. OSWER Directive 9285.6-03.

EPA, 1993: Superfund's Standard Default Exposure Factors for the Central Tendency and Reasonable Maximum Exposure.

TABLE 4.10

VALUES USED FOR DAILY INTAKE CALCULATIONS

Site 5, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Air
Exposure Point: Alluvial aquifer-Volatilization from Water in Excavation Pit
Receptor Population: Construction Worker
Receptor Age: Adult

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/ Model Name
Inhalation	CA	Air concentration	mg/m^3	see Table --		see Table --		Two-Film Volatilization Model for CA
	IN	Inhalation Rate	$m^3/hour$	3.3	EPA, 1997 (2)	2.5	EPA, 1997 (2)	
	ET	Exposure Time	hr/day	8	(1)	8	(1)	Chronic Daily Intake (CDI) (mg/kg-day) =
	EF	Exposure Frequency	days/year	250	EPA, 1993	219	EPA, 1993	
	ED	Exposure Duration	years	1	EPA, 1991	1	EPA, 1991	CA x IN x ET x EF x ED x 1/BW x 1/AT
	BW	Body Weight	kg	70	EPA, 1991	70	EPA, 1991	
	AT-C	Averaging Time (Cancer)	days	25,550	EPA, 1989	25,550	EPA, 1989	
	AT-N	Averaging Time (Non-Cancer)	days	365	EPA, 1989	365	EPA, 1989	

(1) Professional Judgement based on maintenance activities that would occur 8 hrs per day.
(2) RME inhalation rate is the short-term exposure to outdoor workers hourly average upper percentile and CT is the short term exposure to outdoor workers hourly average during heavy activities, as per recommendations by EPA, Table 5-23, EFH 1997.

Sources:

EPA, 1989: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual, Part A. OERR. EPA/540/1-89/002.

EPA, 1991: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual - Supplemental Guidance, Standard Default Exposure Factors. Interim Final. OSWER Directive 9285.6-03.

EPA, 1993: Superfund's Standard Default Exposure Factors for the Central Tendency and Reasonable Maximum Exposure.

EPA, 1997: Exposure Factors Handbook. EPA/600/P-95/002Fa.

TABLE 4.11

VALUES USED FOR DAILY INTAKE CALCULATIONS

Site 5, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Bedrock Aquifer-Tap Water
Receptor Population: Resident
Receptor Age: Adult

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/ Model Name
Ingestion	CW	Chemical Concentration in Water	µg/l	see Table ----		see Table ----		Chronic Daily Intake (CDI) (mg/kg-day) =
	IR-W	Ingestion Rate of Water	liters/day	2	EPA, 1997a	1.4	EPA, 1993	CW x IR-W x EF x ED x CF1 x 1/BW x 1/AT
	EF	Exposure Frequency	days/year	350	EPA, 1991	234	EPA, 1993	
	ED	Exposure Duration	years	24	EPA, 1991	9	EPA, 1993	
	CF1	Conversion Factor 1	mg/µg	0.001	- -	0.001	- -	
	BW	Body Weight	kg	70	EPA, 1991	70	EPA, 1991	
	AT-C	Averaging Time (Cancer)	days	25,550	EPA, 1989	25,550	EPA, 1989	
	AT-N	Averaging Time (Non-Cancer)	days	8,760	EPA, 1989	3,285	EPA, 1989	

Sources:

EPA, 1989: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual, Part A. OERR. EPA/540/1-89/002.

EPA, 1991: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual - Supplemental Guidance, Standard Default Exposure Factors. Interim Final. OSWER Directive 9285.6-03.

EPA, 1992: Dermal Exposure Assessment: Principals and Applications. ORD. EPA/600/8-91/011B.

EPA, 1993: Superfund's Standard Default Exposure Factors for the Central Tendency and Reasonable Maximum Exposure.

EPA, 1997a: Exposure Factors Handbook. EPA/600/P-95/002Fa.

EPA, 1997b: Risk Assessment Guidance for Superfund. Vol.1: Supplemental guidance, Dermal Risk Assessment Guidance. Interim Guidance. NCEA-W-0364.

TABLE 4.12

VALUES USED FOR DAILY INTAKE CALCULATIONS

Site 5, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Bedrock Aquifer-Tap Water
Receptor Population: Resident
Receptor Age: Child

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/ Model Name
Ingestion	CW	Chemical Concentration in Water	µg/L	see Table ----		see Table ----		Chronic Daily Intake (CDI) (mg/kg-day) =
	IR-W	Ingestion Rate of Water	L/day	1.29	EPA, 1997a, [2]	0.74	EPA, 1997a, [2]	CW x IR-W x EF x ED x CF3 x 1/BW x 1/AT
	EF	Exposure Frequency	days/year	350	EPA, 1991	234	EPA, 1993	
	ED	Exposure Duration	years	6	EPA, 1991	2	EPA, 1993	
	CF3	Conversion Factor 3	mg/µg	0.001	- -	0.001	- -	
	BW	Body Weight	kg	16.6	EPA, 1997a, [3]	16.6	EPA, 1997a, [3]	
	AT-C	Averaging Time (Cancer)	days	25,550	EPA, 1989	25,550	EPA, 1989	
	AT-N	Averaging Time (Non-Cancer)	days	2,190	EPA, 1989	730	EPA, 1989	
Dermal Absorption	CW	Chemical Concentration in Water	µg/l	see Table ---		see Table ---		CDI (mg/kg-day) =
	DAevent	Dermally Absorbed Dose per Event	mg/cm^2-event	calculated	EPA, 1992	calculated	EPA, 1992	DAevent x SA x EF x ED x 1/BW x 1/AT
	CF1	Conversion Factor 1	mg/µg	0.001	- -	0.001	- -	Inorganics: DAevent (mg/cm2-event) =
	PC	Permeability Constant	cm/hr	chem specific	EPA, 1992	chem specific	EPA, 1992	PC x CW x ET x CF1 x CF2
	t	Lag Time	hours	chem specific	EPA, 1992	chem specific	EPA, 1992	
	ET	Exposure Time	hr/day	0.33	EPA, 1992	0.17	EPA, 1997a	Organics :
	CF2	Conversion Factor 2	l/cm^3	0.001	- -	0.001	- -	ET<t*: DAevent (mg/cm2-event) =
	SA	Skin Surface Area Available for Contact	cm^2	7,213	EPA, 1997a,[1]	7,213	EPA, 1997a,[1]	2 x PC x CW x (sqrt((6 x t x ET)/3.1415))
	EF	Exposure Frequency	days/year	350	EPA, 1991	234	EPA, 1993	x CF1 x CF2
	ED	Exposure Duration	years	6	EPA, 1991	2	EPA, 1993	
	BW	Body Weight	kg	16.6	EPA, 1997a, [3]	16.6	EPA, 1997a, [3]	ET>t*: DAevent (mg/cm2-event) =
	AT-C	Averaging Time (Cancer)	days	25,550	EPA, 1989	25,550	EPA, 1989	PC x CW x (ET/(1+B) + 2 x t x ((1 + 3xB)/(1+B))
	AT-N	Averaging Time (Non-Cancer)	days	2,190	EPA, 1989	730	EPA, 1989	x CF1 x CF2

(1) Surface area is the average of child surface area for ages 1-6 years.
(2) RME Ingestion Rate is the 90th percentile drinking water intake rates of age group 1-10 years; CT ingestion rate is the mean drinking water intake rates of age group 1-10 years, Table 3-6, EFH 1997.
(3) Body weight is the average of mean weight of boys and girls for ages 1-6 years, Table 7-3, EFH 1997.

Sources:

EPA, 1989: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual, Part A. OERR. EPA/540/1-89/002.

EPA, 1991: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual - Supplemental Guidance, Standard Default Exposure Factors. Interim Final. OSWER Directive 9285.6-03.

EPA, 1992: Dermal Exposure Assessment: Principals and Applications. ORD. EPA/600/8-91/011B.

EPA, 1993: Superfund's Standard Default Exposure Factors for the Central Tendency and Reasonable Maximum Exposure.

EPA, 1995: Assessing Dermal Exposure from Soil. EPA Region III. EPA/903-K-95-003.

EPA, 1997a: Exposure Factors Handbook. EPA/600/P-95/002Fa.

EPA, 1997b: Risk Assessment Guidance for Superfund. Vol.1: Supplemental guidance, Dermal Risk Assessment Guidance. Interim Guidance. NCEA-W-0364.

DABS: Based on Region III Technical Guidance "Assessing Dermal Exposure from Soil, December 1995", for constituents not listed used volatile organics value of 20%, semi-volatile organics value of 10%, and Inorganics value of 1%.

TABLE 4.13

VALUES USED FOR DAILY INTAKE CALCULATIONS

Site 5, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Bedrock Aquifer-Tap Water
Receptor Population: Resident
Receptor Age: Adult/Child

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/ Model Name
Ingestion	CW	Chemical Concentration in Water	µg/l	see Table ---	--	see Table ---	--	Chronic Daily Intake (CDI) (mg/kg-day) =
	IR-W-A	Ingestion Rate of Water, Adult	liters/day	2	EPA, 1997a	1.4	EPA, 1993	CW x IR-W-Adj x EF x CF1 x 1/AT
	IR-W-C	Ingestion Rate of Water, Child	liters/day	1.29	EPA, 1997a	0.74	EPA, 1997a	
	IR-W-Adj	Ingestion Rate of Water, Age-adjusted	liter-year/kg-day	1.15	calculated	0.27	calculated	IR-W-Adj (liter-year/kg-day) =
	EF	Exposure Frequency	days/year	350	EPA, 1991	234	EPA, 1993	(ED-C x IR-W-C / BW-C) + (ED-A x IR-W-A / BW-A)
	ED-A	Exposure Duration, Adult	years	24	EPA, 1991	9	EPA, 1993	
	ED-C	Exposure Duration, Child	years	6	EPA, 1991	2	EPA, 1993	
	CF1	Conversion Factor 1	mg/µg	0.001	- -	0.001	- -	
	BW-A	Body Weight , Adult	kg	70	EPA, 1991	70	EPA, 1991	
	BW-C	Body Weight, Child	kg	16.6	EPA, 1997	16.6	EPA, 1997	
	AT-C	Averaging Time (Cancer)	days	25,550	EPA, 1989	25,550	EPA, 1989	

(1) Not available, used RME value.

Sources:

EPA, 1989: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual, Part A. OERR. EPA/540/1-89/002.

EPA, 1991: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual - Supplemental Guidance, Standard Default Exposure Factors. Interim Final. OSWER Directive 9285.6-03.

EPA, 1992: Dermal Exposure Assessment: Principals and Applications. ORD. EPA/600/8-91/011B.

EPA, 1993: Superfund's Standard Default Exposure Factors for the Central Tendency and Reasonable Maximum Exposure.

EPA, 1997a: Exposure Factors Handbook. EPA/600/P-95/002Fa.

EPA, 1997b: Risk Assessment Guidance for Superfund. Vol.1: Supplemental guidance, Dermal Risk Assessment Guidance. Interim Guidance. NCEA-W-0364.

TABLE 4.14

VALUES USED FOR DAILY INTAKE CALCULATIONS

Site 5, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Air
Exposure Point: Bedrock Aquifer-Water Vapors at Showerhead
Receptor Population: Resident
Receptor Age: Adult

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/ Model Name
Inhalation	InhExp	Inhalation Exposure per Shower	mg/kg-shower	see Table ----		see Table ----		Foster & Chrostowski Shower Inhalation Model for InhExp
	EF	Exposure Frequency	days/year	350	EPA, 1991	234	EPA, 1993	
	ED	Exposure Duration	years	24	EPA, 1991	9	EPA, 1993	Chronic Daily Intake (CDI) (mg/kg-day) =
	AT-C	Averaging Time (Cancer)	days	25,550	EPA, 1989	25,550	EPA, 1989	InhExp x EF x ED x 1/AT
	AT-N	Averaging Time (Non-Cancer)	days	8,760	EPA. 1989	3,285	EPA. 1989	

Sources:

EPA, 1989: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual, Part A. OERR. EPA/540/1-89/002.

EPA, 1991: Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual - Supplemental Guidance, Standard Default Exposure Factors. Interim Final. OSWER Directive 9285.6-03.

EPA, 1993: Superfund's Standard Default Exposure Factors for the Central Tendency and Reasonable Maximum Exposure.

TABLE 5.1

NON-CANCER TOXICITY DATA -- ORAL/DERMAL

Site 5, Allegany ballistics Laboratory

Chemical of Potential Concern	Chronic/ Subchronic	Oral RfD Value	Oral RfD Units	Oral to Dermal Adjustment Factor (1)	Adjusted Dermal RfD (2)	Units	Primary Target Organ	Combined Uncertainty/Modifying Factors	Sources of RfD: Target Organ	Dates of RfD: Target Organ (3) (MM/DD/YY)
Aluminum	Chronic	1.0E+00	mg/kg-day	27%	2.7E-01	mg/kg-day	CNS	100	NCEA	08/26/1996
	Subchronic	N/A								
Antimony	Chronic	4.0E-04	mg/kg-day	10%	4.0E-05	mg/kg-day	Blood	1000/1	IRIS	10/10/2002
	Subchronic	4.0E-04	mg/kg-day	10%	4.0E-05	mg/kg-day	Blood	1000	HEAST	7/1997
Arsenic	Chronic	3.0E-04	mg/kg-day	95%	2.9E-04	mg/kg-day	Skin/Vascular	3	IRIS	03/21/2002
	Subchronic	3.0E-04	mg/kg-day	95%	2.9E-04	mg/kg-day	Skin/Vascular	3	HEAST	7/1997
Barium	Chronic	7.0E-02	mg/kg-day	100%	7.0E-02	mg/kg-day	Kidney	3/1	IRIS	05/21/2002
	Subchronic	7.0E-02	mg/kg-day	100%	7.0E-02	mg/kg-day	Cardiovascular	3	HEAST	7/1997
Cadmium (water)	Chronic	5.0E-04	mg/kg-day	5%	2.5E-05	mg/kg-day	Kidney	10/1	IRIS	02/07/2002
(for water and air)	Subchronic	N/A								
Cadmium (food)	Chronic	1.0E-03	mg/kg-day	3%	2.5E-05	mg/kg-day	Kidney	10/1	IRIS	02/07/2002
(for soil)	Subchronic	N/A								
Iron	Chronic	3.0E-01	mg/kg-day	20%	6.0E-02	mg/kg-day	Gastrointestinal	1	NCEA	09/30/2002
	Subchronic	N/A								
Manganese (nonfood)	Chronic	2.0E-02	mg/kg-day	35%	7.0E-03	mg/kg-day	CNS	1	IRIS	03/21/2002
	Subchronic	N/A								
Nickel	Chronic	2.0E-02	mg/kg-day	10%	2.0E-03	mg/kg-day	Whole body	300/1	IRIS	02/07/2002
	Subchronic	2.0E-02	mg/kg-day	10%	2.0E-03	mg/kg-day	Whole body	300	HEAST	07/1998
Thallium	Chronic	7.0E-05	mg/kg-day	100%	7.0E-05	mg/kg-day	Blood & Hair		O	
	Subchronic	N/A								
cis-1,2-Dichloroethene	Chronic	1.0E-02	mg/kg-day	100%	1.0E-02	mg/kg-day	Blood	3000	HEAST	7/1997
	Subchronic	1.0E-01	mg/kg-day	100%	1.0E-01	mg/kg-day	Blood	300	HEAST	7/1997
Trichloroethene	Chronic	3.0E-04	mg/kg-day	80%	2.4E-04	mg/kg-day	Liver, Kidney		NCEA	
	Subchronic	N/A				mg/kg-day				

N/A = Not Applicable or Not Available. IRIS indicates that calculations of dermal risks may not be appropriate for this chemical.

(1) Refer to RAGS, Part A. Source is EPA Region III *Oral Absorption Values for Oral-to-Dermal Extrapolation* , April 8, 1999.

For constituents not available in the Region III document the following general values were used: VOCs - 80%, Pesticides/PCBs - 50%, dioxins/furans - 50%, and metals - 20%.

ATSDR = Agency for Toxic Substances and Disease Registry

IRIS = Integrated Risk Information System

HEAST= Health Effects Assessment Summary Tables

NCEA = National Center for Environmental Assessment

(2) Provide equation for derivation in text.

(3) For IRIS values, provide the date IRIS was searched.

For HEAST values, provide the date of HEAST.

For NCEA values, provide the date of the article provided by NCEA.

RESP = Respiratory System

CNS = Central Nervous System

NOAEL = No adverse effect level

TABLE 5.2

NON-CANCER TOXICITY DATA -- INHALATION

Site 5, Allegany ballistics Laboratory

Chemical of Potential Concern	Chronic/ Subchronic	Value Inhalation RfC	Units	Adjusted Inhalation RfD (1)	Units	Primary Target Organ	Combined Uncertainty/Modifying Factors	Sources of RfC:RfD: Target Organ (2)	Dates (3) (MM/DD/YY)
Aluminum	Chronic	3.50E-03	mg/m^3	1.00E-03	mg/kg-day	CNS	300	NCEA	06/20/1997
	Subchronic	N/A							
Antimony	Chronic	N/A							
	Subchronic	N/A							
Arsenic	Chronic	N/A							
	Subchronic	N/A							
Barium	Chronic	4.90E-04	mg/m^3	1.40E-04	mg/kg-day	Cardiovascular		A	
	Subchronic	N/A							
Cadmium (water)	Chronic	2.0E-04	mg/m3	5.7E-05	mg/kg-day	Kidney	N/A	NCEA	
	Subchronic	9.0E-04	mg/m3	2.6E-04	mg/kg-day	Kidney	N/A	NCEA	
Cadmium (food)	Chronic	2.0E-04	mg/m3	5.7E-05	mg/kg-day	Kidney	N/A	NCEA	
	Subchronic	9.0E-04	mg/m3	2.6E-04	mg/kg-day	Kidney	N/A	NCEA	
Iron	Chronic	N/A							
	Subchronic	N/A							
Manganese	Chronic	5.01E-05	mg/m^3	1.43E-05	mg/kg-day	CNS	1000	IRIS	03/21/2002
	Subchronic	N/A							
Nickel	Chronic	N/A							
Thallium	Chronic	N/A							
	Subchronic	N/A							
cis-1,2-Dichloroethene	Chronic	N/A							
	Subchronic	N/A							
Trichloroethene	Chronic	3.50E-02	mg/m^3	1.00E-02	mg/kg-day	Liver, Kidney		NCEA	09/03/2002
	Subchronic	N/A							

N/A = Not Applicable

(1) Provide equation used for derivation in text.

(2) HEAST, Alternative Methods used as source of barium values.

Chromium and cadmium values were withdrawn from HEAST, but available in Region III RBC Table.

(3) For IRIS values, provide the date IRIS was searched.

For HEAST values, provide the date of HEAST.

For NCEA values, provide the date of the article provided by NCEA.

ATSDR = Agency for Toxic Substances and Disease Registry

IRIS = Integrated Risk Information System

HEAST= Health Effects Assessment Summary Tables

HEAST(3) = Health Effects Assessment Summary Tables, Alternate Methods

HEAST(4)= Health Effects Assessment Summary Tables, Withdrawn

NCEA = National Center for Environmental Assessment

TABLE 6.1

CANCER TOXICITY DATA -- ORAL/DERMAL

Site 5, Allegany Ballistics Laboratory

Chemical of Potential Concern	Oral Cancer Slope Factor	Oral to Dermal Adjustment Factor	Adjusted Dermal Cancer Slope Factor (1)	Units	EPA Carcinogen Group	Source	Date (2) (MM/DD/YY)
Aluminum	N/A						
Antimony	N/A						
Arsenic	1.5E+00	95%	1.6E+00	$(mg/kg\text{-}day)^{-1}$	A	IRIS	03/21/2002
Barium	N/A						
Cadmium-Water	N/A						
Cadmium-Food	N/A						
Iron	N/A						
Manganese (nonfood)	N/A						
Manganese (food)	N/A						
Nickel	N/A						
Thallium	N/A						
cis-1,2-Dichloroethene	N/A						
Trichloroethene	4.0E-01	80%	5.0E-01	$(mg/kg\text{-}day)^{-1}$		NCEA	09/30/2002

N/A-Not available

IRIS = Integrated Risk Information System

HEAST= Health Effects Assessment Summary Tables

NCEA = National Center for Environmental Assessment

U = Under review.

EPA Carcinogen Group:

A - Human carcinogen

B1 - Probable human carcinogen - indicates that limited human data are available

B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans

C - Possible human carcinogen

D - Not classifiable as a human carcinogen

E - Evidence of noncarcinogenicity

(1) Refer to RAGS, Part A. Source is EPA Region III *Oral Absorption Values for Oral-to-Dermal Extrapolation*, April 8, 1999.

Dermal carcinogenicity should not be assessed for the carcinogenic PAHs, as these chemicals may act directly at the point of contact.

For constituents not available in the Region III document the following general values were used: VOCs - 80%, Pesticides/PCBs - 50%, dioxins/furans - 50%, and metals - 20%.

* - 2,3,7,8-TCDD value from *Derivation of Toxicity Values for Dermal Exposure from the Toxicologist* (USEPA, March 1996), Volume 30, Number 1, Part 2.

(2) For IRIS values, provide the date IRIS was searched.

For HEAST values, provide the date of HEAST.

For NCEA values, provide article date provided by NCEA.

TABLE 6.2

CANCER TOXICITY DATA -- INHALATION

Site 5, Allegany Ballistics Laboratory

Chemical of Potential Concern	Unit Risk	Units	Adjustment (1)	Inhalation Cancer Slope Factor	Units	Weight of Evidence/ Cancer Guidance Description	Source	Date (2) (MM/DD/YY)
Aluminum	N/A							
Antimony	N/A							
Arsenic	4.0E-03	$(ug/m3)^{-1}$	3500	1.5E+01	$(mg/kg\text{-}day)^{-1}$	A	IRIS	03/21/2002
Barium	N/A							
Cadmium	1.8E-03	$(ug/m3)^{-1}$	3500	6.3E+00	$(mg/kg\text{-}day)^{-1}$	B1	IRIS	06/13/1998
Manganese	N/A							
Nickel	N/A							
cis-1,2-Dichloroethene	N/A							
Trichloroethene	1.1E-04	$(ug/m3)^{-1}$	3500	4.0E-01	$(mg/kg\text{-}day)^{-1}$		NCEA	09/30/2002

IRIS = Integrated Risk Information System

HEAST= Health Effects Assessment Summary Tables

NCEA = National Center for Environmental Assessment

U = Under review.

N/A = Not Available

(1) Adjustment Factor applied to Unit Risk to calculate Inhalation Slope Factor = 70kg x 1/20m3/day x 1000ug/mg

(2) For IRIS values, provide the date IRIS was searched.
For HEAST values, provide the date of HEAST.
For NCEA values, provide the date of the article provided by NCEA.
For RBC values, provide the date of last change in the Tables.

EPA Group:

A - Human carcinogen

B1 - Probable human carcinogen - indicates that limited human data are available

B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans

C - Possible human carcinogen

D - Not classifiable as a human carcinogen

E - Evidence of noncarcinogenicity

TABLE 7.1.RME
CALCULATION OF NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
Site 5, Allegany Ballistics Laboratory

Scenario Timeframe: Current/Future
Medium: Surface Water
Exposure Medium: Surface Water
Exposure Point: Site 5 Surface Water
Receptor Population: Other Recreational Person
Receptor Age: Adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose (2)	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Ingestion	Arsenic (Total)	2.95E+00	ug/L	2.95E+00	ug/L	M	1.6E-07	mg/kg-day	3.0E-04	mg/kg-day	N/A	N/A	5.2E-04
													5.2E-04
Dermal	Arsenic (Total)	2.95E+00	ug/L	2.95E+00	ug/L	M	1.0E-05	mg/kg-day	2.9E-04	mg/kg-day	N/A	N/A	3.4E-02
													3.4E-02
												Total Hazard Index Across All Exposure Routes/Pathways	3.5E-02

(1) Specify Medium-Specific (M) or Route-Specific (R) EPC selected for hazard calculation.
(2) Chronic.

TABLE 7.2.RME
CALCULATION OF NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
Site 5, Allegany Ballistics Laboratory

Scenario Timeframe: Current/Future
Medium: Surface Water
Exposure Medium: Surface Water
Exposure Point: Site 5 Surface Water
Receptor Population: Other Recreational Person
Receptor Age: Adolescents

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose (2)	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Ingestion	Arsenic (Total)	2.95E+00	ug/L	2.95E+00	ug/L	M	2.1E-07	mg/kg-day	3.0E-04	mg/kg-day	N/A	N/A	7.1E-04
													7.1E-04
Dermal	Arsenic (Total)	2.95E+00	ug/L	2.95E+00	ug/L	M	1.0E-05	mg/kg-day	2.9E-04	mg/kg-day	N/A	N/A	3.5E-02
													3.5E-02
												Total Hazard Index Across All Exposure Routes/Pathways	3.6E-02

(1) Specify Medium-Specific (M) or Route-Specific (R) EPC selected for hazard calculation.
(2) Chronic.

TABLE 7.3.RME
CALCULATION OF NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
Site 5, Allegany Ballistics Laboratory

Scenario Timeframe: Current/Future
Medium: Sediment
Exposure Medium: Sediment
Exposure Point: Site 5 Sediment
Receptor Population: Other Recreational Person
Receptor Age: Adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose (2)	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Ingestion	Arsenic	1.19E+01	mg/kg	1.19E+01	mg/kg	M	1.2E-06	mg/kg-day	3.0E-04	mg/kg-day	N/A	N/A	4.0E-03
	Iron	3.09E+04	mg/kg	3.09E+04	mg/kg	M	3.1E-03	mg/kg-day	3.0E-01	mg/kg-day	N/A	N/A	1.0E-02
	Manganese	9.86E+02	mg/kg	9.86E+02	mg/kg	M	1.0E-04	mg/kg-day	2.0E-02	mg/kg-day	N/A	N/A	5.0E-03
	(Total)												2.0E-02
Dermal	Arsenic	1.19E+01	mg/kg	1.19E+01	mg/kg	M	3.2E-07	mg/kg-day	2.9E-04	mg/kg-day	N/A	N/A	1.1E-03
	Iron	3.09E+04	mg/kg	3.09E+04	mg/kg	M	2.6E-04	mg/kg-day	6.0E-02	mg/kg-day	N/A	N/A	4.3E-03
	Manganese	9.86E+02	mg/kg	9.86E+02	mg/kg	M	8.3E-06	mg/kg-day	7.0E-03	mg/kg-day	N/A	N/A	1.2E-03
	(Total)												6.6E-03
												Total Hazard Index Across All Exposure Routes/Pathways	2.6E-02

(1) Specify Medium-Specific (M) or Route-Specific (R) EPC selected for hazard calculation.
(2) Chronic.

TABLE 7.4.RME
CALCULATION OF NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
Site 5, Allegany Ballistics Laboratory

Scenario Timeframe: Current/Future
Medium: Sediment
Exposure Medium: Sediment
Exposure Point: Site 5 Sediment
Receptor Population: Other Recreational Person
Receptor Age: Adolescent

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose (2)	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Ingestion	Arsenic	1.19E+01	mg/kg	1.19E+01	mg/kg	M	1.7E-06	mg/kg-day	3.0E-04	mg/kg-day	N/A	N/A	5.5E-03
	Iron	3.07E+04	mg/kg	3.07E+04	mg/kg	M	4.3E-03	mg/kg-day	3.0E-01	mg/kg-day	N/A	N/A	1.4E-02
	Manganese	1.38E+03	mg/kg	1.38E+03	mg/kg	M	1.9E-04	mg/kg-day	2.0E-02	mg/kg-day	N/A	N/A	9.6E-03
	(Total)												2.9E-02
Dermal	Arsenic	1.19E+01	mg/kg	1.19E+01	mg/kg	M	1.3E-07	mg/kg-day	2.9E-04	mg/kg-day	N/A	N/A	4.5E-04
	Iron	3.07E+04	mg/kg	3.07E+04	mg/kg	M	1.1E-04	mg/kg-day	6.0E-02	mg/kg-day	N/A	N/A	1.8E-03
	Manganese	1.38E+03	mg/kg	1.38E+03	mg/kg	M	4.8E-06	mg/kg-day	7.0E-03	mg/kg-day	N/A	N/A	6.8E-04
	(Total)												2.9E-03
												Total Hazard Index Across All Exposure Routes/Pathways	3.2E-02

(1) Specify Medium-Specific (M) or Route-Specific (R) EPC selected for hazard calculation.
(2) Chronic.

TABLE 7.5.RME

CALCULATION OF NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Site 5, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Alluvial Aquifer-Tap Water
Receptor Population: Resident
Receptor Age: Adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose (2)	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Ingestion	Trichloroethene	1.5E+02	ug/L	1.5E+02	ug/L	M	4.1E-03	mg/kg-day	3.0E-04	mg/kg-day	NA	NA	1.4E+01
	cis-1,2-Dichloroethene	2.4E+01	ug/L	2.4E+01	ug/L	M	6.6E-04	mg/kg-day	1.0E-02	mg/kg-day	NA	NA	6.6E-02
	Aluminum	5.3E+03	ug/L	5.3E+03	ug/L	M	1.4E-01	mg/kg-day	1.0E+00	mg/kg-day	NA	NA	1.4E-01
	Antimony	3.2E+00	ug/L	3.2E+00	ug/L	M	8.8E-05	mg/kg-day	4.0E-04	mg/kg-day	NA	NA	2.2E-01
	Arsenic	3.7E+00	ug/L	3.7E+00	ug/L	M	1.0E-04	mg/kg-day	3.0E-04	mg/kg-day	NA	NA	3.3E-01
	Barium	3.5E+02	ug/L	3.5E+02	ug/L	M	9.5E-03	mg/kg-day	7.0E-02	mg/kg-day	NA	NA	1.4E-01
	Iron	1.4E+04	ug/L	1.4E+04	ug/L	M	3.8E-01	mg/kg-day	3.0E-01	mg/kg-day	NA	NA	1.3E+00
	Manganese	2.8E+03	ug/L	2.8E+03	ug/L	M	7.8E-02	mg/kg-day	2.0E-02	mg/kg-day	NA	NA	3.9E+00
	Nickel	9.2E+01	ug/L	9.2E+01	ug/L	M	2.5E-03	mg/kg-day	2.0E-02	mg/kg-day	NA	NA	1.3E-01
	(Total)												2.0E+01
												Total Hazard Index Across All Exposure Routes/Pathways	2.0E+01

(1) Specify Medium-Specific (M) or Route-Specific (R) EPC selected for hazard calculation.

(2) Chronic.

NA - not applicable.

TABLE 7.6.RME

CALCULATION OF NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Site 5, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Alluvial Aquifer-Tap Water
Receptor Population: Resident
Receptor Age: Child

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose (2)	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Ingestion	Trichloroethene	1.5E+02	ug/L	1.5E+02	ug/L	M	1.1E-02	mg/kg-day	3.0E-04	mg/kg-day	NA	NA	3.7E+01
	cis-1,2-Dichloroethene	2.4E+01	ug/L	2.4E+01	ug/L	M	1.8E-03	mg/kg-day	1.0E-02	mg/kg-day	NA	NA	1.8E-01
	Aluminum	5.3E+03	ug/L	5.3E+03	ug/L	M	3.9E-01	mg/kg-day	1.0E+00	mg/kg-day	NA	NA	3.9E-01
	Antimony	3.2E+00	ug/L	3.2E+00	ug/L	M	2.4E-04	mg/kg-day	4.0E-04	mg/kg-day	NA	NA	6.0E-01
	Arsenic	3.7E+00	ug/L	3.7E+00	ug/L	M	2.7E-04	mg/kg-day	3.0E-04	mg/kg-day	NA	NA	9.1E-01
	Barium	3.5E+02	ug/L	3.5E+02	ug/L	M	2.6E-02	mg/kg-day	7.0E-02	mg/kg-day	NA	NA	3.7E-01
	Iron	1.4E+04	ug/L	1.4E+04	ug/L	M	1.0E+00	mg/kg-day	3.0E-01	mg/kg-day	NA	NA	3.4E+00
	Manganese	2.8E+03	ug/L	2.8E+03	ug/L	M	2.1E-01	mg/kg-day	2.0E-02	mg/kg-day	NA	NA	1.1E+01
	Nickel	9.2E+01	ug/L	9.2E+01	ug/L	M	6.8E-03	mg/kg-day	2.0E-02	mg/kg-day	NA	NA	3.4E-01
	(Total)												5.4E+01
Dermal Absorption	Trichloroethene	1.5E+02	ug/L	1.5E+02	ug/L	M	1.2E-03	mg/kg-day	2.4E-04	mg/kg-day	NA	NA	4.9E+00
	cis-1,2-Dichloroethene	2.4E+01	ug/L	2.4E+01	ug/L	M	9.3E-05	mg/kg-day	1.0E-02	mg/kg-day	NA	NA	9.3E-03
	Aluminum	5.3E+03	ug/L	5.3E+03	ug/L	M	7.2E-04	mg/kg-day	2.7E-01	mg/kg-day	NA	NA	2.7E-03
	Antimony	3.2E+00	ug/L	3.2E+00	ug/L	M	4.4E-07	mg/kg-day	4.0E-05	mg/kg-day	NA	NA	1.1E-02
	Arsenic	3.7E+00	ug/L	3.7E+00	ug/L	M	5.0E-07	mg/kg-day	2.9E-04	mg/kg-day	NA	NA	1.7E-03
	Barium	3.5E+02	ug/L	3.5E+02	ug/L	M	4.8E-05	mg/kg-day	7.0E-02	mg/kg-day	NA	NA	6.8E-04
	Iron	1.4E+04	ug/L	1.4E+04	ug/L	M	1.9E-03	mg/kg-day	6.0E-02	mg/kg-day	NA	NA	3.2E-02
	Manganese	2.8E+03	ug/L	2.8E+03	ug/L	M	3.9E-04	mg/kg-day	7.0E-03	mg/kg-day	NA	NA	5.6E-02
	Nickel	9.2E+01	ug/L	9.2E+01	ug/L	M	1.3E-05	mg/kg-day	2.0E-03	mg/kg-day	NA	NA	6.3E-03
	(Total)												5.0E+00
												Total Hazard Index Across All Exposure Routes/Pathways	5.9E+01

(1) Specify Medium-Specific (M) or Route-Specific (R) EPC selected for hazard calculation.

(2) Chronic.

NA - not applicable.

Table 7.6.RME Supplement
Calculation of DAevent (Child)
Alluvial Aquifer-Tap Water
Site 5, Allegany Ballistics Laboratory

Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Permeability Constant (PC) (cm/hr)	Lag Time (t) (hr)	Duration of Event (ET) (hr)	DAevent (mg/cm^2-event)	t*	B (dimensionless)	Eq
Trichloroethene	1.5E+02	µg/l	1.6E-02	5.5E-01	3.3E-01	2.8E-06	1.3E+00	2.6E-02	2
cis-1,2-Dichloroethene	2.4E+01	µg/l	1.0E-02	3.4E-01	3.3E-01	2.2E-07	8.2E-01	7.2E-03	2
Aluminum	5.3E+03	µg/l	1.0E-03	NA	3.3E-01	1.7E-06	NA	NA	1
Antimony	3.2E+00	µg/l	1.0E-03	NA	3.3E-01	1.1E-09	NA	NA	1
Arsenic	3.7E+00	µg/l	1.0E-03	NA	3.3E-01	1.2E-09	NA	NA	1
Barium	3.5E+02	µg/l	1.0E-03	NA	3.3E-01	1.1E-07	NA	NA	1
Iron	1.4E+04	µg/l	1.0E-03	NA	3.3E-01	4.6E-06	NA	NA	1
Manganese	2.8E+03	µg/l	1.0E-03	NA	3.3E-01	9.4E-07	NA	NA	1
Nickel	9.2E+01	µg/l	1.0E-03	NA	3.3E-01	3.0E-08	NA	NA	1

Inorganics: DAevent (mg/cm2-event) =
PC x CW x ET x CF1 x CF2 (eq 1)

Organics: DAevent (mg/cm2-event) =

ET<t*: DAevent (mg/cm2-event) =
2 x PC x CW x (sqrt((6 x t x ET)/3.1415))
x CF1 x CF2 (eq 2)

ET>t*: DAevent (mg/cm2-event) =
PC x CW x (ET/(1+B) + 2 x t x ((1 + 3xB)/(1+B))
x CF1 x CF2 (eq 3)

Permeability constants from EPA 1992, Dermal Exposure Assessment: Principals and Applications.
ORD, EPA/600/8-91/001B. Default value of 0.001 cm/hour used for inorganics without published values.
NA - not applicable, DAevent for organics calculated using values calculated on Table 7.30b RME Supplement.

TABLE 7.7.RME

CALCULATION OF NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Site 5, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Alluvial Aquifer-Water in Excavation Pit
Receptor Population: Construction Worker
Receptor Age: Adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose (2)	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Dermal Absorption	Trichloroethene	1.5E+02	ug/L	1.5E+02	ug/L	M	1.3E-03	mg/kg-day	2.4E-04	mg/kg-day	NA	NA	5.3E+00
	cis-1,2-Dichloroethene	2.4E+01	ug/L	2.4E+01	ug/L	M	1.2E-04	mg/kg-day	1.0E-01	mg/kg-day	NA	NA	1.2E-03
	Aluminum	5.3E+03	ug/L	5.3E+03	ug/L	M	2.5E-03	mg/kg-day	2.7E-01	mg/kg-day	NA	NA	9.1E-03
	Antimony	3.2E+00	ug/L	3.2E+00	ug/L	M	1.5E-06	mg/kg-day	4.0E-05	mg/kg-day	NA	NA	3.8E-02
	Arsenic	3.7E+00	ug/L	3.7E+00	ug/L	M	1.7E-06	mg/kg-day	2.9E-04	mg/kg-day	NA	NA	6.0E-03
	Barium	3.5E+02	ug/L	3.5E+02	ug/L	M	1.6E-04	mg/kg-day	7.0E-02	mg/kg-day	NA	NA	2.3E-03
	Iron	1.4E+04	ug/L	1.4E+04	ug/L	M	6.5E-03	mg/kg-day	6.0E-02	mg/kg-day	NA	NA	1.1E-01
	Manganese	2.8E+03	ug/L	2.8E+03	ug/L	M	1.3E-03	mg/kg-day	7.0E-03	mg/kg-day	NA	NA	1.9E-01
	Nickel	9.2E+01	ug/L	9.2E+01	ug/L	M	4.3E-05	mg/kg-day	2.0E-03	mg/kg-day	NA	NA	2.2E-02
	(Total)												5.6E+00
												Total Hazard Index Across All Exposure Routes/Pathways	5.6E+00

(1) Specify Medium-Specific (M) or Route-Specific (R) EPC selected for hazard calculation.

(2) Subchronic values. Chronic used if Subchronic is NA.

NA - not applicable.

Table 7.7.RME Supplement
Calculation of DAevent
Alluvial Aquifer-Water in Excavation Pit
Site 5, Allegany Ballistics Laboratory

Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Permeability Constant (PC) (cm/hr)	Lag Time (t) (hr)	Duration of Event (ET) (hr)	DAevent mg/cm^2-event	t*	B (dimensionless)	Eq
Trichloroethene	1.5E+02	µg/l	1.6E-02	5.5E-01	8.0E+00	2.1E-05	1.3E+00	2.6E-02	3
cis-1,2-Dichloroethene	2.4E+01	µg/l	1.0E-02	3.4E-01	8.0E+00	2.1E-06	8.2E-01	7.2E-03	3
Aluminum	5.3E+03	µg/l	1.0E-03	NA	8.0E+00	4.2E-05	NA	NA	1
Antimony	3.2E+00	µg/l	1.0E-03	NA	8.0E+00	2.6E-08	NA	NA	1
Arsenic	3.7E+00	µg/l	1.0E-03	NA	8.0E+00	2.9E-08	NA	NA	1
Barium	3.5E+02	µg/l	1.0E-03	NA	8.0E+00	2.8E-06	NA	NA	1
Iron	1.4E+04	µg/l	1.0E-03	NA	8.0E+00	1.1E-04	NA	NA	1
Manganese	2.8E+03	µg/l	1.0E-03	NA	8.0E+00	2.3E-05	NA	NA	1
Nickel	9.2E+01	µg/l	1.0E-03	NA	8.0E+00	7.3E-07	NA	NA	1

Inorganics: DAevent (mg/cm2-event) =
PC x CW x ET x CF1 x CF2 (eq 1)

Organics: DAevent (mg/cm2-event) =

ET<t*: DAevent (mg/cm2-event) =
2 x PC x CW x (sqrt((6 x t x ET)/3.1415))
x CF1 x CF2 (eq 2)

ET>t*: DAevent (mg/cm2-event) =
PC x CW x (ET/(1+B) + 2 x t x ((1 + 3xB)/(1+B))
x CF1 x CF2 (eq 3)

Permeability constants from EPA 1992, Dermal Exposure Assessment: Principals and Applications.
ORD, EPA/600/8-91/001B. Default value of 0.001 cm/hour used for inorganics without published values.
NA - not applicable, DAevent for organics calculated using values calculated on Table 7.31b RME Supplement.

TABLE 7.8.RME
CALCULATION OF NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
Site 5, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Air
Exposure Point: Alluvial Aquifer-Water Vapors at Showerhead
Receptor Population: Resident
Receptor Age: Adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose (2)	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Inhalation	Trichloroethene	1.5E+02	µg/l	8.2E-03	mg/kg/shower	R	7.8E-03	mg/kg-day	1.0E-02	mg/kg-day	3.5E-02	mg/m^3	7.8E-01
	cis-1,2-Dichloroethene	2.4E+01	µg/l	1.4E-03	mg/kg/shower	R	1.4E-03	mg/kg-day	NA	mg/kg-day	NA	mg/m^3	NA
	(Total)												7.8E-01
												Total Hazard Index Across All Exposure Routes/Pathways	7.8E-01

(1) Specify Medium-Specific (M) or Route-Specific (R) EPC selected for hazard calculation.
(2) Chronic.
NV - Non-volatiles

Table 7.8.RME Supplement
Inhalation Exposure Concentrations from Foster and Chrostowski Shower Model (Alluvial Aquifer)
Site 5, Allegany Ballistics Laboratory

Chemical	Exposure Point Concentration Cwo (mg/l)	Molecular weight (HH) (g/mole)	Henry's Law Constant (H) (atm-m^3/mole)	Kg (VOC) (cm/hr)	Kl(VOC) (cm/hr)	KL (cm/hr)	Kal (cm/hr)	Cwd (mg/l)	S (mg/m^3 - min)	Calculated Inhalation Exposure (Einh) (mg/kg/shower)
Trichloroethene	1.5E+02	1.3E+02	1.1E-02	1.1E+03	1.2E+01	1.1E+01	1.5E+01	6.0E+01	4.0E+02	**8.2E-03**
cis-1,2,-Dichloroethene	2.4E+01	9.7E+01	5.0E-03	1.3E+03	1.3E+01	1.3E+01	1.7E+01	1.1E+01	7.0E+01	**1.4E-03**

Variables	Units	Exposure Assumptions
Kg(VOC) = gas-film mass transfer coefficient	cm/hr	Solved by Eq 1
Kl(VOC) = liquid-film mass transfer coefficient	cm/hr	Solved by Eq 2
KL = overall mass transfer coefficient	cm/hr	Solved by Eq 3
Kal = adjusted overall mass transfer coeff.	cm/hr	Solved by Eq 4
Tl = Calibration temp. of water	K (20C +273)	2.9E+02
Ts = Shower water temperature	k (45C)	3.2E+02
Us = water viscosity at Ts	centipoise	6.0E-01
Ul = water viscosity at Tl	cp	1.0E+00
Cwd = conc. leaving droplets after time sdt	ug/l	Solved by Eq 5
sdt = shower droplet drop time	sec	2.0E+00
d = shower droplet diameter	mm	1.0E+00
FR = shower water flow rate	l/min	2.0E+01
SV = shower room air volume	m^3	3.0E+00
S = indoor VOC generation rate	ug/m^3-min	Solved by Eq 6
VR = ventilation rate	l/min	1.4E+01
BW = body weight	kg	7.0E+01
Ds = duration of shower	min	1.2E+01
Dt = total duration in shower room	min	1.5E+01
R = air exchange rate	min^{-1}	8.3E-03
Ca = indoor air concentration of VOCs	ug/m^3	Solved by Eq 7
Einh = inhalation exposure per shower	mg/kg/shower	Solved by Eq 8

Equation 1:	Kg(VOC) =	$3000 * (18 / HH)^{0.5}$	
Equation 2:	Kl(VOC) =	$20 * (44 / HH)^{0.5}$	
Equation 3:	KL =	$((1 / Kl(VOC)) + (0.024 / (Kg (VOC) * H)))^{-1}$	
Equation 4:	Kal =	$(KL * (((Tl * Us) / (Ts * Ul))^{0.5}))$	
Equation 5:	Cwd =	(Cwo * (1-EXP((-1 * Kal * sdt)/(60 * d))))	
Equation 6:	S =	(Cwd * FR / SV)	
Equation 7:	see time series example on Table I-GW-5		
Equation 8:	**Einh =**	**If t>Ds**	(((VR * S) / (BW * R * 1000000)) * ((Ds + (EXP(-R * Dt) / R)-(EXP(R * (Ds - Dt))) / R)))

Henry's Law Constant from USEPA's *Superfund Public Health Evaluation Manual.* USEPA/540/1-86/060, October 1986.

TABLE 7.9.RME
CALCULATION OF NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
Site 5, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Air
Exposure Point: Alluvial Aquifer-Volatilization from Water in Excavation Pit
Receptor Population: Construction Worker
Receptor Age: Adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose (2)	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Inhalation	Trichloroethene	1.5E+02	µg/l	1.3E-03	mg/m^3	R	3.5E-04	mg/kg-day	1.0E-02	mg/kg-day	3.5E-02	mg/m^3	3.5E-02
	cis-1,2-Dichloroethene	2.4E+01	µg/l	2.3E-04	mg/m^3	R	6.0E-05	mg/kg-day	NA	mg/kg-day	NA	mg/m^3	NA
	(Total)												3.5E-02
												Total Hazard Index Across All Exposure Routes/Pathways	3.5E-02

(1) Specify Medium-Specific (M) or Route-Specific (R) EPC selected for hazard calculation.

(2) Subchronic values. Chronic used if Subchronic is NA.

NV - Non-volatiles

Table 7.9.RME Supplement
Inhalation of Volatiles from Groundwater During Construction
Inhalation Exposure Concentrations Calculated Using a Two-Film Volatilization Model
Future Construction Worker Senario
Site 5, Allegany Ballistics Laboratory

Chemical	Cw (µg/L)	MW (mol/gram)	K_H (unitless)	k_l (cm/hr)	k_g (cm/hr)	K_v (cm/hr)	ER (mg/hr)	ERa (g/sec-m^2)	Ca (mg/m^3)
Trichloroethene	1.50E+02	1.3E+02	4.2E-01	3.1E+00	1.9E+03	3.1E+00	4.6E+02	4.8E-08	1.3E-03
cis-1,2,-Dichloroethene	2.40E+01	9.7E+01	1.7E-01	3.3E+00	2.0E+03	3.3E+00	7.9E+01	8.2E-09	2.3E-04

Equations

Equation 1 $Kv = 1/(1/k_l + 1/K_H{*}K_g)$

Equation 2 $k_g = 700(18/MW)^{1/4}V$

Equation 3 $k_l = (32/MW)^{1/4}Ka'$

Equation 4 ER = Kv * Cw * L/1000 cm^3 * mg/1000 µg

Equation 5 ERa = ER * g/1000 mg * hr/60 min * min/60 sec * 1/A

Variables	Units	Exposure Assumptions
Cw = groundwater concentration	(µg/L)	chem-specific
MW = molecular weight	(mol/gram)	chem-specific
K_H - Henry's Law Constant	(unitless)	chem-specific
Kv = volatilization rate	(cm/hr)	Solved by Eq 1
k_g = gas phase transfer coefficient	(cm/hr)	Solved by Eq 2
k_l = liquid phase transfer coefficient	(cm/hr)	Solved by Eq 3
V = wind speed	(m/s)	4.4E+00
Ka' = aeration rate	(cm/hr)	6.3E-02
ER = emission rate	(mg/hr)	Solved by Eq 4
A = area of excavation (utility ditch)	(m^2)	2.7E+03
Era = area emission rate	(g/sec-m^2)	Solved by Eq 5
Ca = air concentration	(mg/m^3)	Solved using SCREEN3 model

Note: aeration rate based on aeration rate for small pond (0.1/day) multiplied by depth of water in excavation (1/2 ft)

TABLE 7.10.RME

CALCULATION OF NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Site 5, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Bedrock Aquifer-Tap Water
Receptor Population: Resident
Receptor Age: Adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose (2)	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Ingestion	Trichloroethene	8.6E+00	ug/L	8.6E+00	ug/L	M	2.3E-04	mg/kg-day	3.0E-04	mg/kg-day	NA	NA	7.8E-01
	Cadmium	1.8E+00	ug/L	1.8E+00	ug/L	M	5.0E-05	mg/kg-day	5.0E-04	mg/kg-day	NA	NA	1.0E-01
	Iron	7.2E+04	ug/L	7.2E+04	ug/L	M	2.0E+00	mg/kg-day	3.0E-01	mg/kg-day	NA	NA	6.5E+00
	Manganese	1.5E+03	ug/L	1.5E+03	ug/L	M	4.0E-02	mg/kg-day	2.0E-02	mg/kg-day	NA	NA	2.0E+00
	Nickel	6.5E+01	ug/L	6.5E+01	ug/L	M	1.8E-03	mg/kg-day	2.0E-02	mg/kg-day	NA	NA	8.9E-02
	(Total)												9.5E+00
												Total Hazard Index Across All Exposure Routes/Pathways	9.5E+00

(1) Specify Medium-Specific (M) or Route-Specific (R) EPC selected for hazard calculation.

(2) Chronic.

NA - not applicable.

TABLE 7.11.RME

CALCULATION OF NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURE

Site 5, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Bedrock Aquifer-Tap Water
Receptor Population: Resident
Receptor Age: Child

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose (2)	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Ingestion	Trichloroethene	8.6E+00	ug/L	8.6E+00	ug/L	M	6.4E-04	mg/kg-day	3.0E-04	mg/kg-day	NA	NA	2.1E+00
	Cadmium	1.8E+00	ug/L	1.8E+00	ug/L	M	1.4E-04	mg/kg-day	5.0E-04	mg/kg-day	NA	NA	2.7E-01
	Iron	7.2E+04	ug/L	7.2E+04	ug/L	M	5.3E+00	mg/kg-day	3.0E-01	mg/kg-day	NA	NA	1.8E+01
	Manganese	1.5E+03	ug/L	1.5E+03	ug/L	M	1.1E-01	mg/kg-day	2.0E-02	mg/kg-day	NA	NA	5.4E+00
	Nickel	6.5E+01	ug/L	6.5E+01	ug/L	M	4.9E-03	mg/kg-day	2.0E-02	mg/kg-day	NA	NA	2.4E-01
	(Total)												2.6E+01
Dermal Absorption	Trichloroethene	8.6E+00	ug/L	8.6E+00	ug/L	M	6.7E-05	mg/kg-day	2.4E-04	mg/kg-day	NA	NA	2.8E-01
	Cadmium	1.8E+00	ug/L	1.8E+00	ug/L	M	2.5E-07	mg/kg-day	2.5E-05	mg/kg-day	NA	NA	1.0E-02
	Iron	7.2E+04	ug/L	7.2E+04	ug/L	M	9.8E-03	mg/kg-day	6.0E-02	mg/kg-day	NA	NA	1.6E-01
	Manganese	1.5E+03	ug/L	1.5E+03	ug/L	M	2.0E-04	mg/kg-day	7.0E-03	mg/kg-day	NA	NA	2.9E-02
	Nickel	6.5E+01	ug/L	6.5E+01	ug/L	M	9.0E-06	mg/kg-day	2.0E-03	mg/kg-day	NA	NA	4.5E-03
	(Total)												4.9E-01
												Total Hazard Index Across All Exposure Routes/Pathways	2.6E+01

(1) Specify Medium-Specific (M) or Route-Specific (R) EPC selected for hazard calculation.

(2) Chronic.

NA - not applicable.

Table 7.11.RME Supplement
Calculation of DAevent (Child)
Bedrock Aquifer-Tap Water
Site 5, Allegany Ballistics Laboratory

Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Permeability Constant (PC) (cm/hr)	Lag Time (t) (hr)	Duration of Event (ET) (hr)	DAevent (mg/cm^2-event)	t*	B (dimensionless)	Eq
Trichloroethene	8.6E+00	µg/l	1.6E-02	5.5E-01	3.3E-01	1.6E-07	1.3E+00	2.6E-02	2
Cadmium	1.8E+00	µg/l	1.0E-03	NA	3.3E-01	6.0E-10	NA	NA	1
Iron	7.2E+04	µg/l	1.0E-03	NA	3.3E-01	2.4E-05	NA	NA	1
Manganese	1.5E+03	µg/l	1.0E-03	NA	3.3E-01	4.8E-07	NA	NA	1
Nickel	6.5E+01	µg/l	1.0E-03	NA	3.3E-01	2.1E-08	NA	NA	1

Inorganics: DAevent (mg/cm2-event) =
PC x CW x ET x CF1 x CF2 (eq 1)

Organics: DAevent (mg/cm2-event) =

ET<t*: DAevent (mg/cm2-event) =
2 x PC x CW x (sqrt((6 x t x ET)/3.1415))
x CF1 x CF2 (eq 2)

ET>t*: DAevent (mg/cm2-event) =
PC x CW x (ET/(1+B) + 2 x t x ((1 + 3xB)/(1+B))
x CF1 x CF2 (eq 3)

Permeability constants from EPA 1992, Dermal Exposure Assessment: Principals and Applications.
ORD, EPA/600/8-91/001B. Default value of 0.001 cm/hour used for inorganics without published values.
NA - not applicable, DAevent for organics calculated using values calculated on Table 7.30b RME Supplement.

TABLE 7.12.RME
CALCULATION OF NON-CANCER HAZARDS
REASONABLE MAXIMUM EXPOSURE
Site 5, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Air
Exposure Point: Bedrock Aquifer-Water Vapors at Showerhead
Receptor Population: Resident
Receptor Age: Adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose (2)	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Inhalation	Trichloroethene	8.6E+00	µg/l	4.7E-04	mg/kg/shower	R	4.5E-04	mg/kg-day	1.0E-02	mg/kg-day	3.5E-02	mg/m^3	4.5E-02
	(Total)												4.5E-02
												Total Hazard Index Across All Exposure Routes/Pathways	4.5E-02

(1) Specify Medium-Specific (M) or Route-Specific (R) EPC selected for hazard calculation.
(2) Chronic.
NV - Non-volatiles

Table 7.12.RME Supplement
Inhalation Exposure Concentrations from Foster and Chrostowski Shower Model (Bedrock Aquifer)
Site 5, Allegany Ballistics Laboratory

Chemical	Exposure Point Concentration Cwo (mg/l)	Molecular weight (HH) (g/mole)	Henry's Law Constant (H) (atm-m^3/mole)	Kg (VOC) (cm/hr)	Kl(VOC) (cm/hr)	KL (cm/hr)	Kal (cm/hr)	Cwd (mg/l)	S (mg/m^3 - min)	Calculated Inhalation Exposure (Einh) (mg/kg/shower)
Trichloroethene	8.6E+00	1.3E+02	1.1E-02	1.1E+03	1.2E+01	1.1E+01	1.5E+01	3.4E+00	2.3E+01	**4.7E-04**

Variables	Units	Exposure Assumptions
Kg(VOC) = gas-film mass transfer coefficient	cm/hr	Solved by Eq 1
Kl(VOC) = liquid-film mass transfer coefficient	cm/hr	Solved by Eq 2
KL = overall mass transfer coefficient	cm/hr	Solved by Eq 3
Kal = adjusted overall mass transfer coeff.	cm/hr	Solved by Eq 4
Tl = Calibration temp. of water	K (20C +273)	2.9E+02
Ts = Shower water temperature	k (45C)	3.2E+02
Us = water viscosity at Ts	centipoise	6.0E-01
Ul = water viscosity at Tl	cp	1.0E+00
Cwd = conc. leaving droplets after time sdt	ug/l	Solved by Eq 5
sdt = shower droplet drop time	sec	2.0E+00
d = shower droplet diameter	mm	1.0E+00
FR = shower water flow rate	l/min	2.0E+01
SV = shower room air volume	m^3	3.0E+00
S = indoor VOC generation rate	ug/m^3-min	Solved by Eq 6
VR = ventilation rate	l/min	1.4E+01
BW = body weight	kg	7.0E+01
Ds = duration of shower	min	1.2E+01
Dt = total duration in shower room	min	1.5E+01
R = air exchange rate	min^{-1}	8.3E-03
Ca = indoor air concentration of VOCs	ug/m^3	Solved by Eq 7
Einh = inhalation exposure per shower	mg/kg/shower	Solved by Eq 8

Equation 1:	Kg(VOC) =	3000 * (18 / HH)$^{0.5}$	
Equation 2:	Kl(VOC) =	20 * (44 / HH)$^{0.5}$	
Equation 3:	KL =	((1 / Kl(VOC)) + (0.024 / (Kg (VOC) * H)))$^{-1}$	
Equation 4:	Kal =	(KL * (((Tl * Us) / (Ts * Ul))$^{0.5}$))	
Equation 5:	Cwd =	(Cwo * (1-EXP((-1 * Kal * sdt)/(60 * d))))	
Equation 6:	S =	(Cwd * FR / SV)	
Equation 7:	see time series example on Table I-GW-5		
Equation 8:	**Einh =**	**If t>Ds**	(((VR * S) / (BW * R * 1000000)) * ((Ds + (EXP(-R * Dt) / R)-(EXP(R * (Ds - Dt))) / R)))

Henry's Law Constant from USEPA's *Superfund Public Health Evaluation Manual.* USEPA/540/1-86/060, October 1986.

TABLE 7.13.CT

CALCULATION OF NON-CANCER HAZARDS

CENTRAL TENDENCY

Site 5, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Alluvial Aquifer-Tap Water
Receptor Population: Resident
Receptor Age: Adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose (2)	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Ingestion	Trichloroethene	1.5E+02	ug/L	1.5E+02	ug/L	M	2.5E-04	mg/kg-day	3.0E-04	mg/kg-day	NA	NA	8.2E-01
	cis-1,2-Dichloroethene	2.4E+01	ug/L	2.4E+01	ug/L	M	4.0E-05	mg/kg-day	1.0E-02	mg/kg-day	NA	NA	4.0E-03
	Aluminum	5.3E+03	ug/L	5.3E+03	ug/L	M	8.7E-03	mg/kg-day	1.0E+00	mg/kg-day	NA	NA	8.7E-03
	Antimony	3.2E+00	ug/L	3.2E+00	ug/L	M	5.3E-06	mg/kg-day	4.0E-04	mg/kg-day	NA	NA	1.3E-02
	Arsenic	3.7E+00	ug/L	3.7E+00	ug/L	M	6.0E-06	mg/kg-day	3.0E-04	mg/kg-day	NA	NA	2.0E-02
	Barium	3.5E+02	ug/L	3.5E+02	ug/L	M	5.7E-04	mg/kg-day	7.0E-02	mg/kg-day	NA	NA	8.2E-03
	Iron	1.4E+04	ug/L	1.4E+04	ug/L	M	2.3E-02	mg/kg-day	3.0E-01	mg/kg-day	NA	NA	7.6E-02
	Manganese	2.8E+03	ug/L	2.8E+03	ug/L	M	4.7E-03	mg/kg-day	2.0E-02	mg/kg-day	NA	NA	2.3E-01
	Nickel	9.2E+01	ug/L	9.2E+01	ug/L	M	1.5E-04	mg/kg-day	2.0E-02	mg/kg-day	NA	NA	7.6E-03
	(Total)												1.2E+00
												Total Hazard Index Across All Exposure Routes/Pathways	1.2E+00

(1) Specify Medium-Specific (M) or Route-Specific (R) EPC selected for hazard calculation.

(2) Chronic.

NA - not applicable.

TABLE 7.14.CT

CALCULATION OF NON-CANCER HAZARDS

CENTRAL TENDENCY

Site 5, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Alluvial Aquifer-Tap Water
Receptor Population: Resident
Receptor Age: Child

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose (2)	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Ingestion	Trichloroethene	1.5E+02	ug/L	1.5E+02	ug/L	M	4.3E-03	mg/kg-day	3.0E-04	mg/kg-day	NA	NA	1.4E+01
	cis-1,2-Dichloroethene	2.4E+01	ug/L	2.4E+01	ug/L	M	6.9E-04	mg/kg-day	1.0E-02	mg/kg-day	NA	NA	6.9E-02
	Aluminum	5.3E+03	ug/L	5.3E+03	ug/L	M	1.5E-01	mg/kg-day	1.0E+00	mg/kg-day	NA	NA	1.5E-01
	Antimony	3.2E+00	ug/L	3.2E+00	ug/L	M	9.2E-05	mg/kg-day	4.0E-04	mg/kg-day	NA	NA	2.3E-01
	Arsenic	3.7E+00	ug/L	3.7E+00	ug/L	M	1.0E-04	mg/kg-day	3.0E-04	mg/kg-day	NA	NA	3.5E-01
	Barium	3.5E+02	ug/L	3.5E+02	ug/L	M	9.9E-03	mg/kg-day	7.0E-02	mg/kg-day	NA	NA	1.4E-01
	Iron	1.4E+04	ug/L	1.4E+04	ug/L	M	3.9E-01	mg/kg-day	3.0E-01	mg/kg-day	NA	NA	1.3E+00
	Manganese	2.8E+03	ug/L	2.8E+03	ug/L	M	8.1E-02	mg/kg-day	2.0E-02	mg/kg-day	NA	NA	4.1E+00
	Nickel	9.2E+01	ug/L	9.2E+01	ug/L	M	2.6E-03	mg/kg-day	2.0E-02	mg/kg-day	NA	NA	1.3E-01
	(Total)												2.1E+01
Dermal Absorption	Trichloroethene	1.5E+02	ug/L	1.5E+02	ug/L	M	5.7E-04	mg/kg-day	2.4E-04	mg/kg-day	NA	NA	2.4E+00
	cis-1,2-Dichloroethene	2.4E+01	ug/L	2.4E+01	ug/L	M	4.4E-05	mg/kg-day	1.0E-02	mg/kg-day	NA	NA	4.4E-03
	Aluminum	5.3E+03	ug/L	5.3E+03	ug/L	M	2.5E-04	mg/kg-day	2.7E-01	mg/kg-day	NA	NA	9.2E-04
	Antimony	3.2E+00	ug/L	3.2E+00	ug/L	M	1.5E-07	mg/kg-day	4.0E-05	mg/kg-day	NA	NA	3.8E-03
	Arsenic	3.7E+00	ug/L	3.7E+00	ug/L	M	1.7E-07	mg/kg-day	2.9E-04	mg/kg-day	NA	NA	6.0E-04
	Barium	3.5E+02	ug/L	3.5E+02	ug/L	M	1.6E-05	mg/kg-day	7.0E-02	mg/kg-day	NA	NA	2.4E-04
	Iron	1.4E+04	ug/L	1.4E+04	ug/L	M	6.5E-04	mg/kg-day	6.0E-02	mg/kg-day	NA	NA	1.1E-02
	Manganese	2.8E+03	ug/L	2.8E+03	ug/L	M	1.3E-04	mg/kg-day	7.0E-03	mg/kg-day	NA	NA	1.9E-02
	Nickel	9.2E+01	ug/L	9.2E+01	ug/L	M	4.3E-06	mg/kg-day	2.0E-03	mg/kg-day	NA	NA	2.2E-03
	(Total)												2.4E+00
												Total Hazard Index Across All Exposure Routes/Pathways	2.3E+01

(1) Specify Medium-Specific (M) or Route-Specific (R) EPC selected for hazard calculation.

(2) Chronic.

NA - not applicable.

Table 7.14.CT Supplement
Calculation of DAevent (Child)
Alluvial Aquifer-Tap Water
Site 5, Allegany Ballistics Laboratory

Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Permeability Constant (PC) (cm/hr)	Lag Time (t) (hr)	Duration of Event (ET) (hr)	DAevent (mg/cm^2-event)	t*	B (dimensionless)	Eq
Trichloroethene	1.5E+02	µg/l	1.6E-02	5.5E-01	1.7E-01	2.0E-06	1.3E+00	2.6E-02	2
cis-1,2-Dichloroethene	2.4E+01	µg/l	1.0E-02	3.4E-01	1.7E-01	1.6E-07	8.2E-01	7.2E-03	2
Aluminum	5.3E+03	µg/l	1.0E-03	NA	1.7E-01	8.9E-07	NA	NA	1
Antimony	3.2E+00	µg/l	1.0E-03	NA	1.7E-01	5.5E-10	NA	NA	1
Arsenic	3.7E+00	µg/l	1.0E-03	NA	1.7E-01	6.2E-10	NA	NA	1
Barium	3.5E+02	µg/l	1.0E-03	NA	1.7E-01	5.9E-08	NA	NA	1
Iron	1.4E+04	µg/l	1.0E-03	NA	1.7E-01	2.3E-06	NA	NA	1
Manganese	2.8E+03	µg/l	1.0E-03	NA	1.7E-01	4.8E-07	NA	NA	1
Nickel	9.2E+01	µg/l	1.0E-03	NA	1.7E-01	1.6E-08	NA	NA	1

Inorganics: DAevent (mg/cm2-event) =
PC x CW x ET x CF1 x CF2 (eq 1)

Organics: DAevent (mg/cm2-event) =

ET<t*: DAevent (mg/cm2-event) =
2 x PC x CW x (sqrt((6 x t x ET)/3.1415))
x CF1 x CF2 (eq 2)

ET>t*: DAevent (mg/cm2-event) =
PC x CW x (ET/(1+B) + 2 x t x ((1 + 3xB)/(1+B))
x CF1 x CF2 (eq 3)

Permeability constants from EPA 1992, Dermal Exposure Assessment: Principals and Applications.
ORD, EPA/600/8-91/001B. Default value of 0.001 cm/hour used for inorganics without published values.
NA - not applicable, DAevent for organics calculated using values calculated on Table 7.30b RME Supplement.

TABLE 7.15.CT

CALCULATION OF NON-CANCER HAZARDS

CENTRAL TENDENCY

Site 5, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Alluvial Aquifer-Water in Excavation Pit
Receptor Population: Construction Worker
Receptor Age: Adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose (2)	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Dermal Absorption	Trichloroethene	1.5E+02	ug/L	1.5E+02	ug/L	M	9.4E-04	mg/kg-day	2.4E-04	mg/kg-day	NA	NA	3.9E+00
	cis-1,2-Dichloroethene	2.4E+01	ug/L	2.4E+01	ug/L	M	9.1E-05	mg/kg-day	1.0E-01	mg/kg-day	NA	NA	9.1E-04
	Aluminum	5.3E+03	ug/L	5.3E+03	ug/L	M	1.8E-03	mg/kg-day	2.7E-01	mg/kg-day	NA	NA	6.8E-03
	Antimony	3.2E+00	ug/L	3.2E+00	ug/L	M	1.1E-06	mg/kg-day	4.0E-05	mg/kg-day	NA	NA	2.8E-02
	Arsenic	3.7E+00	ug/L	3.7E+00	ug/L	M	1.3E-06	mg/kg-day	2.9E-04	mg/kg-day	NA	NA	4.5E-03
	Barium	3.5E+02	ug/L	3.5E+02	ug/L	M	1.2E-04	mg/kg-day	7.0E-02	mg/kg-day	NA	NA	1.7E-03
	Iron	1.4E+04	ug/L	1.4E+04	ug/L	M	4.8E-03	mg/kg-day	6.0E-02	mg/kg-day	NA	NA	8.0E-02
	Manganese	2.8E+03	ug/L	2.8E+03	ug/L	M	9.9E-04	mg/kg-day	7.0E-03	mg/kg-day	NA	NA	1.4E-01
	Nickel	9.2E+01	ug/L	9.2E+01	ug/L	M	3.2E-05	mg/kg-day	2.0E-03	mg/kg-day	NA	NA	1.6E-02
	(Total)												4.2E+00
												Total Hazard Index Across All Exposure Routes/Pathways	4.2E+00

(1) Specify Medium-Specific (M) or Route-Specific (R) EPC selected for hazard calculation.

(2) Subchronic values. Chronic used if Subchronic is NA.

NA - not applicable.

Table 7.15.CT Supplement
Calculation of DAevent
Alluvial Aquifer-Water in Excavation Pit
Site 5, Allegany Ballistics Laboratory

Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Permeability Constant (PC) (cm/hr)	Lag Time (t) (hr)	Duration of Event (ET) (hr)	DAevent (mg/cm^2-event)	t*	B (dimensionless)	Eq
Trichloroethene	1.5E+02	µg/l	1.6E-02	5.5E-01	8.0E+00	2.1E-05	1.3E+00	2.6E-02	3
cis-1,2-Dichloroethene	2.4E+01	µg/l	1.0E-02	3.4E-01	8.0E+00	2.1E-06	8.2E-01	7.2E-03	3
Aluminum	5.3E+03	µg/l	1.0E-03	NA	8.0E+00	4.2E-05	NA	NA	1
Antimony	3.2E+00	µg/l	1.0E-03	NA	8.0E+00	2.6E-08	NA	NA	1
Arsenic	3.7E+00	µg/l	1.0E-03	NA	8.0E+00	2.9E-08	NA	NA	1
Barium	3.5E+02	µg/l	1.0E-03	NA	8.0E+00	2.8E-06	NA	NA	1
Iron	1.4E+04	µg/l	1.0E-03	NA	8.0E+00	1.1E-04	NA	NA	1
Manganese	2.8E+03	µg/l	1.0E-03	NA	8.0E+00	2.3E-05	NA	NA	1
Nickel	9.2E+01	µg/l	1.0E-03	NA	8.0E+00	7.3E-07	NA	NA	1

Inorganics: DAevent (mg/cm2-event) =
PC x CW x ET x CF1 x CF2 (eq 1)

Organics: DAevent (mg/cm2-event) =

ET<t*: DAevent (mg/cm2-event) =
2 x PC x CW x (sqrt((6 x t x ET)/3.1415))
x CF1 x CF2 (eq 2)

ET>t*: DAevent (mg/cm2-event) =
PC x CW x (ET/(1+B) + 2 x t x ((1 + 3xB)/(1+B))
x CF1 x CF2 (eq 3)

Permeability constants from EPA 1992, Dermal Exposure Assessment: Principals and Applications.
ORD, EPA/600/8-91/001B. Default value of 0.001 cm/hour used for inorganics without published values.
NA - not applicable, DAevent for organics calculated using values calculated on Table 7.31b RME Supplement.

TABLE 7.16.CT

CALCULATION OF NON-CANCER HAZARDS

CENTRAL TENDENCY

Site 5, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Bedrock Aquifer-Tap Water
Receptor Population: Resident
Receptor Age: Adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose (2)	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Ingestion	Trichloroethene	8.6E+00	ug/L	8.6E+00	ug/L	M	1.1E-04	mg/kg-day	3.0E-04	mg/kg-day	NA	NA	3.7E-01
	Cadmium	1.8E+00	ug/L	1.8E+00	ug/L	M	2.3E-05	mg/kg-day	5.0E-04	mg/kg-day	NA	NA	4.7E-02
	Iron	7.2E+04	ug/L	7.2E+04	ug/L	M	9.2E-01	mg/kg-day	3.0E-01	mg/kg-day	NA	NA	3.1E+00
	Manganese	1.5E+03	ug/L	1.5E+03	ug/L	M	1.9E-02	mg/kg-day	2.0E-02	mg/kg-day	NA	NA	9.3E-01
	Nickel	6.5E+01	ug/L	6.5E+01	ug/L	M	8.4E-04	mg/kg-day	2.0E-02	mg/kg-day	NA	NA	4.2E-02
	(Total)												4.4E+00
												Total Hazard Index Across All Exposure Routes/Pathways	4.4E+00

(1) Specify Medium-Specific (M) or Route-Specific (R) EPC selected for hazard calculation.

(2) Chronic.

NA - not applicable.

TABLE 7.17.CT

CALCULATION OF NON-CANCER HAZARDS

CENTRAL TENDENCY

Site 5, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Bedrock Aquifer-Tap Water
Receptor Population: Resident
Receptor Age: Child

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose (2)	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Ingestion	Trichloroethene	8.6E+00	ug/L	8.6E+00	ug/L	M	2.5E-04	mg/kg-day	3.0E-04	mg/kg-day	NA	NA	8.2E-01
	Cadmium	1.8E+00	ug/L	1.8E+00	ug/L	M	5.2E-05	mg/kg-day	5.0E-04	mg/kg-day	NA	NA	1.0E-01
	Iron	7.2E+04	ug/L	7.2E+04	ug/L	M	2.0E+00	mg/kg-day	3.0E-01	mg/kg-day	NA	NA	6.8E+00
	Manganese	1.5E+03	ug/L	1.5E+03	ug/L	M	4.2E-02	mg/kg-day	2.0E-02	mg/kg-day	NA	NA	2.1E+00
	Nickel	6.5E+01	ug/L	6.5E+01	ug/L	M	1.9E-03	mg/kg-day	2.0E-02	mg/kg-day	NA	NA	9.3E-02
	(Total)												9.8E+00
Dermal Absorption	Trichloroethene	8.6E+00	ug/L	8.6E+00	ug/L	M	4.5E-05	mg/kg-day	2.4E-04	mg/kg-day	NA	NA	1.9E-01
	Cadmium	1.8E+00	ug/L	1.8E+00	ug/L	M	1.7E-07	mg/kg-day	2.5E-05	mg/kg-day	NA	NA	6.7E-03
	Iron	7.2E+04	ug/L	7.2E+04	ug/L	M	6.6E-03	mg/kg-day	6.0E-02	mg/kg-day	NA	NA	1.1E-01
	Manganese	1.5E+03	ug/L	1.5E+03	ug/L	M	1.3E-04	mg/kg-day	7.0E-03	mg/kg-day	NA	NA	1.9E-02
	Nickel	6.5E+01	ug/L	6.5E+01	ug/L	M	6.0E-06	mg/kg-day	2.0E-03	mg/kg-day	NA	NA	3.0E-03
	(Total)												3.3E-01
												Total Hazard Index Across All Exposure Routes/Pathways	1.0E+01

(1) Specify Medium-Specific (M) or Route-Specific (R) EPC selected for hazard calculation.

(2) Chronic.

NA - not applicable.

Table 7.17.CT Supplement
Calculation of DAevent (Child)
Bedrock Aquifer-Tap Water
Site 5, Allegany Ballistics Laboratory

Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Permeability Constant (PC) (cm/hr)	Lag Time (t) (hr)	Duration of Event (ET) (hr)	DAevent (mg/cm^2-event)	t*	B (dimensionless)	Eq
Trichloroethene	8.6E+00	µg/l	1.6E-02	5.5E-01	3.3E-01	1.6E-07	1.3E+00	2.6E-02	2
Cadmium	1.8E+00	µg/l	1.0E-03	NA	3.3E-01	6.0E-10	NA	NA	1
Iron	7.2E+04	µg/l	1.0E-03	NA	3.3E-01	2.4E-05	NA	NA	1
Manganese	1.5E+03	µg/l	1.0E-03	NA	3.3E-01	4.8E-07	NA	NA	1
Nickel	6.5E+01	µg/l	1.0E-03	NA	3.3E-01	2.1E-08	NA	NA	1

Inorganics: DAevent (mg/cm2-event) =
PC x CW x ET x CF1 x CF2 (eq 1)

Organics: DAevent (mg/cm2-event) =

ET<t*: DAevent (mg/cm2-event) =
2 x PC x CW x (sqrt((6 x t x ET)/3.1415))
x CF1 x CF2 (eq 2)

ET>t*: DAevent (mg/cm2-event) =
PC x CW x (ET/(1+B) + 2 x t x ((1 + 3xB)/(1+B))
x CF1 x CF2 (eq 3)

Permeability constants from EPA 1992, Dermal Exposure Assessment: Principals and Applications.
ORD, EPA/600/8-91/001B. Default value of 0.001 cm/hour used for inorganics without published values.
NA - not applicable, DAevent for organics calculated using values calculated on Table 7.30b RME Supplement.

TABLE 8.1.RME
CALCULATION OF CANCER RISKS
REASONABLE MAXIMUM EXPOSURE
Site 5, Allegany Ballistics Laboratory

Scenario Timeframe: Current/Future
Medium: Surface Water
Exposure Medium: Surface Water
Exposure Point: Site 5 Surface Water
Receptor Population: Other Recreational Person
Receptor Age: Adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor	Cancer Slope Factor Units	Cancer Risk
Ingestion	Arsenic (Total)	2.95E+00	mg/kg	2.95E+00	mg/kg	M	5.4E-08	mg/kg-day	1.5E+00	1/mg/kg-day	8.0E-08
											8.0E-08
Dermal	Arsenic (Total)	2.95E+00	mg/kg	2.95E+00	mg/kg	M	3.4E-06	mg/kg-day	1.6E+00	1/mg/kg-day	5.5E-06
											5.5E-06
											5.6E-06

NA-not applicable

(1) Specify Medium-Specific (M) or Route-Specific (R) EPC selected for hazard calculation.

(2) Chronic.

TABLE 8.2.RME
CALCULATION OF CANCER RISKS
REASONABLE MAXIMUM EXPOSURE
Site 5, Allegany Ballistics Laboratory

Scenario Timeframe: Current/Future
Medium: Surface Water
Exposure Medium: Surface Water
Exposure Point: Site 5 Surface Water
Receptor Population: Other Recreational Person
Receptor Age: Adolescents

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor	Cancer Slope Factor Units	Cancer Risk
Ingestion	Arsenic (Total)	2.95E+00	mg/kg	2.95E+00	mg/kg	M	2.8E-08	mg/kg-day	1.5E+00	1/mg/kg-day	4.1E-08
											4.1E-08
Dermal	Arsenic (Total)	2.95E+00	mg/kg	2.95E+00	mg/kg	M	1.3E-06	mg/kg-day	1.6E+00	1/mg/kg-day	2.1E-06
											2.1E-06
											2.2E-06

NA-not applicable

(1) Specify Medium-Specific (M) or Route-Specific (R) EPC selected for hazard calculation.

(2) Chronic.

TABLE 8.3.RME
CALCULATION OF CANCER RISKS
REASONABLE MAXIMUM EXPOSURE
Site 5, Allegany Ballistics Laboratory

Scenario Timeframe: Current/Future
Medium: Sediment
Exposure Medium: Sediment
Exposure Point: Site 5 Sediment
Receptor Population: Other Recreational Person
Receptor Age: Adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor	Cancer Slope Factor Units	Cancer Risk
Ingestion	Arsenic	1.19E+01	mg/kg	1.19E+01	mg/kg	M	4.1E-07	mg/kg-day	1.5E+00	1/mg/kg-day	6.2E-07
	Iron	3.09E+04	mg/kg	3.09E+04	mg/kg	M	1.1E-03	mg/kg-day	NA	1/mg/kg-day	NA
	Manganese	9.86E+02	mg/kg	9.86E+02	mg/kg	M	3.4E-05	mg/kg-day	NA	1/mg/kg-day	NA
	(Total)										6.2E-07
Dermal	Arsenic	1.19E+01	mg/kg	1.19E+01	mg/kg	M	1.1E-07	mg/kg-day	1.6E+00	1/mg/kg-day	1.8E-07
	Iron	3.09E+04	mg/kg	3.09E+04	mg/kg	M	8.9E-05	mg/kg-day	NA	1/mg/kg-day	NA
	Manganese	9.86E+02	mg/kg	9.86E+02	mg/kg	M	2.8E-06	mg/kg-day	NA	1/mg/kg-day	NA
	(Total)										1.8E-07
											8.0E-07

NA-not applicable

(1) Specify Medium-Specific (M) or Route-Specific (R) EPC selected for hazard calculation.

(2) Chronic.

TABLE 8.4.RME
CALCULATION OF CANCER RISKS
REASONABLE MAXIMUM EXPOSURE
Site 5, Allegany Ballistics Laboratory

Scenario Timeframe: Current/Future
Medium: Sediment
Exposure Medium: Sediment
Exposure Point: Site 5 Sediment
Receptor Population: Other Recreational Person
Receptor Age: Adolescents

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor	Cancer Slope Factor Units	Cancer Risk
Ingestion	Arsenic	1.19E+01	mg/kg	1.19E+01	mg/kg	M	2.1E-07	mg/kg-day	1.5E+00	1/mg/kg-day	3.2E-07
	Iron	3.09E+04	mg/kg	3.09E+04	mg/kg	M	5.5E-04	mg/kg-day	NA	1/mg/kg-day	NA
	Manganese	9.86E+02	mg/kg	9.86E+02	mg/kg	M	1.8E-05	mg/kg-day	NA	1/mg/kg-day	NA
	(Total)										3.2E-07
Dermal	Arsenic	1.19E+01	mg/kg	1.19E+01	mg/kg	M	1.7E-08	mg/kg-day	1.6E+00	1/mg/kg-day	2.7E-08
	Iron	3.09E+04	mg/kg	3.09E+04	mg/kg	M	1.4E-05	mg/kg-day	NA	1/mg/kg-day	NA
	Manganese	9.86E+02	mg/kg	9.86E+02	mg/kg	M	4.4E-07	mg/kg-day	NA	1/mg/kg-day	NA
	(Total)										2.7E-08
											3.5E-07

NA-not applicable

(1) Specify Medium-Specific (M) or Route-Specific (R) EPC selected for hazard calculation.

(2) Chronic.

TABLE 8.5.RME
CALCULATION OF CANCER RISKS
REASONABLE MAXIMUM EXPOSURE
Site 5, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Alluvial Aquifer - Tap Water
Receptor Population: Resident
Receptor Age: Child

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor	Cancer Slope Factor Units	Cancer Risk
Dermal Absorption	Trichloroethene	1.5E+02	µg/l	1.5E+02	µg/l	M	1.0E-04	mg/kg-day	5.0E-01	1/mg/kg/day	5.0E-05
	cis-1,2-Dichloroethene	2.4E+01	µg/l	2.4E+01	µg/l	M	7.9E-06	mg/kg-day	NA	NA	NA
	Aluminum	5.3E+03	µg/l	5.3E+03	µg/l	M	6.2E-05	mg/kg-day	NA	NA	NA
	Antimony	3.2E+00	µg/l	3.2E+00	µg/l	M	3.8E-08	mg/kg-day	NA	NA	NA
	Arsenic	3.7E+00	µg/l	3.7E+00	µg/l	M	4.3E-08	mg/kg-day	1.6E+00	1/mg/kg/day	6.9E-08
	Barium	3.5E+02	µg/l	3.5E+02	µg/l	M	4.1E-06	mg/kg-day	NA	NA	NA
	Iron	1.4E+04	µg/l	1.4E+04	µg/l	M	1.6E-04	mg/kg-day	NA	NA	NA
	Manganese	2.8E+03	µg/l	2.8E+03	µg/l	M	3.3E-05	mg/kg-day	NA	NA	NA
	Nickel	9.2E+01	µg/l	9.2E+01	µg/l	M	1.1E-06	mg/kg-day	NA	NA	NA
	(Total)										5.1E-05
										Total Risk Across All Exposure Routes/Pathways	5.1E-05

NA - not applicable.

(1) Specify Medium-Specific (M) or Route-Specific (R) EPC selected for hazard calculation.

Permeability constants from EPA 1992, Dermal Exposure Assessment: Principals and Applications. ORD, EPA/600/8-91/001B. Default value of 0.001 cm/hour used for inorganics without published values.

Table 8.5.RME Supplement
Calculation of DAevent (Child)
Alluvial Aquifer-Tap Water
Site 5, Allegany Ballistics Laboratory

Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Permeability Constant (PC) (cm/hr)	Lag Time (t) (hr)	Duration of Event (ET) (hr)	DAevent (mg/cm^2-event)	t*	B (dimensionless)	Eq
Trichloroethene	1.5E+02	µg/l	1.6E-02	5.5E-01	3.3E-01	2.8E-06	1.3E+00	2.6E-02	2
cis-1,2-Dichloroethene	2.4E+01	µg/l	1.0E-02	3.4E-01	3.3E-01	2.2E-07	8.2E-01	7.2E-03	2
Aluminum	5.3E+03	µg/l	1.0E-03	NA	3.3E-01	1.7E-06	NA	NA	1
Antimony	3.2E+00	µg/l	1.0E-03	NA	3.3E-01	1.1E-09	NA	NA	1
Arsenic	3.7E+00	µg/l	1.0E-03	NA	3.3E-01	1.2E-09	NA	NA	1
Barium	3.5E+02	µg/l	1.0E-03	NA	3.3E-01	1.1E-07	NA	NA	1
Iron	1.4E+04	µg/l	1.0E-03	NA	3.3E-01	4.6E-06	NA	NA	1
Manganese	2.8E+03	µg/l	1.0E-03	NA	3.3E-01	9.4E-07	NA	NA	1
Nickel	9.2E+01	µg/l	1.0E-03	NA	3.3E-01	3.0E-08	NA	NA	1

Inorganics: DAevent (mg/cm2-event) =
PC x CW x ET x CF1 x CF2 (eq 1)

Organics: DAevent (mg/cm2-event) =

ET<t*: DAevent (mg/cm2-event) =
2 x PC x CW x (sqrt((6 x t x ET)/3.1415))
x CF1 x CF2 (eq 2)

ET>t*: DAevent (mg/cm2-event) =
PC x CW x (ET/(1+B) + 2 x t x ((1 + 3xB)/(1+B))
x CF1 x CF2 (eq 3)

Permeability constants from EPA 1992, Dermal Exposure Assessment: Principals and Applications.
ORD, EPA/600/8-91/001B. Default value of 0.001 cm/hour used for inorganics without published values.
NA - not applicable, DAevent for organics calculated using values calculated on Table 7.30b RME Supplement.

TABLE 8.6.RME
CALCULATION OF CANCER RISKS
REASONABLE MAXIMUM EXPOSURE
Site 5, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Alluvial Aquifer - Tap Water
Receptor Population: Resident
Receptor Age: Adult/Child

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor	Cancer Slope Factor Units	Cancer Risk
Ingestion	Trichloroethene	1.5E+02	µg/l	1.5E+02	µg/l	M	2.4E-03	mg/kg-day	4.0E-01	1/mg/kg/day	9.5E-04
	cis-1,2-Dichloroethene	2.4E+01	µg/l	2.4E+01	µg/l	M	3.8E-04	mg/kg-day	NA	NA	NA
	Aluminum	5.3E+03	µg/l	5.3E+03	µg/l	M	8.3E-02	mg/kg-day	NA	NA	NA
	Antimony	3.2E+00	µg/l	3.2E+00	µg/l	M	5.1E-05	mg/kg-day	NA	NA	NA
	Arsenic	3.7E+00	µg/l	3.7E+00	µg/l	M	5.8E-05	mg/kg-day	1.5E+00	1/mg/kg/day	8.7E-05
	Barium	3.5E+02	µg/l	3.5E+02	µg/l	M	5.5E-03	mg/kg-day	NA	NA	NA
	Iron	1.4E+04	µg/l	1.4E+04	µg/l	M	2.2E-01	mg/kg-day	NA	NA	NA
	Manganese	2.8E+03	µg/l	2.8E+03	µg/l	M	4.5E-02	mg/kg-day	NA	NA	NA
	Nickel	9.2E+01	µg/l	9.2E+01	µg/l	M	1.4E-03	mg/kg-day	NA	NA	NA
	(Total)										1.0E-03
								Total Risk Across All Exposure Routes/Pathways			1.0E-03

NA - not applicable.

(1) Specify Medium-Specific (M) or Route-Specific (R) EPC selected for hazard calculation.

* - Vinyl chloride intakes calculated per *Derivation of Vinyl Chloride RBCs*, EPA Region III, May 6, 2001 Memorandum from Jennifer Hubbard.

TABLE 8.7.RME
CALCULATION OF CANCER RISKS
REASONABLE MAXIMUM EXPOSURE
Site 5, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Alluvial Aquifer-Water in Excavation Pit
Receptor Population: Construction Worker
Receptor Age: Adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor	Cancer Slope Factor Units	Cancer Risk
Dermal Absorption	Trichloroethene	1.5E+02	µg/l	1.5E+02	µg/l	M	1.8E-05	mg/kg-day	5.0E-01	1/mg/kg/day	9.0E-06
	cis-1,2-Dichloroethene	2.4E+01	µg/l	2.4E+01	µg/l	M	1.7E-06	mg/kg-day	NA	NA	NA
	Aluminum	5.3E+03	µg/l	5.3E+03	µg/l	M	3.5E-05	mg/kg-day	NA	NA	NA
	Antimony	3.2E+00	µg/l	3.2E+00	µg/l	M	2.2E-08	mg/kg-day	NA	NA	NA
	Arsenic	3.7E+00	µg/l	3.7E+00	µg/l	M	2.5E-08	mg/kg-day	1.6E+00	1/mg/kg/day	3.9E-08
	Barium	3.5E+02	µg/l	3.5E+02	µg/l	M	2.3E-06	mg/kg-day	NA	NA	NA
	Iron	1.4E+04	µg/l	1.4E+04	µg/l	M	9.3E-05	mg/kg-day	NA	NA	NA
	Manganese	2.8E+03	µg/l	2.8E+03	µg/l	M	1.9E-05	mg/kg-day	NA	NA	NA
	Nickel	9.2E+01	µg/l	9.2E+01	µg/l	M	6.2E-07	mg/kg-day	NA	NA	NA
	(Total)										9.0E-06

NA - not applicable.

Total Risk Across All Exposure Routes/Pathways: 9.0E-06

(1) Specify Medium-Specific (M) or Route-Specific (R) EPC selected for hazard calculation.

Permeability constants from EPA 1992, Dermal Exposure Assessment: Principals and Applications. ORD, EPA/600/8-91/001B. Default value of 0.001 cm/hour used for inorganics without published values.

Table 8.7.RME Supplement
Calculation of DAevent
Alluvial Aquifer-Water in Excavation Pit
Site 5, Allegany Ballistics Laboratory

Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Permeability Constant (PC) (cm/hr)	Lag Time (t) (hr)	Duration of Event (ET) (hr)	DAevent mg/cm^2-event	t*	B (dimensionless)	Eq
Trichloroethene	1.5E+02	µg/l	1.6E-02	5.5E-01	8.0E+00	2.1E-05	1.3E+00	2.6E-02	3
cis-1,2-Dichloroethene	2.4E+01	µg/l	1.0E-02	3.4E-01	8.0E+00	2.1E-06	8.2E-01	7.2E-03	3
Aluminum	5.3E+03	µg/l	1.0E-03	NA	8.0E+00	4.2E-05	NA	NA	1
Antimony	3.2E+00	µg/l	1.0E-03	NA	8.0E+00	2.6E-08	NA	NA	1
Arsenic	3.7E+00	µg/l	1.0E-03	NA	8.0E+00	2.9E-08	NA	NA	1
Barium	3.5E+02	µg/l	1.0E-03	NA	8.0E+00	2.8E-06	NA	NA	1
Iron	1.4E+04	µg/l	1.0E-03	NA	8.0E+00	1.1E-04	NA	NA	1
Manganese	2.8E+03	µg/l	1.0E-03	NA	8.0E+00	2.3E-05	NA	NA	1
Nickel	9.2E+01	µg/l	1.0E-03	NA	8.0E+00	7.3E-07	NA	NA	1

Inorganics: DAevent (mg/cm2-event) =
PC x CW x ET x CF1 x CF2 (eq 1)

Organics: DAevent (mg/cm2-event) =

ET<t*: DAevent (mg/cm2-event) =
2 x PC x CW x (sqrt((6 x t x ET)/3.1415))
x CF1 x CF2 (eq 2)

ET>t*: DAevent (mg/cm2-event) =
PC x CW x (ET/(1+B) + 2 x t x ((1 + 3xB)/(1+B))
x CF1 x CF2 (eq 3)

Permeability constants from EPA 1992, Dermal Exposure Assessment: Principals and Applications.
ORD, EPA/600/8-91/001B. Default value of 0.001 cm/hour used for inorganics without published values.
NA - not applicable, DAevent for organics calculated using values calculated on Table 7.31b RME Supplement.

TABLE 8.8.RME
CALCULATION OF CANCER RISKS
REASONABLE MAXIMUM EXPOSURE
Site 5, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Air
Exposure Point: Alluvial Aquifer - Water Vapors at Showerhead
Receptor Population: Resident
Receptor Age: Adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor	Cancer Slope Factor Units	Cancer Risk
Inhalation	Trichloroethene	1.5E+02	µg/l	8.2E-03	µg/l	R	2.7E-03	mg/kg-day	4.0E-01	1/mg/kg/day	1.1E-03
	cis-1,2-Dichloroethene	2.4E+01	µg/l	1.4E-03	µg/l	R	4.7E-04	mg/kg-day	NA	NA	NA
	Aluminum	5.3E+03	µg/l	NV							
	Antimony	3.2E+00	µg/l	NV							
	Arsenic	3.7E+00	µg/l	NV							
	Barium	3.5E+02	µg/l	NV							
	Iron	1.4E+04	µg/l	NV							
	Manganese	2.8E+03	µg/l	NV							
	Nickel	9.2E+01	µg/l	NV							
	(Total)										1.1E-03
										Total Risk Across All Exposure Routes/Pathways	1.1E-03

NA - not applicable.

(1) Specify Medium-Specific (M) or Route-Specific (R) EPC selected for hazard calculation.

Table 8.8.RME Supplement
Inhalation Exposure Concentrations from Foster and Chrostowski Shower Model (Alluvial Aquifer)
Site 5, Allegany Ballistics Laboratory

Chemical	Exposure Point Concentration Cwo (mg/l)	Molecular weight (HH) (g/mole)	Henry's Law Constant (H) (atm-m^3/mole)	Kg (VOC) (cm/hr)	Kl(VOC) (cm/hr)	KL (cm/hr)	Kal (cm/hr)	Cwd (mg/l)	S (mg/m^3 - min)	Calculated Inhalation Exposure (Einh) (mg/kg/shower)
Trichloroethene	1.5E+02	1.3E+02	1.1E-02	1.1E+03	1.2E+01	1.1E+01	1.5E+01	6.0E+01	4.0E+02	**8.2E-03**
cis-1,2,-Dichloroethene	2.4E+01	9.7E+01	5.0E-03	1.3E+03	1.3E+01	1.3E+01	1.7E+01	1.1E+01	7.0E+01	**1.4E-03**

Variables	Units	Exposure Assumptions
Kg(VOC) = gas-film mass transfer coefficient	cm/hr	Solved by Eq 1
Kl(VOC) = liquid-film mass transfer coefficient	cm/hr	Solved by Eq 2
KL = overall mass transfer coefficient	cm/hr	Solved by Eq 3
Kal = adjusted overall mass transfer coeff.	cm/hr	Solved by Eq 4
Tl = Calibration temp. of water	K (20C +273)	2.9E+02
Ts = Shower water temperature	k (45C)	3.2E+02
Us = water viscosity at Ts	centipoise	6.0E-01
Ul = water viscosity at Tl	cp	1.0E+00
Cwd = conc. leaving droplets after time sdt	ug/l	Solved by Eq 5
sdt = shower droplet drop time	sec	2.0E+00
d = shower droplet diameter	mm	1.0E+00
FR = shower water flow rate	l/min	2.0E+01
SV = shower room air volume	m^3	3.0E+00
S = indoor VOC generation rate	ug/m^3-min	Solved by Eq 6
VR = ventilation rate	l/min	1.4E+01
BW = body weight	kg	7.0E+01
Ds = duration of shower	min	1.2E+01
Dt = total duration in shower room	min	1.5E+01
R = air exchange rate	min^{-1}	8.3E-03
Ca = indoor air concentration of VOCs	ug/m^3	Solved by Eq 7
Einh = inhalation exposure per shower	mg/kg/shower	Solved by Eq 8

Equation 1:	Kg(VOC) =	$3000 * (18 / HH)^{0.5}$	
Equation 2:	Kl(VOC) =	$20 * (44 / HH)^{0.5}$	
Equation 3:	KL =	$((1 / Kl(VOC)) + (0.024 / (Kg (VOC) * H)))^{-1}$	
Equation 4:	Kal =	$(KL * (((Tl * Us) / (Ts * Ul))^{0.5}))$	
Equation 5:	Cwd =	(Cwo * (1-EXP((-1 * Kal * sdt)/(60 * d))))	
Equation 6:	S =	(Cwd * FR / SV)	
Equation 7:	see time series example on Table I-GW-5		
Equation 8:	**Einh =**	**If t>Ds**	(((VR * S) / (BW * R * 1000000)) * ((Ds + (EXP(-R * Dt) / R)-(EXP(R * (Ds - Dt))) / R)))

Henry's Law Constant from USEPA's *Superfund Public Health Evaluation Manual.* USEPA/540/1-86/060, October 1986.

TABLE 8.9.RME
CALCULATION OF CANCER RISKS
REASONABLE MAXIMUM EXPOSURE
Site 5, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Air
Exposure Point: Alluvial Aquifer - Volatilization from Water in Excavation Pit
Receptor Population: Construction Worker
Receptor Age: Adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor	Cancer Slope Factor Units	Cancer Risk
Inhalation	Trichloroethene	1.5E+02	µg/l	1.3E-03	mg/m^3	R	9.6E-07	mg/kg-day	4.0E-01	1/mg/kg/day	3.8E-07
	cis-1,2-Dichloroethene	2.4E+01	µg/l	2.3E-04	mg/m^3	R	1.6E-07	mg/kg-day	NA	NA	NA
	Aluminum	5.3E+03	µg/l	NV							
	Antimony	3.2E+00	µg/l	NV							
	Arsenic	3.7E+00	µg/l	NV							
	Barium	3.5E+02	µg/l	NV							
	Iron	1.4E+04	µg/l	NV							
	Manganese	2.8E+03	µg/l	NV							
	Nickel	9.2E+01	µg/l	NV							
	(Total)										3.8E-07
										Total Risk Across All Exposure Routes/Pathways	3.8E-07

NA - not applicable.

(1) Specify Medium-Specific (M) or Route-Specific (R) EPC selected for hazard calculation.

Table 8.9.RME Supplement
Inhalation of Volatiles from Groundwater During Construction
Inhalation Exposure Concentrations Calculated Using a Two-Film Volatilization Model
Future Construction Worker Senario
Site 5, Allegany Ballistics Laboratory

Chemical	Cw (µg/L)	MW (mol/gram)	K_H (unitless)	k_l (cm/hr)	k_g (cm/hr)	K_v (cm/hr)	ER (mg/hr)	ERa (g/sec-m^2)	Ca (mg/m^3)
Trichloroethene	1.50E+02	1.3E+02	4.2E-01	3.1E+00	1.9E+03	3.1E+00	4.6E+02	4.8E-08	1.3E-03
cis-1,2,-Dichloroethene	2.40E+01	9.7E+01	1.7E-01	3.3E+00	2.0E+03	3.3E+00	7.9E+01	8.2E-09	2.3E-04

Equations

Equation 1 $Kv = 1/(1/k_l + 1/K_H * K_g)$

Equation 2 $k_g = 700(18/MW)^{1/4}V$

Equation 3 $k_l = (32/MW)^{1/4}Ka'$

Equation 4 $ER = Kv * Cw * L/1000\ cm^3 * mg/1000\ \mu g$

Equation 5 $ERa = ER * g/1000\ mg * hr/60\ min * min/60\ sec * 1/A$

Variables	Units	Exposure Assumptions
Cw = groundwater concentration	(µg/L)	chem-specific
MW = molecular weight	(mol/gram)	chem-specific
K_H - Henry's Law Constant	(unitless)	chem-specific
Kv = volatilization rate	(cm/hr)	Solved by Eq 1
k_g = gas phase transfer coefficient	(cm/hr)	Solved by Eq 2
k_l = liquid phase transfer coefficient	(cm/hr)	Solved by Eq 3
V = wind speed	(m/s)	4.4E+00
Ka' = aeration rate	(cm/hr)	6.3E-02
ER = emission rate	(mg/hr)	Solved by Eq 4
A = area of excavation (utility ditch)	(m^2)	2.7E+03
Era = area emission rate	(g/sec-m^2)	Solved by Eq 5
Ca = air concentration	(mg/m^3)	Solved using SCREEN3 model

Note: aeration rate based on aeration rate for small pond (0.1/day) multiplied by depth of water in excavation (1/2 ft)

TABLE 8.10.RME
CALCULATION OF CANCER RISKS
REASONABLE MAXIMUM EXPOSURE
Site 5, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Bedrock Aquifer - Tap Water
Receptor Population: Resident
Receptor Age: Child

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor	Cancer Slope Factor Units	Cancer Risk
Dermal Absorption	Trichloroethene	8.6E+00	µg/l	8.6E+00	µg/l	M	5.8E-06	mg/kg-day	5.0E-01	1/mg/kg/day	2.9E-06
	Cadmium	1.8E+00	µg/l	1.8E+00	µg/l	M	2.1E-08	mg/kg-day	NA	NA	NA
	Iron	7.2E+04	µg/l	7.2E+04	µg/l	M	8.4E-04	mg/kg-day	NA	NA	NA
	Manganese	1.5E+03	µg/l	1.5E+03	µg/l	M	1.7E-05	mg/kg-day	NA	NA	NA
	Nickel	6.5E+01	µg/l	6.5E+01	µg/l	M	7.7E-07	mg/kg-day	NA	NA	NA
	(Total)										2.9E-06
										Total Risk Across All Exposure Routes/Pathways	2.9E-06

NA - not applicable.

(1) Specify Medium-Specific (M) or Route-Specific (R) EPC selected for hazard calculation.

Permeability constants from EPA 1992, Dermal Exposure Assessment: Principals and Applications. ORD, EPA/600/8-91/001B. Default value of 0.001 cm/hour used for inorganics without published values.

Table 8.10.RME Supplement
Calculation of DAevent (Child)
Bedrock Aquifer-Tap Water
Site 5, Allegany Ballistics Laboratory

Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Permeability Constant (PC) (cm/hr)	Lag Time (t) (hr)	Duration of Event (ET) (hr)	DAevent (mg/cm^2-event)	t*	B (dimensionless)	Eq
Trichloroethene	8.6E+00	µg/l	1.6E-02	5.5E-01	3.3E-01	1.6E-07	1.3E+00	2.6E-02	2
Cadmium	1.8E+00	µg/l	1.0E-03	NA	3.3E-01	6.0E-10	NA	NA	1
Iron	7.2E+04	µg/l	1.0E-03	NA	3.3E-01	2.4E-05	NA	NA	1
Manganese	1.5E+03	µg/l	1.0E-03	NA	3.3E-01	4.8E-07	NA	NA	1
Nickel	6.5E+01	µg/l	1.0E-03	NA	3.3E-01	2.1E-08	NA	NA	1

Inorganics: DAevent (mg/cm2-event) =
PC x CW x ET x CF1 x CF2 (eq 1)

Organics: DAevent (mg/cm2-event) =

ET<t*: DAevent (mg/cm2-event) =
2 x PC x CW x (sqrt((6 x t x ET)/3.1415))
x CF1 x CF2 (eq 2)

ET>t*: DAevent (mg/cm2-event) =
PC x CW x (ET/(1+B) + 2 x t x ((1 + 3xB)/(1+B))
x CF1 x CF2 (eq 3)

Permeability constants from EPA 1992, Dermal Exposure Assessment: Principals and Applications.
ORD, EPA/600/8-91/001B. Default value of 0.001 cm/hour used for inorganics without published values.
NA - not applicable, DAevent for organics calculated using values calculated on Table 7.30b RME Supplement.

TABLE 8.11.RME
CALCULATION OF CANCER RISKS
REASONABLE MAXIMUM EXPOSURE
Site 5, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Bedrock Aquifer - Tap Water
Receptor Population: Resident
Receptor Age: Adult/Child

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor	Cancer Slope Factor Units	Cancer Risk
Ingestion	Trichloroethene	8.6E+00	µg/l	8.6E+00	µg/l	M	1.4E-04	mg/kg-day	4.0E-01	1/mg/kg/day	5.4E-05
	Cadmium	1.8E+00	µg/l	1.8E+00	µg/l	M	2.9E-05	mg/kg-day	NA	NA	NA
	Iron	7.2E+04	µg/l	7.2E+04	µg/l	M	1.1E+00	mg/kg-day	NA	NA	NA
	Manganese	1.5E+03	µg/l	1.5E+03	µg/l	M	2.3E-02	mg/kg-day	NA	NA	NA
	Nickel	6.5E+01	µg/l	6.5E+01	µg/l	M	1.0E-03	mg/kg-day	NA	NA	NA
	(Total)										5.4E-05
								Total Risk Across All Exposure Routes/Pathways			5.4E-05

NA - not applicable.

(1) Specify Medium-Specific (M) or Route-Specific (R) EPC selected for hazard calculation.

* - Vinyl chloride intakes calculated per *Derivation of Vinyl Chloride RBCs*, EPA Region III, May 6, 2001 Memorandum from Jennifer Hubbard.

TABLE 8.12.RME
CALCULATION OF CANCER RISKS
REASONABLE MAXIMUM EXPOSURE
Site 5, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Air
Exposure Point: Bedrock Aquifer - Water Vapors at Showerhead
Receptor Population: Resident
Receptor Age: Adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor	Cancer Slope Factor Units	Cancer Risk
Inhalation	Trichloroethene	8.6E+00	µg/l	4.7E-04	µg/l	R	1.5E-04	mg/kg-day	4.0E-01	1/mg/kg/day	6.1E-05
	Cadmium	1.8E+00	µg/l	NV							
	Iron	7.2E+04	µg/l	NV							
	Manganese	1.5E+03	µg/l	NV							
	Nickel	6.5E+01	µg/l	NV							
	(Total)										6.1E-05
										Total Risk Across All Exposure Routes/Pathways	6.1E-05

NA - not applicable.

(1) Specify Medium-Specific (M) or Route-Specific (R) EPC selected for hazard calculation.

Table 8.12.RME Supplement
Inhalation Exposure Concentrations from Foster and Chrostowski Shower Model (Bedrock Aquifer)
Site 5, Allegany Ballistics Laboratory

Chemical	Exposure Point Concentration Cwo (mg/l)	Molecular weight (HH) (g/mole)	Henry's Law Constant (H) (atm-m^3/mole)	Kg (VOC) (cm/hr)	Kl(VOC) (cm/hr)	KL (cm/hr)	Kal (cm/hr)	Cwd (mg/l)	S (mg/m^3 - min)	Calculated Inhalation Exposure (Einh) (mg/kg/shower)
Trichloroethene	8.6E+00	1.3E+02	1.1E-02	1.1E+03	1.2E+01	1.1E+01	1.5E+01	3.4E+00	2.3E+01	**4.7E-04**

Variables	Units	Exposure Assumptions
Kg(VOC) = gas-film mass transfer coefficient	cm/hr	Solved by Eq 1
Kl(VOC) = liquid-film mass transfer coefficient	cm/hr	Solved by Eq 2
KL = overall mass transfer coefficient	cm/hr	Solved by Eq 3
Kal = adjusted overall mass transfer coeff.	cm/hr	Solved by Eq 4
Tl = Calibration temp. of water	K (20C +273)	2.9E+02
Ts = Shower water temperature	k (45C)	3.2E+02
Us = water viscosity at Ts	centipoise	6.0E-01
Ul = water viscosity at Tl	cp	1.0E+00
Cwd = conc. leaving droplets after time sdt	ug/l	Solved by Eq 5
sdt = shower droplet drop time	sec	2.0E+00
d = shower droplet diameter	mm	1.0E+00
FR = shower water flow rate	l/min	2.0E+01
SV = shower room air volume	m^3	3.0E+00
S = indoor VOC generation rate	ug/m^3-min	Solved by Eq 6
VR = ventilation rate	l/min	1.4E+01
BW = body weight	kg	7.0E+01
Ds = duration of shower	min	1.2E+01
Dt = total duration in shower room	min	1.5E+01
R = air exchange rate	min^{-1}	8.3E-03
Ca = indoor air concentration of VOCs	ug/m^3	Solved by Eq 7
Einh = inhalation exposure per shower	mg/kg/shower	Solved by Eq 8

Equation 1:	Kg(VOC) =	$3000 * (18 / HH)^{0.5}$	
Equation 2:	Kl(VOC) =	$20 * (44 / HH)^{0.5}$	
Equation 3:	KL =	$((1 / Kl(VOC)) + (0.024 / (Kg (VOC) * H)))^{-1}$	
Equation 4:	Kal =	$(KL * (((Tl * Us) / (Ts * Ul))^{0.5}))$	
Equation 5:	Cwd =	(Cwo * (1-EXP((-1 * Kal * sdt)/(60 * d))))	
Equation 6:	S =	(Cwd * FR / SV)	
Equation 7:	see time series example on Table I-GW-5		
Equation 8:	**Einh =**	**If t>Ds**	(((VR * S) / (BW * R * 1000000)) * ((Ds + (EXP(-R * Dt) / R)-(EXP(R * (Ds - Dt))) / R)))

Henry's Law Constant from USEPA's *Superfund Public Health Evaluation Manual.* USEPA/540/1-86/060, October 1986.

TABLE 8.13.CT
CALCULATION OF CANCER RISKS
CENTRAL TENDENCY
Site 5, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Alluvial Aquifer - Tap Water
Receptor Population: Resident
Receptor Age: Child

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor	Cancer Slope Factor Units	Cancer Risk
Dermal Absorption	Trichloroethene	1.5E+02	µg/l	1.5E+02	µg/l	M	1.6E-05	mg/kg-day	5.0E-01	1/mg/kg/day	8.1E-06
	cis-1,2-Dichloroethene	2.4E+01	µg/l	2.4E+01	µg/l	M	1.3E-06	mg/kg-day	NA	NA	NA
	Aluminum	5.3E+03	µg/l	5.3E+03	µg/l	M	7.1E-06	mg/kg-day	NA	NA	NA
	Antimony	3.2E+00	µg/l	3.2E+00	µg/l	M	4.4E-09	mg/kg-day	NA	NA	NA
	Arsenic	3.7E+00	µg/l	3.7E+00	µg/l	M	5.0E-09	mg/kg-day	1.6E+00	1/mg/kg/day	7.9E-09
	Barium	3.5E+02	µg/l	3.5E+02	µg/l	M	4.7E-07	mg/kg-day	NA	NA	NA
	Iron	1.4E+04	µg/l	1.4E+04	µg/l	M	1.9E-05	mg/kg-day	NA	NA	NA
	Manganese	2.8E+03	µg/l	2.8E+03	µg/l	M	3.8E-06	mg/kg-day	NA	NA	NA
	Nickel	9.2E+01	µg/l	9.2E+01	µg/l	M	1.2E-07	mg/kg-day	NA	NA	NA
	(Total)										8.1E-06

NA - not applicable.

Total Risk Across All Exposure Routes/Pathways 8.1E-06

(1) Specify Medium-Specific (M) or Route-Specific (R) EPC selected for hazard calculation.

Permeability constants from EPA 1992, Dermal Exposure Assessment: Principals and Applications. ORD, EPA/600/8-91/001B. Default value of 0.001 cm/hour used for inorganics without published values.

Table 8.13.CT Supplement
Calculation of DAevent (Child)
Alluvial Aquifer-Tap Water
Site 5, Allegany Ballistics Laboratory

Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Permeability Constant (PC) (cm/hr)	Lag Time (t) (hr)	Duration of Event (ET) (hr)	DAevent (mg/cm^2-event)	t*	B (dimensionless)	Eq
Trichloroethene	1.5E+02	µg/l	1.6E-02	5.5E-01	1.7E-01	2.0E-06	1.3E+00	2.6E-02	2
cis-1,2-Dichloroethene	2.4E+01	µg/l	1.0E-02	3.4E-01	1.7E-01	1.6E-07	8.2E-01	7.2E-03	2
Aluminum	5.3E+03	µg/l	1.0E-03	NA	1.7E-01	8.9E-07	NA	NA	1
Antimony	3.2E+00	µg/l	1.0E-03	NA	1.7E-01	5.5E-10	NA	NA	1
Arsenic	3.7E+00	µg/l	1.0E-03	NA	1.7E-01	6.2E-10	NA	NA	1
Barium	3.5E+02	µg/l	1.0E-03	NA	1.7E-01	5.9E-08	NA	NA	1
Iron	1.4E+04	µg/l	1.0E-03	NA	1.7E-01	2.3E-06	NA	NA	1
Manganese	2.8E+03	µg/l	1.0E-03	NA	1.7E-01	4.8E-07	NA	NA	1
Nickel	9.2E+01	µg/l	1.0E-03	NA	1.7E-01	1.6E-08	NA	NA	1

Inorganics: DAevent (mg/cm2-event) =
PC x CW x ET x CF1 x CF2 (eq 1)

Organics: DAevent (mg/cm2-event) =

ET<t*: DAevent (mg/cm2-event) =
2 x PC x CW x (sqrt((6 x t x ET)/3.1415))
x CF1 x CF2 (eq 2)

ET>t*: DAevent (mg/cm2-event) =
PC x CW x (ET/(1+B) + 2 x t x ((1 + 3xB)/(1+B))
x CF1 x CF2 (eq 3)

Permeability constants from EPA 1992, Dermal Exposure Assessment: Principals and Applications.
ORD, EPA/600/8-91/001B. Default value of 0.001 cm/hour used for inorganics without published values.
NA - not applicable, DAevent for organics calculated using values calculated on Table 7.30b RME Supplement.

TABLE 8.14.CT
CALCULATION OF CANCER RISKS
CENTRAL TENDENCY
Site 5, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Alluvial Aquifer - Tap Water
Receptor Population: Resident
Receptor Age: Adult/Child

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor	Cancer Slope Factor Units	Cancer Risk
Ingestion	Trichloroethene	1.5E+02	µg/l	1.5E+02	µg/l	M	3.7E-04	mg/kg-day	4.0E-01	1/mg/kg/day	1.5E-04
	cis-1,2-Dichloroethene	2.4E+01	µg/l	2.4E+01	µg/l	M	5.9E-05	mg/kg-day	NA	NA	NA
	Aluminum	5.3E+03	µg/l	5.3E+03	µg/l	M	1.3E-02	mg/kg-day	NA	NA	NA
	Antimony	3.2E+00	µg/l	3.2E+00	µg/l	M	8.0E-06	mg/kg-day	NA	NA	NA
	Arsenic	3.7E+00	µg/l	3.7E+00	µg/l	M	9.1E-06	mg/kg-day	1.5E+00	1/mg/kg/day	1.4E-05
	Barium	3.5E+02	µg/l	3.5E+02	µg/l	M	8.6E-04	mg/kg-day	NA	NA	NA
	Iron	1.4E+04	µg/l	1.4E+04	µg/l	M	3.4E-02	mg/kg-day	NA	NA	NA
	Manganese	2.8E+03	µg/l	2.8E+03	µg/l	M	7.0E-03	mg/kg-day	NA	NA	NA
	Nickel	9.2E+01	µg/l	9.2E+01	µg/l	M	2.3E-04	mg/kg-day	NA	NA	NA
	(Total)										1.6E-04
								Total Risk Across All Exposure Routes/Pathways			1.6E-04

NA - not applicable.

(1) Specify Medium-Specific (M) or Route-Specific (R) EPC selected for hazard calculation.

* - Vinyl chloride intakes calculated per *Derivation of Vinyl Chloride RBCs*, EPA Region III, May 6, 2001 Memorandum from Jennifer Hubbard.

TABLE 8.15.CT
CALCULATION OF CANCER RISKS
CENTRAL TENDENCY
Site 5, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Air
Exposure Point: Alluvial Aquifer - Water Vapors at Showerhead
Receptor Population: Resident
Receptor Age: Adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor	Cancer Slope Factor Units	Cancer Risk
Inhalation	Trichloroethene	1.5E+02	µg/l	8.2E-03	µg/l	R	6.7E-04	mg/kg-day	4.0E-01	1/mg/kg/day	2.7E-04
	cis-1,2-Dichloroethene	2.4E+01	µg/l	1.4E-03	µg/l	R	1.2E-04	mg/kg-day	NA	NA	NA
	Aluminum	5.3E+03	µg/l	NV							
	Antimony	3.2E+00	µg/l	NV							
	Arsenic	3.7E+00	µg/l	NV							
	Barium	3.5E+02	µg/l	NV							
	Iron	1.4E+04	µg/l	NV							
	Manganese	2.8E+03	µg/l	NV							
	Nickel	9.2E+01	µg/l	NV							
	(Total)										2.7E-04
										Total Risk Across All Exposure Routes/Pathways	2.7E-04

NA - not applicable.

(1) Specify Medium-Specific (M) or Route-Specific (R) EPC selected for hazard calculation.

Table 8.15.CT Supplement
Inhalation Exposure Concentrations from Foster and Chrostowski Shower Model (Alluvial Aquifer)
Site 5, Allegany Ballistics Laboratory

Chemical	Exposure Point Concentration Cwo (mg/l)	Molecular weight (HH) (g/mole)	Henry's Law Constant (H) (atm-m^3/mole)	Kg (VOC) (cm/hr)	Kl(VOC) (cm/hr)	KL (cm/hr)	Kal (cm/hr)	Cwd (mg/l)	S (mg/m^3 - min)	Calculated Inhalation Exposure (Einh) (mg/kg/shower)
Trichloroethene	1.5E+02	1.3E+02	1.1E-02	1.1E+03	1.2E+01	1.1E+01	1.5E+01	6.0E+01	4.0E+02	**8.2E-03**
cis-1,2,-Dichloroethene	2.4E+01	9.7E+01	5.0E-03	1.3E+03	1.3E+01	1.3E+01	1.7E+01	1.1E+01	7.0E+01	**1.4E-03**

Variables	Units	Exposure Assumptions
Kg(VOC) = gas-film mass transfer coefficient	cm/hr	Solved by Eq 1
Kl(VOC) = liquid-film mass transfer coefficient	cm/hr	Solved by Eq 2
KL = overall mass transfer coefficient	cm/hr	Solved by Eq 3
Kal = adjusted overall mass transfer coeff.	cm/hr	Solved by Eq 4
Tl = Calibration temp. of water	K (20C +273)	2.9E+02
Ts = Shower water temperature	k (45C)	3.2E+02
Us = water viscosity at Ts	centipoise	6.0E-01
Ul = water viscosity at Tl	cp	1.0E+00
Cwd = conc. leaving droplets after time sdt	ug/l	Solved by Eq 5
sdt = shower droplet drop time	sec	2.0E+00
d = shower droplet diameter	mm	1.0E+00
FR = shower water flow rate	l/min	2.0E+01
SV = shower room air volume	m^3	3.0E+00
S = indoor VOC generation rate	ug/m^3-min	Solved by Eq 6
VR = ventilation rate	l/min	1.4E+01
BW = body weight	kg	7.0E+01
Ds = duration of shower	min	1.2E+01
Dt = total duration in shower room	min	1.5E+01
R = air exchange rate	min^{-1}	8.3E-03
Ca = indoor air concentration of VOCs	ug/m^3	Solved by Eq 7
Einh = inhalation exposure per shower	mg/kg/shower	Solved by Eq 8

Equation 1:	Kg(VOC) =	$3000 * (18 / HH)^{0.5}$	
Equation 2:	Kl(VOC) =	$20 * (44 / HH)^{0.5}$	
Equation 3:	KL =	$((1 / Kl(VOC)) + (0.024 / (Kg (VOC) * H)))^{-1}$	
Equation 4:	Kal =	$(KL * (((Tl * Us) / (Ts * Ul))^{0.5}))$	
Equation 5:	Cwd =	(Cwo * (1-EXP((-1 * Kal * sdt)/(60 * d))))	
Equation 6:	S =	(Cwd * FR / SV)	
Equation 7:	see time series example on Table I-GW-5		
Equation 8:	**Einh =**	**If t>Ds**	(((VR * S) / (BW * R * 1000000)) * ((Ds + (EXP(-R * Dt) / R)-(EXP(R * (Ds - Dt))) / R)))

Henry's Law Constant from USEPA's *Superfund Public Health Evaluation Manual.* USEPA/540/1-86/060, October 1986.

TABLE 9.1.RME

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

REASONABLE MAXIMUM EXPOSURE

Site 5, Allegany Ballistics Laboratory

Scenario Timeframe: Current/Future
Receptor Population: Other Recreational Person
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal Absorption	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal Absorption	Exposure Routes Total
Surface Water	Surface Water	Site 5 Surface Water	Arsenic	8.0E-08	--	5.5E-06	5.6E-06	Arsenic	Skin/vascular	5.2E-04	--	3.4E-02	3.5E-02
			(Total)	8.0E-08	0.0E+00	5.5E-06	5.6E-06	(Total)		5.2E-04	0.0E+00	3.4E-02	3.5E-02
			Total Risk Across Surface Water				5.6E-06	Total Hazard Index Across Surface Water					3.5E-02
Sediment	Sediment	Site 5 Sediment	Arsenic	6.2E-07	--	1.8E-07	8.0E-07	Arsenic	Skin/vascular	4.0E-03	--	1.1E-03	5.1E-03
			Iron	NA	--	NA	0.0E+00	Iron	Gastrointestinal	1.0E-02	--	4.3E-03	1.5E-02
			Manganese	NA	--	NA	0.0E+00	Manganese	CNS	5.0E-03	--	1.2E-03	6.2E-03
			(Total)	6.2E-07	0.0E+00	1.8E-07	8.0E-07	(Total)		2.0E-02	0.0E+00	6.6E-03	2.6E-02
			Total Risk Across Sediment				8.0E-07	Total Hazard Index Across Sediment					2.6E-02
Total Risk Across All Media and All Exposure Routes							6.4E-06	Total Hazard Index Across All Media and All Exposure Routes					6.1E-02

Total CNS HI =	6.2E-03
Total Skin HI =	4.0E-02
Total Vascular HI =	4.0E-02
Total Gastrointestinal HI =	1.5E-02

TABLE 9.2.RME

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

REASONABLE MAXIMUM EXPOSURE

Site 5, Allegany Ballistics Laboratory

Scenario Timeframe: Current/Future
Receptor Population: Other Recreational Person
Receptor Age: Adolescent

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal Absorption	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal Absorption	Exposure Routes Total
Surface Water	Surface Water	Site 5 Surface Water											
			Arsenic	4.1E-08	--	2.1E-06	2.2E-06	Arsenic	Skin/vascular	7.1E-04	--	3.5E-02	3.6E-02
			(Total)	4.1E-08	0.0E+00	2.1E-06	2.2E-06	(Total)		7.1E-04	0.0E+00	3.5E-02	3.6E-02
			Total Risk Across Surface Water				2.2E-06	Total Hazard Index Across Surface Water					3.6E-02
Sediment	Sediment	Site 5 Sediment											
			Arsenic	3.2E-07	--	2.7E-08	3.5E-07	Arsenic	Skin/vascular	5.5E-03	--	4.5E-04	6.0E-03
			Iron	NA	--	NA	0.0E+00	Iron	Gastrointestinal	1.4E-02	--	1.8E-03	1.6E-02
			Manganese	NA	--	NA	0.0E+00	Manganese	CNS	9.6E-03	--	6.8E-04	1.0E-02
			(Total)	3.2E-07	0.0E+00	2.7E-08	3.5E-07	(Total)		2.9E-02	0.0E+00	2.9E-03	3.2E-02
			Total Risk Across Sediment				3.5E-07	Total Hazard Index Across Sediment					3.2E-02
Total Risk Across All Media and All Exposure Routes							2.5E-06	Total Hazard Index Across All Media and All Exposure Routes					6.9E-02

Total CNS HI =	1.0E-02
Total Skin HI =	4.2E-02
Total Vascular HI =	4.2E-02
Total Gastrointestinal HI =	1.6E-02

TABLE 9.3.RME

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

REASONABLE MAXIMUM EXPOSURE

Site 5, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal Absorption	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal Absorption	Exposure Routes Total
Groundwater	Groundwater	Alluvial Aquifer - Tap Water						Trichloroethene	Liver, Kidney, Fetus	1.4E+01	--	--	1.4E+01
								cis-1,2-Dichloroethene	Blood	6.6E-02	--	--	6.6E-02
								Aluminum	CNS	1.4E-01	--	--	1.4E-01
								Antimony	Blood	2.2E-01	--	--	2.2E-01
								Arsenic	Skin/vascular	3.3E-01	--	--	3.3E-01
								Barium	Kidney	1.4E-01	--	--	1.4E-01
								Iron	Gastrointestinal	1.3E+00	--	--	1.3E+00
								Manganese	CNS	3.9E+00	--	--	3.9E+00
								Nickel	Whole body	1.3E-01	--	--	1.3E-01
			(Total)	0.0E+00	0.0E+00	0.0E+00	0.0E+00	(Total)		2.0E+01	0.0E+00	0.0E+00	2.0E+01
			Total Risk Across Alluvial Aquifer - Tap Water				0.0E+00	Total Hazard Index Across Alluvial Aquifer - Tap Water					2.0E+01
Groundwater	Air	Alluvial Aquifer - Water Vapors at Showerhead	Trichloroethene	--	1.1E-03	--	1.1E-03	Trichloroethene	CNS, Liver, Endocrine System	--	7.8E-01	--	7.8E-01
			cis-1,2-Dichloroethene	--	NA	--	0.0E+00	cis-1,2-Dichloroethene	NA	--	NA	--	0.0E+00
			(Total)	0.0E+00	1.1E-03	0.0E+00	1.1E-03	(Total)		0.0E+00	7.8E-01	0.0E+00	7.8E-01
			Total Risk Across Alluvial Aquifer - Water Vapors at Showerhead				1.1E-03	Total Hazard Index Across Alluvial Aquifer - Water Vapors at Showerhead					7.8E-01
			Total Risk Across Alluvial Aquifer Groundwater				1.1E-03	Total Hazard Index Across Alluvial Aquifer Groundwater					2.1E+01
Groundwater	Groundwater	Bedrock Aquifer- Tap Water						Trichloroethene	Liver, Kidney, Fetus	7.8E-01	--	--	7.8E-01
								Cadmium	Kidney	1.0E-01	--	--	1.0E-01
								Iron	Gastrointestinal	6.5E+00	--	--	6.5E+00
								Manganese	CNS	2.0E+00	--	--	2.0E+00
								Nickel	Whole body	8.9E-02	--	--	8.9E-02
			(Total)	0.0E+00	0.0E+00	0.0E+00	0.0E+00	(Total)		9.5E+00	0.0E+00	0.0E+00	9.5E+00
			Total Risk Across BedrockAquifer - Tap Water				0.0E+00	Total Hazard Index Across BedrockAquifer - Tap Water					9.5E+00
Groundwater	Air	Bedrock Aquifer - Water Vapors at Showerhead	Trichloroethene	--	6.1E-05	--	6.1E-05	Trichloroethene	CNS, Liver, Endocrine system	--	4.5E-02	--	4.5E-02
			(Total)	0.0E+00	6.1E-05	0.0E+00	6.1E-05	(Total)		0.0E+00	4.5E-02	0.0E+00	4.5E-02
			Total Risk Across Bedrock Aquifer - Water Vapors at Showerhead				6.1E-05	Total Hazard Index Across Bedrock Aquifer - Water Vapors at Showerhead					4.5E-02
			Total Risk Across Bedrock Aquifer Groundwater				6.1E-05	Total Hazard Index Across Bedrock Aquifer Groundwater					9.6E+00
			Total Risk Across All Media and All Exposure Routes				1.1E-03	Total Hazard Index Across All Media and All Exposure Routes					3.0E+01

Total Liver HI = 1.5E+01

TABLE 9.3.RME

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

REASONABLE MAXIMUM EXPOSURE

Site 5, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal Absorption	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal Absorption	Exposure Routes Total
												Total Fetus HI =	1.4E+01
												Total Endocrine System HI =	8.3E-01
												Total Blood HI =	2.9E-01
												Total CNS HI =	6.9E+00
												Total Gastrointestinal HI =	7.8E+00
												Total Kidney HI =	1.5E+01
												Total Skin HI =	3.3E-01
												Total Vascular HI =	3.3E-01
												Total Whole Body HI =	2.1E-01

TABLE 9.4.RME

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

REASONABLE MAXIMUM EXPOSURE

Site 5, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal Absorption	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal Absorption	Exposure Routes Total
Groundwater	Groundwater	Alluvial Aquifer - Tap Water											
			Trichloroethene	--	--	5.0E-05	5.0E-05	Trichloroethene	Liver, Kidney, Fetus	3.7E+01	--	4.9E+00	4.2E+01
			cis-1,2-Dichloroethene	--	--	NA	0.0E+00	cis-1,2-Dichloroethene	Blood	1.8E-01	--	9.3E-03	1.9E-01
			Aluminum	--	--	NA	0.0E+00	Aluminum	CNS	3.9E-01	--	2.7E-03	3.9E-01
			Antimony	--	--	NA	0.0E+00	Antimony	Blood	6.0E-01	--	1.1E-02	6.1E-01
			Arsenic	--	--	6.9E-08	6.9E-08	Arsenic	Skin/vascular	9.1E-01	--	1.7E-03	9.1E-01
			Barium	--	--	NA	0.0E+00	Barium	Kidney	3.7E-01	--	6.8E-04	3.7E-01
			Iron	--	--	NA	0.0E+00	Iron	Gastrointestinal	3.4E+00	--	3.2E-02	3.5E+00
			Manganese	--	--	NA	0.0E+00	Manganese	CNS	1.1E+01	--	5.6E-02	1.1E+01
			Nickel	--	--	NA	0.0E+00	Nickel	Whole body	3.4E-01	--	6.3E-03	3.5E-01
			(Total)	0.0E+00	0.0E+00	5.1E-05	5.1E-05	(Total)		5.4E+01	0.0E+00	5.0E+00	5.9E+01
			Total Risk Across Alluvial Aquifer - Tap Water				5.1E-05	Total Hazard Index Across Alluvial Aquifer - Tap Water					5.9E+01
			Total Risk Across Alluvial Aquifer Groundwater				5.1E-05	Total Hazard Index Across Alluvial Aquifer Groundwater					5.9E+01
Groundwater	Groundwater	Bedrock Aquifer - Tap Water											
			Trichloroethene	--	--	2.9E-06	2.9E-06	Trichloroethene	Liver, Kidney, Fetus	2.1E+00	--	2.8E-01	2.4E+00
			Cadmium	--	--	NA	0.0E+00	Cadmium	Kidney	2.7E-01	--	1.0E-02	2.8E-01
			Iron	--	--	NA	0.0E+00	Iron	Gastrointestinal	1.8E+01	--	1.6E-01	1.8E+01
			Manganese	--	--	NA	0.0E+00	Manganese	CNS	5.4E+00	--	2.9E-02	5.5E+00
			Nickel	--	--	NA	0.0E+00	Nickel	Whole body	2.4E-01	--	4.5E-03	2.5E-01
			(Total)	0.0E+00	0.0E+00	2.9E-06	2.9E-06	(Total)		2.6E+01	0.0E+00	4.9E-01	2.6E+01
			Total Risk Across BedrockAquifer - Tap Water				2.9E-06		Total Hazard Index Across BedrockAquifer - Tap Water				2.6E+01
			Total Risk Across BedrockAquifer Groundwater				2.9E-06		Total Hazard Index Across BedrockAquifer Groundwater				2.6E+01
			Total Risk Across All Media and All Exposure Routes				5.3E-05	Total Hazard Index Across All Media and All Exposure Routes					8.5E+01

Total Liver HI =	4.5E+01
Total Fetus HI =	4.5E+01
Total Blood HI =	8.0E-01
Total CNS HI =	1.6E+01
Total Gastrointestinal HI =	2.1E+01
Total Kidney HI =	4.5E+01
Total Skin HI =	9.1E-01
Total Vascular HI =	9.1E-01
Total Whole Body HI =	6.0E-01

TABLE 9.5.RME

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

REASONABLE MAXIMUM EXPOSURE

Site 5, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child/Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal Absorption	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal Absorption	Exposure Routes Total
Groundwater	Groundwater	Alluvial Aquifer - Tap Water											
			Trichloroethene	9.5E-04	--	--	9.5E-04						
			cis-1,2-Dichloroethene	NA	--	--	0.0E+00						
			Aluminum	NA	--	--	0.0E+00						
			Antimony	NA	--	--	0.0E+00						
			Arsenic	8.7E-05	--	--	8.7E-05						
			Barium	NA	--	--	0.0E+00						
			Iron	NA	--	--	0.0E+00						
			Manganese	NA	--	--	0.0E+00						
			Nickel	NA	--	--	0.0E+00						
			(Total)	1.0E-03	0.0E+00	0.0E+00	1.0E-03	(Total)		0.0E+00	0.0E+00	0.0E+00	0.0E+00
			Total Risk Across Alluvial Aquifer - Tap Water				1.0E-03	Total Hazard Index Across Alluvial Aquifer - Tap Water					0.0E+00
			Total Risk Across Alluvial Aquifer Groundwater				1.0E-03	Total Hazard Index Across Alluvial Aquifer Groundwater					0.0E+00
Groundwater	Groundwater	BedrockAquifer - Tap Water											
			Trichloroethene	5.4E-05	--	--	5.4E-05						
			Cadmium	NA	--	--	0.0E+00						
			Iron	NA	--	--	0.0E+00						
			Manganese	NA	--	--	0.0E+00						
			Nickel	NA	--	--	0.0E+00						
			(Total)	5.4E-05	0.0E+00	0.0E+00	5.4E-05	(Total)		0.0E+00	0.0E+00	0.0E+00	0.0E+00
			Total Risk Across BedrockAquifer - Tap Water				5.4E-05	Total Hazard Index Across BedrockAquifer - Tap Water					0.0E+00
			Total Risk Across BedrockAquifer Groundwater				5.4E-05	Total Hazard Index Across BedrockAquifer Groundwater					0.0E+00
			Total Risk Across All Media and All Exposure Routes				1.1E-03	Total Hazard Index Across All Media and All Exposure Routes					0.0E+00

TABLE 9.6.RME

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

REASONABLE MAXIMUM EXPOSURE

Site 5, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Receptor Population: Construction Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal Absorption	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal Absorption	Exposure Routes Total
Groundwater	Groundwater	Alluvial Aquifer - Water in Excavation Pit											
			Trichloroethene	--	--	9.0E-06	9.0E-06	Trichloroethene	Liver, Kidney, Fetus	--	--	5.3E+00	5.3E+00
			cis-1,2-Dichloroethene	--	--	NA	0.0E+00	cis-1,2-Dichloroethene	Blood	--	--	1.2E-03	1.2E-03
			Aluminum	--	--	NA	0.0E+00	Aluminum	CNS	--	--	9.1E-03	9.1E-03
			Antimony	--	--	NA	0.0E+00	Antimony	Blood	--	--	3.8E-02	3.8E-02
			Arsenic	--	--	3.9E-08	3.9E-08	Arsenic	Skin/vascular	--	--	6.0E-03	6.0E-03
			Barium	--	--	NA	0.0E+00	Barium	Kidney	--	--	2.3E-03	2.3E-03
			Iron	--	--	NA	0.0E+00	Iron	Gastrointestinal	--	--	1.1E-01	1.1E-01
			Manganese	--	--	NA	0.0E+00	Manganese	CNS	--	--	1.9E-01	1.9E-01
			Nickel	--	--	NA	0.0E+00	Nickel	Whole body	--	--	2.2E-02	2.2E-02
			(Total)	0.0E+00	0.0E+00	9.0E-06	9.0E-06	(Total)		0.0E+00	0.0E+00	5.6E+00	5.6E+00
			Total Risk Across Alluvial Aquifer - Water in Excavation Pit				9.0E-06	Total Hazard Index Across Alluvial Aquifer - Water in Excavation Pit					5.6E+00
Groundwater	Air	Alluvial Aquifer - Volatilization from Water in Excavation Pit											
			Trichloroethene	--	3.8E-07	--	3.8E-07	Trichloroethene	CNS, Liver, Endocrine System	--	3.5E-02	--	3.5E-02
			cis-1,2-Dichloroethene	--	NA	--	0.0E+00	cis-1,2-Dichloroethene	NA	--	NA	--	0.0E+00
			(Total)	0.0E+00	3.8E-07	0.0E+00	3.8E-07	(Total)		0.0E+00	3.5E-02	0.0E+00	3.5E-02
			Total Risk Across Alluvial Aquifer - Volatilization from Water in Excavation Pit				3.8E-07	Total Hazard Index Across Alluvial Aquifer - Volatilization from Water in Excavation Pit					3.5E-02
			Total Risk Across Alluvial Aquifer Groundwater				9.4E-06	Total Hazard Index Across Alluvial Aquifer Groundwater					5.6E+00
			Total Risk Across All Media and All Exposure Routes				9.4E-06	Total Hazard Index Across All Media and All Exposure Routes					5.6E+00

Total Liver HI =	5.3E+00
Total Fetus HI =	5.3E+00
Total Blood HI =	3.9E-02
Total CNS HI =	2.3E-01
Total Gastrointestinal HI =	1.1E-01
Total Skin HI =	6.0E-03
Total Vascular HI =	6.0E-03
Total Kidney HI =	5.3E+00
Total Cardiovascular HI =	2.3E-03
Total Endocrine System HI =	3.5E-02
Total Whole Body HI =	2.2E-02

TABLE 9.7.CT

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

CENTRAL TENDENCY

Site 5, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal Absorption	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal Absorption	Exposure Routes Total
Groundwater	Groundwater	Alluvial Aquifer - Tap Water											
								Trichloroethene	Liver, Kidney, Fetus	8.2E-01	--	--	8.2E-01
								cis-1,2-Dichloroethene	Blood	4.0E-03	--	--	4.0E-03
								Aluminum	CNS	8.7E-03	--	--	8.7E-03
								Antimony	Blood	1.3E-02	--	--	1.3E-02
								Arsenic	Skin/vascular	2.0E-02	--	--	2.0E-02
								Barium	Kidney	8.2E-03	--	--	8.2E-03
								Iron	Gastrointestinal	7.6E-02	--	--	7.6E-02
								Manganese	CNS	2.3E-01	--	--	2.3E-01
								Nickel	Whole body	7.6E-03	--	--	7.6E-03
			(Total)	0.0E+00	0.0E+00	0.0E+00	0.0E+00	(Total)		1.2E+00	0.0E+00	0.0E+00	1.2E+00
			Total Risk Across Alluvial Aquifer - Tap Water				0.0E+00	Total Hazard Index Across Alluvial Aquifer - Tap Water					1.2E+00
Groundwater	Air	Alluvial Aquifer - Water Vapors at Showerhead											
			Trichloroethene	--	2.7E-04	--	2.7E-04						
			cis-1,2-Dichloroethene	--	NA	--	0.0E+00						
			(Total)	0.0E+00	2.7E-04	0.0E+00	2.7E-04	(Total)		0.0E+00	0.0E+00	0.0E+00	0.0E+00
			Total Risk Across Alluvial Aquifer - Water Vapors at Showerhead				2.7E-04	Total Hazard Index Across Alluvial Aquifer - Water Vapors at Showerhead					0.0E+00
			Total Risk Across Alluvial Aquifer Groundwater				2.7E-04	Total Hazard Index Across Alluvial Aquifer Groundwater					1.2E+00
Groundwater	Groundwater	Bedrock Aquifer- Tap Water											
								Trichloroethene	Liver, Kidney, Fetus	3.7E-01	--	--	3.7E-01
								Cadmium	Kidney	4.7E-02	--	--	4.7E-02
								Iron	Gastrointestinal	3.1E+00	--	--	3.1E+00
								Manganese	CNS	9.3E-01	--	--	9.3E-01
								Nickel	Whole body	4.2E-02	--	--	4.2E-02
			(Total)	0.0E+00	0.0E+00	0.0E+00	0.0E+00	(Total)		4.4E+00	0.0E+00	0.0E+00	4.4E+00
			Total Risk Across BedrockAquifer - Tap Water				0.0E+00	Total Hazard Index Across BedrockAquifer - Tap Water					4.4E+00
			Total Risk Across All Media and All Exposure Routes				0.0E+00	Total Hazard Index Across All Media and All Exposure Routes					4.4E+00

Total Liver HI =	1.2E+00
Total Blood HI =	1.7E-02
Total Fetus HI =	1.2E+00
Total CNS HI =	1.2E+00
Total Gastrointestinal HI =	3.1E+00

TABLE 9.7.CT

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

CENTRAL TENDENCY

Site 5, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal Absorption	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal Absorption	Exposure Routes Total
												Total Kidney HI =	1.2E+00
												Total Skin HI =	2.0E-02
												Total Vascular HI =	2.0E-02
												Total Whole Body HI =	4.9E-02

TABLE 9.8.CT

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

CENTRAL TENDENCY

Site 5, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal Absorption	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal Absorption	Exposure Routes Total
Groundwater	Groundwater	Alluvial Aquifer - Tap Water											
			Trichloroethene	--	--	8.1E-06	8.1E-06	Trichloroethene	Liver, Kidney, Fetus	1.4E+01	--	2.4E+00	1.7E+01
			cis-1,2-Dichloroethene	--	--	NA	0.0E+00	cis-1,2-Dichloroethene	Blood	6.9E-02	--	4.4E-03	7.3E-02
			Aluminum	--	--	NA	0.0E+00	Aluminum	CNS	1.5E-01	--	9.2E-04	1.5E-01
			Antimony	--	--	NA	0.0E+00	Antimony	Blood	2.3E-01	--	3.8E-03	2.3E-01
			Arsenic	--	--	7.9E-09	7.9E-09	Arsenic	Skin/vascular	3.5E-01	--	6.0E-04	3.5E-01
			Barium	--	--	NA	0.0E+00	Barium	Kidney	1.4E-01	--	2.4E-04	1.4E-01
			Iron	--	--	NA	0.0E+00	Iron	Gastrointestinal	1.3E+00	--	1.1E-02	1.3E+00
			Manganese	--	--	NA	0.0E+00	Manganese	CNS	4.1E+00	--	1.9E-02	4.1E+00
			Nickel	--	--	NA	0.0E+00	Nickel	Whole body	1.3E-01	--	2.2E-03	1.3E-01
			(Total)	0.0E+00	0.0E+00	8.1E-06	8.1E-06	(Total)		2.1E+01	0.0E+00	2.4E+00	2.3E+01
			Total Risk Across Alluvial Aquifer - Tap Water				8.1E-06	Total Hazard Index Across Alluvial Aquifer - Tap Water					2.3E+01
			Total Risk Across Alluvial Aquifer Groundwater				8.1E-06	Total Hazard Index Across Alluvial Aquifer Groundwater					2.3E+01
Groundwater	Groundwater	Bedrock Aquifer - Tap Water											
								Trichloroethene	Liver, Kidney, Fetus	8.2E-01	--	1.9E-01	1.0E+00
								Cadmium	Kidney	1.0E-01	--	6.7E-03	1.1E-01
								Iron	Gastrointestinal	6.8E+00	--	1.1E-01	6.9E+00
								Manganese	CNS	2.1E+00	--	1.9E-02	2.1E+00
								Nickel	Whole body	9.3E-02	--	3.0E-03	9.6E-02
			(Total)	0.0E+00	0.0E+00	0.0E+00	0.0E+00	(Total)		9.9E+00	0.0E+00	3.3E-01	1.0E+01
			Total Risk Across BedrockAquifer - Tap Water				0.0E+00		Total Hazard Index Across BedrockAquifer - Tap Water				1.0E+01
			Total Risk Across BedrockAquifer Groundwater				0.0E+00		Total Hazard Index Across BedrockAquifer Groundwater				1.0E+01
			Total Risk Across All Media and All Exposure Routes				8.1E-06	Total Hazard Index Across All Media and All Exposure Routes					3.3E+01

Total Liver HI =	1.8E+01
Total Fetus HI =	1.8E+01
Total Blood HI =	3.1E-01
Total CNS HI =	6.3E+00
Total Gastrointestinal HI =	8.3E+00

TABLE 9.9.CT

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

CENTRAL TENDENCY

Site 5, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child/Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal Absorption	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal Absorption	Exposure Routes Total
Groundwater	Groundwater	Alluvial Aquifer - Tap Water											
			Trichloroethene	1.5E-04	--	--	1.5E-04						
			cis-1,2-Dichloroethene	NA	--	--	0.0E+00						
			Aluminum	NA	--	--	0.0E+00						
			Antimony	NA	--	--	0.0E+00						
			Arsenic	1.4E-05	--	--	1.4E-05						
			Barium	NA	--	--	0.0E+00						
			Iron	NA	--	--	0.0E+00						
			Manganese	NA	--	--	0.0E+00						
			Nickel	NA	--	--	0.0E+00						
			(Total)	1.6E-04	0.0E+00	0.0E+00	1.6E-04	(Total)		0.0E+00	0.0E+00	0.0E+00	0.0E+00
			Total Risk Across Alluvial Aquifer - Tap Water				1.6E-04	Total Hazard Index Across Alluvial Aquifer - Tap Water					0.0E+00
			Total Risk Across Alluvial Aquifer Groundwater				1.6E-04	Total Hazard Index Across Alluvial Aquifer Groundwater					0.0E+00
			Total Risk Across All Media and All Exposure Routes				1.6E-04	Total Hazard Index Across All Media and All Exposure Routes					0.0E+00

TABLE 9.10.CT

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

CENTRAL TENDENCY

Site 5, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Receptor Population: Construction Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal Absorption	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal Absorption	Exposure Routes Total
Groundwater	Groundwater	Alluvial Aquifer - Water in Excavation Pit						Trichloroethene	Liver, Kidney, Fetus	--	--	3.9E+00	3.9E+00
								cis-1,2-Dichloroethene	Blood	--	--	9.1E-04	9.1E-04
								Aluminum	CNS	--	--	6.8E-03	6.8E-03
								Antimony	Blood	--	--	2.8E-02	2.8E-02
								Arsenic	Skin/vascular	--	--	4.5E-03	4.5E-03
								Barium	Kidney	--	--	1.7E-03	1.7E-03
								Iron	Gastrointestinal	--	--	8.0E-02	8.0E-02
								Manganese	CNS	--	--	1.4E-01	1.4E-01
								Nickel	Whole body	--	--	1.6E-02	1.6E-02
			(Total)	0.0E+00	0.0E+00	0.0E+00	0.0E+00	(Total)		0.0E+00	0.0E+00	4.2E+00	4.2E+00
			Total Risk Across Alluvial Aquifer - Water in Excavation Pit				0.0E+00	Total Hazard Index Across Alluvial Aquifer - Water in Excavation Pit					4.2E+00
			Total Risk Across Alluvial Aquifer Groundwater				0.0E+00	Total Hazard Index Across Alluvial Aquifer Groundwater					4.2E+00
			Total Risk Across All Media and All Exposure Routes				0.0E+00	Total Hazard Index Across All Media and All Exposure Routes					4.2E+00

Total Liver HI =	3.9E+00
Total Fetus HI =	3.9E+00
Total Blood HI =	6.8E-03
Total CNS HI =	1.5E-01
Total Gastrointestinal HI =	8.0E-02
Total Kidney HI =	3.9E+00
Total Skin HI =	4.5E-03
Total vascular HI =	4.5E-03
Total Whole Body HI =	1.6E-02

TABLE 10.1.RME

RISK ASSESSMENT SUMMARY

REASONABLE MAXIMUM EXPOSURE

Site 5, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal Absorption	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal Absorption	Exposure Routes Total
Groundwater	Groundwater	Alluvial Aquifer - Tap Water											
								Trichloroethene	Liver, Kidney, Fetus	1.4E+01	--	--	1.4E+01
								Aluminum	CNS	1.4E-01	--	--	1.4E-01
								Antimony	Blood	2.2E-01	--	--	2.2E-01
								Arsenic	Skin/vascular	3.3E-01	--	--	3.3E-01
								Barium	Kidney	1.4E-01	--	--	1.4E-01
								Iron	Gastrointestinal	1.3E+00	--	--	1.3E+00
								Manganese	CNS	3.9E+00	--	--	3.9E+00
								Nickel	Whole body	1.3E-01	--	--	1.3E-01
			(Total)	0.0E+00	0.0E+00	0.0E+00	0.0E+00	(Total)		2.0E+01	0.0E+00	0.0E+00	2.0E+01
			Total Risk Across Alluvial Aquifer - Tap Water				0.0E+00	Total Hazard Index Across Alluvial Aquifer - Tap Water					2.0E+01
Groundwater	Air	Alluvial Aquifer - Water Vapors at Showerhead											
			Trichloroethene	--	1.1E-03	--	1.1E-03						
			(Total)	0.0E+00	1.1E-03	0.0E+00	1.1E-03	(Total)		0.0E+00	0.0E+00	0.0E+00	0.0E+00
			Total Risk Across Alluvial Aquifer - Water Vapors at Showerhead				1.1E-03	Total Hazard Index Across Alluvial Aquifer - Water Vapors at Showerhead					0.0E+00
			Total Risk Across Alluvial Aquifer Groundwater				1.1E-03	Total Hazard Index Across Alluvial Aquifer Groundwater					2.0E+01
Groundwater	Groundwater	Bedrock Aquifer- Tap Water											
								Trichloroethene	Liver, Kidney, Fetus	7.8E-01	--	--	7.8E-01
								Cadmium	Kidney	1.0E-01	--	--	1.0E-01
								Iron	Gastrointestinal	6.5E+00	--	--	6.5E+00
								Manganese	CNS	2.0E+00	--	--	2.0E+00
			(Total)	0.0E+00	0.0E+00	0.0E+00	0.0E+00	(Total)		9.4E+00	0.0E+00	0.0E+00	9.4E+00
			Total Risk Across BedrockAquifer - Tap Water				0.0E+00	Total Hazard Index Across BedrockAquifer - Tap Water					9.4E+00
			Total Risk Across Bedrock Aquifer Groundwater				1.1E-03	Total Hazard Index Across Bedrock Aquifer Groundwater					2.9E+01
			Total Risk Across All Media and All Exposure Routes				1.1E-03	Total Hazard Index Across All Media and All Exposure Routes					4.9E+01

Total Liver HI =	1.4E+01
Total Fetus HI =	1.4E+01
Total Blood HI =	2.2E-01
Total CNS HI =	6.0E+00
Total Gastrointestinal HI =	7.8E+00
Total Kidney HI =	1.5E+01

TABLE 10.2.RME

RISK ASSESSMENT SUMMARY

REASONABLE MAXIMUM EXPOSURE

Site 5, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal Absorption	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal Absorption	Exposure Routes Total
Groundwater	Groundwater	Alluvial Aquifer - Tap Water											
								Trichloroethene	Liver, Kidney, Fetus	3.7E+01	--	4.9E+00	4.2E+01
								cis-1,2-Dichloroethene	Blood	1.8E-01	--	9.3E-03	1.9E-01
								Aluminum	CNS	3.9E-01	--	2.7E-03	3.9E-01
								Antimony	Blood	6.0E-01	--	1.1E-02	6.1E-01
								Arsenic	Skin/vascular	9.1E-01	--	1.7E-03	9.1E-01
								Barium	Kidney	3.7E-01	--	6.8E-04	3.7E-01
								Iron	Gastrointestinal	3.4E+00	--	3.2E-02	3.5E+00
								Manganese	CNS	1.1E+01	--	5.6E-02	1.1E+01
								Nickel	Whole body	3.4E-01	--	6.3E-03	3.5E-01
			(Total)	0.0E+00	0.0E+00	0.0E+00	0.0E+00	(Total)		5.4E+01	0.0E+00	5.0E+00	5.9E+01
			Total Risk Across Alluvial Aquifer - Tap Water				0.0E+00	Total Hazard Index Across Alluvial Aquifer - Tap Water					5.9E+01
			Total Risk Across Alluvial Aquifer Groundwater				0.0E+00	Total Hazard Index Across Alluvial Aquifer Groundwater					5.9E+01
Groundwater	Groundwater	Bedrock Aquifer - Tap Water											
								Trichloroethene	Liver, Kidney, Fetus	2.1E+00	--	2.8E-01	2.4E+00
								Cadmium	Kidney	2.7E-01	--	1.0E-02	2.8E-01
								Iron	Gastrointestinal	1.8E+01	--	1.6E-01	1.8E+01
								Manganese	CNS	5.4E+00	--	2.9E-02	5.5E+00
								Nickel	Whole body	2.4E-01	--	4.5E-03	2.5E-01
			(Total)	0.0E+00	0.0E+00	0.0E+00	0.0E+00	(Total)		2.6E+01	0.0E+00	4.9E-01	2.6E+01
			Total Risk Across BedrockAquifer - Tap Water				0.0E+00		Total Hazard Index Across BedrockAquifer - Tap Water				2.6E+01
			Total Risk Across BedrockAquifer Groundwater				0.0E+00		Total Hazard Index Across BedrockAquifer Groundwater				2.6E+01
			Total Risk Across All Media and All Exposure Routes				0.0E+00	Total Hazard Index Across All Media and All Exposure Routes					8.5E+01

Total Liver HI =	4.5E+01
Total Fetus HI =	4.5E+01
Total Blood HI =	8.0E-01
Total CNS HI =	1.6E+01
Total Gastrointestinal HI =	2.1E+01

TABLE 10.3.RME

RISK ASSESSMENT SUMMARY

REASONABLE MAXIMUM EXPOSURE

Site 5, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child/Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal Absorption	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal Absorption	Exposure Routes Total
Groundwater	Groundwater	Alluvial Aquifer - Tap Water											
			Trichloroethene	9.5E-04	--	--	9.5E-04						
			Arsenic	8.7E-05	--	--	8.7E-05						
			(Total)	1.0E-03	0.0E+00	0.0E+00	1.0E-03	(Total)		0.0E+00	0.0E+00	0.0E+00	0.0E+00
			Total Risk Across Alluvial Aquifer - Tap Water				1.0E-03	Total Hazard Index Across Alluvial Aquifer - Tap Water					0.0E+00
			Total Risk Across Alluvial Aquifer Groundwater				1.0E-03	Total Hazard Index Across Alluvial Aquifer Groundwater					0.0E+00

TABLE 10.4.RME

RISK ASSESSMENT SUMMARY

REASONABLE MAXIMUM EXPOSURE

Site 5, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Receptor Population: Construction Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal Absorption	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal Absorption	Exposure Routes Total
Groundwater	Groundwater	Alluvial Aquifer - Water in Excavation Pit											
								Trichloroethene	Liver, Kidney, Fetus	--	--	5.3E+00	5.3E+00
								Iron	Gastrointestinal	--	--	1.1E-01	1.1E-01
								Manganese	CNS	--	--	1.9E-01	1.9E-01
			(Total)	0.0E+00	0.0E+00	0.0E+00	0.0E+00	(Total)		0.0E+00	0.0E+00	5.6E+00	5.6E+00
			Total Risk Across Alluvial Aquifer - Water in Excavation Pit				0.0E+00	Total Hazard Index Across Alluvial Aquifer - Water in Excavation Pit					5.6E+00
			Total Risk Across All Media and All Exposure Routes				0.0E+00	Total Hazard Index Across All Media and All Exposure Routes					5.6E+00

Total Liver HI =	5.3E+00
Total Fetus HI =	5.3E+00
Total CNS HI =	1.9E-01
Total Gastrointestinal HI =	1.1E-01
Total Kidney HI =	5.3E+00

TABLE 10.5.CT

RISK ASSESSMENT SUMMARY

CENTRAL TENDENCY

Site 5, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal Absorption	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal Absorption	Exposure Routes Total
Groundwater	Groundwater	Alluvial Aquifer - Tap Water						Manganese	CNS	2.3E-01	--	--	2.3E-01
								Nickel	Whole body	2.2E+00	--	--	2.2E+00
			(Total)	0.0E+00	0.0E+00	0.0E+00	0.0E+00	(Total)		2.4E+00	0.0E+00	0.0E+00	2.4E+00
			Total Risk Across Alluvial Aquifer - Tap Water				0.0E+00	Total Hazard Index Across Alluvial Aquifer - Tap Water					2.4E+00
Groundwater	Air	Alluvial Aquifer - Water Vapors at Showerhead	Trichloroethene	--	2.7E-04	--	2.7E-04						
			(Total)	0.0E+00	2.7E-04	0.0E+00	2.7E-04	(Total)		0.0E+00	0.0E+00	0.0E+00	0.0E+00
			Total Risk Across Alluvial Aquifer - Water Vapors at Showerhead				2.7E-04	Total Hazard Index Across Alluvial Aquifer - Water Vapors at Showerhead					0.0E+00
			Total Risk Across Alluvial Aquifer Groundwater				2.7E-04	Total Hazard Index Across Alluvial Aquifer Groundwater					2.4E+00
Groundwater	Groundwater	Bedrock Aquifer- Tap Water						Trichloroethene	Liver, Kidney, Fetus	3.7E-01	--	--	3.7E-01
								Iron	Gastrointestinal	3.1E+00	--	--	3.1E+00
								Manganese	CNS	9.3E-01	--	--	9.3E-01
			(Total)	0.0E+00	0.0E+00	0.0E+00	0.0E+00	(Total)		4.4E+00	0.0E+00	0.0E+00	4.4E+00
			Total Risk Across BedrockAquifer - Tap Water				0.0E+00	Total Hazard Index Across BedrockAquifer - Tap Water					4.4E+00
			Total Risk Across All Media and All Exposure Routes				0.0E+00	Total Hazard Index Across All Media and All Exposure Routes					4.4E+00

Total Liver HI =	3.7E-01
Total Fetus HI =	3.7E-01
Total CNS HI =	1.2E+00
Total Gastrointestinal HI =	3.1E+00
Total Kidney HI =	3.7E-01
Total Whole Body HI =	2.2E+00

TABLE 10.6.CT

RISK ASSESSMENT SUMMARY

CENTRAL TENDENCY

Site 5, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal Absorption	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal Absorption	Exposure Routes Total
Groundwater	Groundwater	Alluvial Aquifer - Tap Water											
								Trichloroethene	Liver, Kidney, Fetus	1.4E+01	--	2.4E+00	1.7E+01
								Aluminum	CNS	1.5E-01	--	9.2E-04	1.5E-01
								Antimony	Blood	2.3E-01	--	3.8E-03	2.3E-01
								Arsenic	Skin/vascular	3.5E-01	--	6.0E-04	3.5E-01
								Barium	Kidney	1.4E-01	--	2.4E-04	1.4E-01
								Iron	Gastrointestinal	1.3E+00	--	1.1E-02	1.3E+00
								Manganese	CNS	4.1E+00	--	1.9E-02	4.1E+00
								Nickel	Whole body	1.3E-01	--	2.2E-03	1.3E-01
			(Total)	0.0E+00	0.0E+00	0.0E+00	0.0E+00	(Total)		2.1E+01	0.0E+00	2.4E+00	2.3E+01
			Total Risk Across Alluvial Aquifer - Tap Water				0.0E+00	Total Hazard Index Across Alluvial Aquifer - Tap Water					2.3E+01
			Total Risk Across Alluvial Aquifer Groundwater				0.0E+00	Total Hazard Index Across Alluvial Aquifer Groundwater					2.3E+01
Groundwater	Groundwater	Bedrock Aquifer - Tap Water											
								Trichloroethene	Liver, Kidney, Fetus	8.2E-01	--	1.9E-01	1.0E+00
								Cadmium	Kidney	1.0E-01	--	6.7E-03	1.1E-01
								Iron	Gastrointestinal	6.8E+00	--	1.1E-01	6.9E+00
								Manganese	CNS	2.1E+00	--	1.9E-02	2.1E+00
			(Total)	0.0E+00	0.0E+00	0.0E+00	0.0E+00	(Total)		9.8E+00	0.0E+00	3.2E-01	1.0E+01
			Total Risk Across BedrockAquifer - Tap Water				0.0E+00	Total Hazard Index Across BedrockAquifer - Tap Water					1.0E+01
			Total Risk Across BedrockAquifer Groundwater				0.0E+00	Total Hazard Index Across BedrockAquifer Groundwater					1.0E+01
			Total Risk Across All Media and All Exposure Routes				0.0E+00	Total Hazard Index Across All Media and All Exposure Routes					3.3E+01

Total Liver HI =	1.8E+01
Total Fetus HI =	1.8E+01
Total Blood HI =	2.3E-01
Total CNS HI =	6.3E+00
Total Gastrointestinal HI =	8.3E+00
Total Kidney HI =	1.8E+01
Total Skin HI =	3.5E-01
Total Vascular HI =	3.5E-01
Total Whole Body HI =	1.3E-01

TABLE 10.7.CT

RISK ASSESSMENT SUMMARY

CENTRAL TENDENCY

Site 5, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child/Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal Absorption	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal Absorption	Exposure Routes Total
Groundwater	Groundwater	Alluvial Aquifer - Tap Water											
			Trichloroethene	1.5E-04	--	--	1.5E-04						
			Arsenic	1.4E-05	--	--	1.4E-05						
			(Total)	1.6E-04	0.0E+00	0.0E+00	1.6E-04	(Total)		0.0E+00	0.0E+00	0.0E+00	0.0E+00
			Total Risk Across Alluvial Aquifer - Tap Water				1.6E-04	Total Hazard Index Across Alluvial Aquifer - Tap Water					0.0E+00
			Total Risk Across Alluvial Aquifer Groundwater				1.6E-04	Total Hazard Index Across Alluvial Aquifer Groundwater					0.0E+00
			Total Risk Across All Media and All Exposure Routes				1.6E-04	Total Hazard Index Across All Media and All Exposure Routes					0.0E+00

TABLE 10.8.CT

RISK ASSESSMENT SUMMARY

CENTRAL TENDENCY

Site 5, Allegany Ballistics Laboratory

Scenario Timeframe: Future
Receptor Population: Construction Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal Absorption	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal Absorption	Exposure Routes Total
Groundwater	Groundwater	Alluvial Aquifer - Water in Excavation Pit						Trichloroethene	Liver, Kidney, Fetus	--	--	3.9E+00	3.9E+00
								Manganese	CNS	--	--	1.4E-01	1.4E-01
			(Total)	0.0E+00	0.0E+00	0.0E+00	0.0E+00	(Total)		0.0E+00	0.0E+00	4.1E+00	4.1E+00
			Total Risk Across Alluvial Aquifer - Water in Excavation Pit				0.0E+00	Total Hazard Index Across Alluvial Aquifer - Water in Excavation Pit					4.1E+00
			Total Risk Across Alluvial Aquifer Groundwater				0.0E+00	Total Hazard Index Across Alluvial Aquifer Groundwater					4.1E+00
			Total Risk Across All Media and All Exposure Routes				0.0E+00	Total Hazard Index Across All Media and All Exposure Routes					4.1E+00

Total Liver HI =	3.9E+00
Total Fetus HI =	3.9E+00
Total CNS HI =	1.4E-01
Total Kidney HI =	3.9E+00

Appendix G
Ecological Risk Assessment Tables

Table G-1
Analytical Data - Surface Water -
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Chemical	5SD-1/5SW-1				5SD-2/5SW-2				
	AS05-5SW01-R05 08/03/00	AS05-5SW01-R06 06/20/01	AS05-5SW01-R07 02/26/02	AS05-5SW01P-R07 02/26/02	AS05-5SW02-R05 08/03/00	AS05-5SW02P-R05 08/03/00	AS05-5SW02-R06 06/20/01	AS05-5SW02P-R06 06/20/01	AS05-5SW02-R07 02/25/02
Inorganics (UG/L)									
Aluminum	405	171 J	147 J	149 J	408 B	339 B	204	208	148 J
Antimony	5.53 B	3.70 U	5.00 U	5.00 U	7.20 B	4.90 U	3.70 U	3.70 U	5.00 U
Arsenic	3.80 U	5.00 U	5.10 U	5.10 U	3.80 U	3.80 U	5.00 U	5.00 U	5.10 U
Barium	44.5 B	51.8 J	64.1 J	64.2 J	46.0 J	45.0 J	52.6 J	59.4 J	63.1 J
Beryllium	0.15 B	0.10 U	0.10 U	0.10 U	0.14 B	0.12 B	0.10 U	0.10 U	0.10 U
Cadmium	0.40 U	3.00 U	1.70 U	1.70 U	0.40 U	0.42 B	3.00 U	3.00 U	1.70 U
Calcium	53,574	50,700	55,900	55,600	54,500	54,800	52,100	58,600	53,000
Chromium	0.70 U	5.00 U	1.10 J	0.60 U	0.70 UL	0.70 UL	5.00 U	5.00 U	0.60 U
Cobalt	2.23 B	1.80 U	1.30 J	1.40 J	2.50 J	1.20 J	1.80 U	1.80 U	1.30 U
Copper	2.04 B	2.20 U	1.50 U	1.50 U	1.70 B	1.50 B	2.20 U	2.20 U	1.50 U
Cyanide	10.0 U	10.0 U	10.0 U	NA	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U
Iron	749	281	117	139	970	636	308	278	132
Lead	2.00 U	3.00 U	3.40	2.90 U	3.20 K	4.80 K	3.00 U	3.00 U	2.90 U
Magnesium	12,403	13,400	11,500	11,500	12,600	12,600	13,800	15,600	11,000
Manganese	210	177	278	277	221	214	177	198	269
Mercury	0.12 B	0.20 U	0.20 U	0.20 U	0.10 U	0.10 U	0.39	0.38	0.20 U
Nickel	2.35 B	5.40 J	7.60 J	7.70 J	2.00 U	4.40 B	5.80 J	6.70 J	7.00 J
Potassium	3,558 B	3,030 J	3,560 J	3,650 J	3,510 J	3,490 J	3,130 J	3,570 J	3,640 J
Selenium	2.68 B	5.00 U	4.00 U	4.00 U	2.20 U	2.20 U	5.00 U	5.00 U	4.00 U
Silver	0.60 U	5.00 U	0.60 U	0.60 U	0.60 UL	0.60 UL	5.00 U	5.00 U	0.60 U
Sodium	26,807	28,100	37,500 J	37,800 J	26,000 J	26,000 J	28,800	32,700	38,600 J
Thallium	2.30 U	5.70 U	5.00 U	5.00 U	4.50 B	2.30 U	5.70 U	5.70 U	5.00 U
Vanadium	1.00 U	3.20 U	1.40 B	1.40 B	1.00 U	1.00 U	3.20 U	3.20 U	1.40 B
Zinc	37.5	20.5	36.0 B	31.2 B	30.0 B	29.6 B	25.6	33.6	32.8
Dissolved Metals (UG/L)									
Aluminum	NA	93.8 B	NA	NA	NA	NA	75.8 B	76.6 B	NA
Antimony	NA	8.90 U	NA	NA	NA	NA	8.90 U	8.90 U	NA
Arsenic	NA	6.20 U	NA	NA	NA	NA	6.20 U	6.20 U	NA
Barium	NA	54.8 J	NA	NA	NA	NA	54.0 J	52.5 J	NA
Beryllium	NA	0.11 J	NA	NA	NA	NA	0.10 U	0.10 U	NA
Cadmium	NA	0.60 U	NA	NA	NA	NA	0.60 U	0.60 U	NA
Calcium	NA	54,700	NA	NA	NA	NA	53,800	52,500	NA
Chromium	NA	0.60 U	NA	NA	NA	NA	0.60 U	1.70 J	NA
Cobalt	NA	0.90 U	NA	NA	NA	NA	0.90 U	0.90 U	NA
Copper	NA	3.40 B	NA	NA	NA	NA	3.50 B	4.00 J	NA
Iron	NA	15.8 U	NA	NA	NA	NA	44.8 J	61.1 B	NA
Lead	NA	3.00 U	NA	NA	NA	NA	3.00 U	3.00 U	NA
Magnesium	NA	14,400	NA	NA	NA	NA	14,400	14,000	NA
Manganese	NA	7.60 B	NA	NA	NA	NA	7.10 B	8.40 B	NA
Mercury	NA	0.20 U	NA	NA	NA	NA	0.20 U	0.20 U	NA
Nickel	NA	4.40 B	NA	NA	NA	NA	5.30 B	6.90 B	NA
Potassium	NA	3,640 J	NA	NA	NA	NA	3,520 J	3,420 J	NA
Selenium	NA	1.60 U	NA	NA	NA	NA	1.60 U	1.60 U	NA
Silver	NA	1.70 U	NA	NA	NA	NA	1.70 U	1.70 U	NA
Sodium	NA	29,900	NA	NA	NA	NA	30,100	29,200	NA
Thallium	NA	4.30 U	NA	NA	NA	NA	4.30 U	4.30 U	NA
Vanadium	NA	1.20 U	NA	NA	NA	NA	1.20 U	1.20 U	NA
Zinc	NA	39.9	NA	NA	NA	NA	30.2	36.2	NA

Table G-1
Analytical Data - Surface Water -
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

	5SD-1/5SW-1				5SD-2/5SW-2				
Chemical	AS05-5SW01-R05 08/03/00	AS05-5SW01-R06 06/20/01	AS05-5SW01-R07 02/26/02	AS05-5SW01P-R07 02/26/02	AS05-5SW02-R05 08/03/00	AS05-5SW02P-R05 08/03/00	AS05-5SW02-R06 06/20/01	AS05-5SW02P-R06 06/20/01	AS05-5SW02-R07 02/25/02
Volatile Organic Compounds (UG/L)									
1,1,1-Trichloroethane	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
1,1,2,2-Tetrachloroethane	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
1,1,2-Trichloroethane	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
1,1-Dichloroethane	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
1,1-Dichloroethene	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
1,2,4-Trichlorobenzene	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
1,2-Dibromo-3-chloropropane	1.00 UJ	1.00 R	1.00 U	1.00 U	1.00 UJ	1.00 UJ	1.00 R	1.00 R	1.00 U
1,2-Dibromoethane	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
1,2-Dichlorobenzene	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
1,2-Dichloroethane	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
1,2-Dichloropropane	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
1,3-Dichlorobenzene	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
1,4-Dichlorobenzene	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
2-Butanone	5.00 R	5.00 R	5.00 R	5.00 R	5.00 R	5.00 R	5.00 R	5.00 R	5.00 R
2-Hexanone	5.00 UJ	5.00 R	5.00 UJ	5.00 UJ	5.00 UJ	5.00 UJ	5.00 R	5.00 R	5.00 UJ
4-Methyl-2-pentanone	5.00 UJ	5.00 U	5.00 UJ	5.00 UJ	5.00 UJ	5.00 UJ	5.00 U	5.00 U	5.00 UJ
Acetone	5.00 R	5.00 R	5.00 R	5.00 R	5.00 R	5.00 R	5.00 R	5.00 R	5.00 R
Benzene	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
Bromochloromethane	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
Bromodichloromethane	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
Bromoform	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
Bromomethane	1.00 UJ	1.00 U	1.00 U	1.00 U	1.00 UJ	1.00 UJ	1.00 U	1.00 U	1.00 U
Carbon disulfide	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
Carbon tetrachloride	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
Chlorobenzene	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
Chloroethane	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
Chloroform	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
Chloromethane	1.00 UJ	1.00 U	1.00 U	1.00 U	1.00 UJ	1.00 UJ	1.00 U	1.00 U	1.00 U
Dibromochloromethane	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
Ethylbenzene	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
Methylene chloride	1.10 B	2.00 U	2.00 U	2.00 U	1.30 B	1.30 B	2.00 U	2.00 U	2.00 U
Styrene	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
Tetrachloroethene	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
Toluene	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
Trichloroethene	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
Vinyl chloride	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
Xylene, total	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
cis-1,2-Dichloroethene	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
cis-1,3-Dichloropropene	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
m- and p-Xylene	1.00 U	NA	NA	NA	1.00 U	1.00 U	NA	NA	NA
o-Xylene	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
trans-1,2-Dichloroethene	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
trans-1,3-Dichloropropene	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
Other Parameters (MG/L)									
Hardness	NA	180	NA	NA	NA	NA	190	210	NA

Table G-1
Analytical Data - Surface Water -
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

	5SD-3/5SW-3			5SD-4/5SW-4		
Chemical	AS05-5SW03-R05 08/03/00	AS05-5SW03-R06 06/20/01	AS05-5SW03-R07 02/26/02	AS05-5SW04-R05 08/03/00	AS05-5SW04-R06 06/20/01	AS05-5SW04-R07 02/25/02
Inorganics (UG/L)						
Aluminum	419	214	170 J	414 B	192 J	246
Antimony	4.90 U	3.70 U	5.00 U	4.90 U	3.70 U	5.00 U
Arsenic	3.80 U	5.00 U	5.10 U	3.80 U	5.00 U	5.10 J
Barium	50.4 J	55.8 J	65.9 J	45.6 J	54.8 J	65.8 J
Beryllium	0.12 B	0.10 U	0.10 U	0.16 B	0.10 U	0.10 U
Cadmium	0.40 U	3.00 U	1.70 U	0.40 U	3.00 U	1.70 U
Calcium	60,600	54,000	56,000	53,700	54,300	55,900
Chromium	0.70 UL	5.00 U	0.60 U	0.70 UL	5.00 U	1.30 J
Cobalt	1.70 J	1.80 U	2.00 J	2.40 J	1.80 U	2.20 J
Copper	2.20 B	2.20 U	1.50 U	1.70 B	2.20 U	1.50 U
Cyanide	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U
Iron	878	383	219	801	310	355
Lead	2.40 K	3.00 U	4.00	3.90 K	3.00 U	2.90 U
Magnesium	14,000	14,400	11,600	12,300	14,500	11,700
Manganese	238	229	376	235	189	305
Mercury	0.10 U	0.20 U	0.20 U	0.10 U	0.20 U	0.20 U
Nickel	3.00 B	5.50 J	8.10 J	3.40 B	5.80 J	9.30 J
Potassium	4,010 J	3,180 J	3,670 J	3,530 J	3,280 J	3,850 J
Selenium	2.20 U	5.00 U	4.00 U	2.20 U	5.00 U	4.00 U
Silver	0.60 UL	5.00 U	0.60 U	0.60 UL	5.00 U	0.60 U
Sodium	29,400 J	29,700	37,300 J	26,300 J	30,500	40,300 J
Thallium	2.30 U	5.70 U	5.00 U	2.30 U	5.70 U	5.00 U
Vanadium	1.00 U	3.20 U	1.80 B	1.00 U	3.20 U	2.10 B
Zinc	39.4 B	18.2 J	39.2 B	34.7 B	17.8 J	47.7
Dissolved Metals (UG/L)						
Aluminum	NA	73.7 B	NA	NA	93.5 B	NA
Antimony	NA	8.90 U	NA	NA	8.90 U	NA
Arsenic	NA	6.20 U	NA	NA	6.20 U	NA
Barium	NA	51.6 J	NA	NA	52.0 J	NA
Beryllium	NA	0.10 U	NA	NA	0.10 U	NA
Cadmium	NA	0.60 U	NA	NA	0.60 U	NA
Calcium	NA	52,000	NA	NA	53,800	NA
Chromium	NA	0.69 J	NA	NA	1.40 J	NA
Cobalt	NA	0.90 U	NA	NA	0.90 U	NA
Copper	NA	3.20 B	NA	NA	3.40 B	NA
Iron	NA	28.6 J	NA	NA	21.6 B	NA
Lead	NA	3.00 U	NA	NA	3.00 U	NA
Magnesium	NA	13,900	NA	NA	14,400	NA
Manganese	NA	8.20 B	NA	NA	5.90 B	NA
Mercury	NA	0.20 U	NA	NA	0.20 U	NA
Nickel	NA	4.50 B	NA	NA	6.60 B	NA
Potassium	NA	3,330 J	NA	NA	3,470 J	NA
Selenium	NA	1.60 U	NA	NA	1.60 U	NA
Silver	NA	1.70 U	NA	NA	1.70 U	NA
Sodium	NA	28,300	NA	NA	29,300	NA
Thallium	NA	4.30 U	NA	NA	4.30 U	NA
Vanadium	NA	1.20 U	NA	NA	1.20 U	NA
Zinc	NA	27.9	NA	NA	29.6	NA

Table G-1
Analytical Data - Surface Water -
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

	5SD-3/5SW-3			5SD-4/5SW-4		
Chemical	AS05-5SW03-R05 08/03/00	AS05-5SW03-R06 06/20/01	AS05-5SW03-R07 02/26/02	AS05-5SW04-R05 08/03/00	AS05-5SW04-R06 06/20/01	AS05-5SW04-R07 02/25/02
Volatile Organic Compounds (UG/L)						
1,1,1-Trichloroethane	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
1,1,2,2-Tetrachloroethane	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
1,1,2-Trichloroethane	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
1,1-Dichloroethane	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
1,1-Dichloroethene	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
1,2,4-Trichlorobenzene	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
1,2-Dibromo-3-chloropropane	1.00 UJ	1.00 R	1.00 U	1.00 UJ	1.00 R	1.00 U
1,2-Dibromoethane	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
1,2-Dichlorobenzene	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
1,2-Dichloroethane	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
1,2-Dichloropropane	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
1,3-Dichlorobenzene	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
1,4-Dichlorobenzene	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
2-Butanone	5.00 R	5.00 R	5.00 R	5.00 R	5.00 R	5.00 R
2-Hexanone	5.00 UJ	5.00 R	5.00 UJ	5.00 UJ	5.00 R	5.00 UJ
4-Methyl-2-pentanone	5.00 UJ	5.00 U	5.00 UJ	5.00 UJ	5.00 U	5.00 UJ
Acetone	5.00 R	5.00 R	5.00 R	5.00 R	5.00 R	5.00 R
Benzene	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
Bromochloromethane	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
Bromodichloromethane	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
Bromoform	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
Bromomethane	1.00 UJ	1.00 U	1.00 U	1.00 UJ	1.00 U	1.00 U
Carbon disulfide	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
Carbon tetrachloride	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
Chlorobenzene	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
Chloroethane	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
Chloroform	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
Chloromethane	1.00 UJ	1.00 U	1.00 U	1.00 UJ	1.00 U	1.00 U
Dibromochloromethane	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
Ethylbenzene	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
Methylene chloride	1.40 B	2.00 U	2.00 U	1.40 B	2.00 U	2.00 U
Styrene	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
Tetrachloroethene	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
Toluene	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
Trichloroethene	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
Vinyl chloride	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
Xylene, total	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
cis-1,2-Dichloroethene	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
cis-1,3-Dichloropropene	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
m- and p-Xylene	1.00 U	NA	NA	1.00 U	NA	NA
o-Xylene	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
trans-1,2-Dichloroethene	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
trans-1,3-Dichloropropene	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
Other Parameters (MG/L)						
Hardness	NA	190	NA	NA	200	NA

Table G-2
Analytical Data - Sediment - Focused RI/FS
Site 5 Allegany Ballistics Laboratory
Rocket Center, West Virginia

	5SD-1/5SW-1					5SD-1/5SW-1	5SD-1A	5SD-1B	5SD-2/5SW-2		
Chemical	5SD-1(94) 11/16/94	AS05-5SD01-R01 05/08/98	AS05-5SD01-R05 08/03/00	AS05-5SD01-R06 06/20/01	AS05-5SD01-R07 02/26/02	AS05-5SD01P-R07 02/26/02	AS05-5SD01A 02/27/02	AS05-5SD01B 02/27/02	5SD-2(94) 11/16/94	5SD-2(94)DUP 11/16/94	AS05-5SD02-R01 05/08/98
Inorganics (MG/KG)											
Aluminum	4,780	7,820 J	3,990	6,520	9,670	11,100	4,910	4,410	5,780	5,170	13,700 J
Antimony	9.20 UJ	1.10 L	1.50 U	1.40 U	2.70 U	2.90 U	0.76 UL	1.00 L	9.20 UJ	8.70 UJ	0.73 UL
Arsenic	8.40	9.40	6.10	10.2	16.1	17.5	7.30	9.10	8.10	8.60	24.1
Barium	65.4	128 J	70.4	152	182	195	62.8	54.1 J	55.0 B	44.8 B	149 J
Beryllium	1.60	2.20	1.30 J	1.70 J	2.50 J	2.70 J	1.10 J	1.20 J	1.50	1.30 B	2.90
Boron	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cadmium	1.60	0.080 U	0.12 U	1.10 U	0.93 U	1.00 U	0.068 U	0.083 U	1.50	1.30 B	0.090 U
Calcium	2,300	4,210 J	3,470	4,760	7,520	7,580	2,250	1,190 J	1,580	1,340 B	4,780 J
Chromium	9.70	15.6	7.10	14.7	17.2	16.9	8.90	12.2	14.3	12.5	31.0
Cobalt	39.5	44.2	31.7	44.3	66.3	73.4	25.4	27.6	24.5	20.3	28.0
Copper	24.5	38.9	22.3	30.7	50.2	51.0	14.0	18.4	31.0	44.6	67.5
Cyanide	1.50 U	NA	1.70	0.93 U	1.40 U	1.50 U	NA	NA	1.50 U	1.50 U	NA
Iron	28,300	34,800 J	18,600	27,200	34,900	33,700	23,600 J	29,900 J	27,500	24,100	47,100 J
Lead	21.2	36.0	24.3	37.9	35.9	39.8	15.0 K	22.8 K	32.5	31.0	43.6
Magnesium	616 B	1,240 J	797 J	1,130 J	1,870 J	2,150 J	836 J	559 J	720 B	646 B	1,040 J
Manganese	855	941 J	1,190	1,130	1,240	1,160	1,050 K	482 K	341	237	603 J
Mercury	0.060 UJ	0.070 U	0.21 B	0.17 U	0.38 L	0.46 L	0.039 U	0.046 U	0.17 J	0.10 J	0.24 B
Nickel	63.4	63.7	50.0	70.6	117	132	45.9	49.9	44.7	40.3	48.8
Potassium	573 B	948 J	532 J	849 J	854 J	1,090 J	775 J	726 J	576 B	520 B	843 J
Selenium	0.75 B	1.00 U	0.68 U	2.10	2.40 J	2.30 U	0.71 U	0.77 U	0.57 U	1.20 B	1.10 U
Silver	1.10 UJ	2.40 B	0.18 UL	1.80 U	0.33 U	0.52 J	0.22 UL	0.27 UL	1.10 UJ	1.10 UJ	3.10 B
Sodium	73.2 U	59.1 B	299 B	181 U	298 J	476 J	171 J	179 J	115 B	76.0 B	114 B
Thallium	0.86 U	0.48 U	3.40 B	2.10 U	2.70 U	2.90 U	1.30 J	1.50 J	0.86 U	0.82 U	1.10 J
Vanadium	15.6	23.8	11.3 J	16.7 J	26.3 J	29.4	14.7	15.4 J	17.4	15.4	28.0
Zinc	194 J	221 J	141	203	337	388	120 J	153 J	154 J	144 J	209 J
Semivolatile Organic Compounds (UG/KG)											
1,1-Biphenyl	NA	NA	NA	620 U	890 U	960 U	NA	NA	NA	NA	NA
1-Methylnaphthalene	NA	NA	NA	NA	20.0	NA	7.10	4.00	NA	NA	NA
2,2'-Oxybis(1-chloropropane)	490 U	440 U	510 U	620 U	890 U	960 U	NA	NA	480 U	510 U	600 U
2,4,5-Trichlorophenol	1,200 U	1,100 U	1,300 U	1,500 U	2,200 U	2,400 U	NA	NA	1,200 U	1,200 U	1,500 U
2,4,6-Trichlorophenol	490 U	440 U	510 U	620 U	890 U	960 U	NA	NA	480 U	510 U	600 U
2,4-Dichlorophenol	490 U	440 U	510 U	620 U	890 U	960 U	NA	NA	480 U	510 U	600 U
2,4-Dimethylphenol	490 U	440 U	510 U	620 U	890 U	960 U	NA	NA	480 U	510 U	600 U
2,4-Dinitrophenol	1,200 U	1,100 U	1,300 UJ	1,500 U	2,200 U	2,400 U	NA	NA	1,200 U	1,200 U	1,500 U
2-Chloronaphthalene	490 U	440 U	510 U	620 U	890 U	960 U	NA	NA	480 U	510 U	600 U
2-Chlorophenol	490 U	440 U	510 U	620 U	890 U	960 U	NA	NA	480 U	510 U	600 UJ
2-Methylnaphthalene	52.0 J	52.0	510 U	620 U	22.0	960 U	17.0	7.70	94.0 J	110 J	79.0
2-Methylphenol	490 U	440 U	510 U	620 U	890 U	960 U	NA	NA	480 U	510 U	600 U
2-Nitroaniline	1,200 U	1,100 U	1,300 U	1,500 U	2,200 U	2,400 U	NA	NA	1,200 U	1,200 U	1,500 U
2-Nitrophenol	490 U	440 U	510 U	620 U	890 U	960 U	NA	NA	480 U	510 U	600 U
3,3'-Dichlorobenzidine	490 U	440 U	510 U	620 U	890 U	960 U	NA	NA	480 UJ	510 U	600 U
3- and 4-Methylphenol	NA	NA	510 U	620 U	NA	NA	NA	NA	NA	NA	NA
3-Nitroaniline	1,200 U	1,100 U	1,300 U	1,500 U	2,200 U	2,400 U	NA	NA	1,200 U	1,200 U	1,500 U
4,6-Dinitro-2-methylphenol	1,200 U	1,100 U	1,300 U	1,500 U	2,200 U	2,400 U	NA	NA	1,200 U	1,200 U	1,500 U
4-Bromophenyl-phenylether	490 U	440 U	510 U	620 U	890 U	960 U	NA	NA	480 U	510 U	600 U
4-Chloro-3-methylphenol	490 U	440 U	510 U	620 U	890 U	960 U	NA	NA	480 U	510 U	600 UJ
4-Chloroaniline	490 U	440 U	510 U	620 U	890 U	960 U	NA	NA	480 U	510 U	600 U
4-Chlorophenyl-phenylether	490 U	440 U	510 U	620 U	890 U	960 U	NA	NA	480 U	510 U	600 U
4-Methylphenol	210 J	440 U	NA	NA	190 J	500 J	NA	NA	56.0 J	180 J	600 U

Table G-2
Analytical Data - Sediment - Focused RI/FS
Site 5 Allegany Ballistics Laboratory
Rocket Center, West Virginia

	5SD-1/5SW-1					5SD-1/5SW-1	5SD-1A	5SD-1B	5SD-2/5SW-2		
Chemical	5SD-1(94) 11/16/94	AS05-5SD01-R01 05/08/98	AS05-5SD01-R05 08/03/00	AS05-5SD01-R06 06/20/01	AS05-5SD01-R07 02/26/02	AS05-5SD01P-R07 02/26/02	AS05-5SD01A 02/27/02	AS05-5SD01B 02/27/02	5SD-2(94) 11/16/94	5SD-2(94)DUP 11/16/94	AS05-5SD02-R01 05/08/98
4-Nitroaniline	1,200 U	1,100 U	1,300 U	1,500 U	2,200 U	2,400 U	NA	NA	1,200 U	1,200 U	1,500 U
4-Nitrophenol	1,200 U	1,100 U	1,300 U	1,500 U	2,200 U	2,400 U	NA	NA	1,200 U	1,200 U	1,500 UJ
Acenaphthene	490 U	440 U	510 U	620 U	89.0 J	960 U	2.30 J	1.80 J	480 U	510 U	600 UJ
Acenaphthylene	490 U	440 U	510 U	620 U	9.10	960 U	1.30 J	2.10 J	480 U	510 U	600 U
Acetophenone	NA	NA	NA	620 U	890 U	960 U	NA	NA	NA	NA	NA
Anthracene	490 U	440 U	510 U	620 U	25.0	960 U	1.90 J	3.50	480 U	510 U	600 U
Atrazine	NA	NA	NA	620 U	890 U	960 U	NA	NA	NA	NA	NA
Benzaldehyde	NA	NA	NA	620 U	1,400	1,400	NA	NA	NA	NA	NA
Benzo(a)anthracene	490 U	63.0	510 U	620 U	110	960 U	8.70	25.0	64.0 J	68.0 J	85.0
Benzo(a)pyrene	490 UJ	49.0	510 U	620 U	120	960 UJ	7.50	27.0	480 UJ	66.0 J	62.0
Benzo(b)fluoranthene	70.0 J	110	510 U	620 U	140 J	150 J	10.0	27.0	75.0 J	86.0 J	140
Benzo(g,h,i)perylene	490 UJ	440 U	510 U	620 U	96.0	960 UJ	5.80	21.0	480 UJ	510 UJ	600 U
Benzo(k)fluoranthene	490 UJ	440 U	510 U	620 U	120	960 UJ	7.30	26.0	480 UJ	66.0 J	600 U
Butylbenzylphthalate	490 U	440 U	510 U	620 U	890 U	960 U	NA	NA	480 UJ	510 U	600 U
Caprolactam	NA	NA	NA	71.0 L	890 U	960 U	NA	NA	NA	NA	NA
Carbazole	490 U	440 U	510 U	620 U	890 U	960 U	NA	NA	480 U	510 U	600 U
Chrysene	60.0 J	100	510 U	79.0 J	180 J	160 J	11.0	28.0	93.0 J	120 J	150
Di-n-butylphthalate	490 U	440 U	100 J	330 J	890 U	960 U	NA	NA	480 U	510 U	600 U
Di-n-octylphthalate	490 UJ	440 U	510 U	620 U	890 UJ	960 UJ	NA	NA	480 UJ	510 UJ	600 U
Dibenz(a,h)anthracene	490 UJ	440 U	510 U	620 U	30.0	960 UJ	3.20	7.70	480 UJ	510 UJ	600 U
Dibenzofuran	490 U	440 U	510 U	620 U	890 U	960 U	NA	NA	480 U	510 U	600 U
Diethylphthalate	490 U	440 U	510 U	160 J	260 J	200 J	NA	NA	480 U	510 U	600 U
Dimethyl phthalate	490 U	440 U	510 U	620 U	890 U	960 U	NA	NA	480 U	510 U	600 U
Fluoranthene	87.0 J	110	510 U	170 J	160	160 J	11.0	36.0	110 J	130 J	160
Fluorene	490 U	440 U	510 U	620 U	22.0	960 U	6.20	5.30	480 U	510 U	600 U
Hexachlorobenzene	490 U	440 U	510 U	620 U	890 U	960 U	NA	NA	480 U	510 U	600 U
Hexachlorobutadiene	490 U	440 U	510 U	620 U	890 U	960 U	NA	NA	480 U	510 U	600 U
Hexachlorocyclopentadiene	490 U	440 U	510 U	620 U	890 U	960 U	NA	NA	480 U	510 U	600 U
Hexachloroethane	490 U	440 U	510 U	620 U	890 U	960 U	NA	NA	480 U	510 U	600 U
Indeno(1,2,3-cd)pyrene	490 UJ	440 U	510 U	620 U	81.0	960 UJ	5.50	19.0	480 UJ	510 UJ	600 U
Isophorone	490 U	440 U	510 U	620 U	890 U	960 U	NA	NA	480 U	510 U	600 U
Naphthalene	490 U	440 U	510 U	620 U	14.0	960 U	7.90	5.30	55.0 J	59.0 J	600 U
Pentachlorophenol	1,200 U	1,100 U	1,300 U	1,500 U	2,200 U	2,400 U	NA	NA	1,200 U	1,200 U	1,500 UJ
Phenanthrene	120 J	140	510 U	63.0 J	160 J	170 J	22.0	22.0	190 J	200 J	250
Phenol	490 U	440 U	510 U	64.0 J	890 U	960 U	NA	NA	480 U	510 U	600 UJ
Pyrene	72.0 J	88.0	510 U	130 J	250 J	280 J	12.0	44.0	160 J	150 J	140 J
bis(2-Chloroethoxy)methane	490 U	440 U	510 U	620 U	890 U	960 U	NA	NA	480 U	510 U	600 U
bis(2-Chloroethyl)ether	490 U	440 U	510 U	620 U	890 U	960 U	NA	NA	480 U	510 U	600 U
bis(2-Ethylhexyl)phthalate	490 U	72.0	510 U	620 U	670 B	330 B	NA	NA	480 UJ	510 U	83.0
n-Nitroso-di-n-propylamine	490 U	440 U	510 U	620 U	890 U	960 U	NA	NA	480 U	510 U	600 UJ
n-Nitrosodiphenylamine	490 U	440 U	510 U	620 U	890 U	960 U	NA	NA	480 U	510 U	600 U
Explosives (UG/KG)											
2,4-Dinitrotoluene	490 U	440 U	510 U	620 U	890 U	960 U	NA	NA	480 U	510 U	600 UJ
2,6-Dinitrotoluene	490 U	440 U	510 U	620 U	890 U	960 U	NA	NA	480 U	510 U	600 U
Nitrobenzene	490 U	440 U	510 U	620 U	890 U	960 U	NA	NA	480 U	510 U	600 U
Volatile Organic Compounds (UG/KG)											
1,1,1-Trichloroethane	14.0 U	15.0 U	15.0 UJ	14.0 B	27.0 U	30.0 U	NA	NA	18.0 U	16.0 U	17.0 U
1,1,2,2-Tetrachloroethane	14.0 U	15.0 U	15.0 UJ	19.0 U	27.0 U	30.0 U	NA	NA	18.0 U	16.0 U	17.0 U
1,1,2-Trichloro-1,2,2-trifluoroethane	NA	NA	NA	19.0 U	27.0 U	30.0 U	NA	NA	NA	NA	NA
1,1,2-Trichloroethane	14.0 U	15.0 U	15.0 UJ	19.0 U	27.0 U	30.0 U	NA	NA	18.0 U	16.0 U	17.0 U

Table G-2
Analytical Data - Sediment - Focused RI/FS
Site 5 Allegany Ballistics Laboratory
Rocket Center, West Virginia

	5SD-1/5SW-1					5SD-1/5SW-1	5SD-1A	5SD-1B	5SD-2/5SW-2		
Chemical	5SD-1(94) 11/16/94	AS05-5SD01-R01 05/08/98	AS05-5SD01-R05 08/03/00	AS05-5SD01-R06 06/20/01	AS05-5SD01-R07 02/26/02	AS05-5SD01P-R07 02/26/02	AS05-5SD01A 02/27/02	AS05-5SD01B 02/27/02	5SD-2(94) 11/16/94	5SD-2(94)DUP 11/16/94	AS05-5SD02-R01 05/08/98
1,1-Dichloroethane	14.0 U	15.0 U	15.0 UJ	19.0 U	27.0 U	30.0 U	NA	NA	18.0 U	16.0 U	17.0 U
1,1-Dichloroethene	14.0 U	15.0 U	15.0 UJ	19.0 U	27.0 U	30.0 U	NA	NA	18.0 U	16.0 U	17.0 U
1,2,4-Trichlorobenzene	490 U	440 U	510 U	19.0 U	27.0 U	30.0 U	NA	NA	480 U	510 U	600 UJ
1,2-Dibromo-3-chloropropane	NA	NA	NA	19.0 U	27.0 U	30.0 U	NA	NA	NA	NA	NA
1,2-Dibromoethane	NA	NA	NA	19.0 U	27.0 U	30.0 U	NA	NA	NA	NA	NA
1,2-Dichlorobenzene	490 U	440 U	510 U	19.0 U	27.0 U	30.0 U	NA	NA	480 U	510 U	600 U
1,2-Dichloroethane	14.0 U	15.0 U	15.0 UJ	19.0 U	27.0 U	30.0 U	NA	NA	18.0 U	16.0 U	17.0 U
1,2-Dichloroethene (total)	14.0 U	15.0 U	NA	NA	NA	NA	NA	NA	18.0 U	16.0 U	17.0 U
1,2-Dichloropropane	14.0 U	15.0 U	15.0 UJ	19.0 U	27.0 U	30.0 U	NA	NA	18.0 U	16.0 U	17.0 U
1,3-Dichlorobenzene	490 U	440 U	510 U	19.0 U	27.0 U	30.0 U	NA	NA	480 U	510 U	600 U
1,4-Dichlorobenzene	490 U	440 U	510 U	19.0 U	27.0 U	30.0 U	NA	NA	480 U	510 U	600 UJ
2-Butanone	5.00 J	15.0 U	15.0 UJ	19.0 U	27.0 U	30.0 U	NA	NA	12.0 J	16.0 U	17.0 U
2-Hexanone	14.0 U	15.0 U	15.0 UJ	19.0 U	27.0 U	30.0 U	NA	NA	18.0 U	16.0 U	17.0 U
4-Methyl-2-pentanone	14.0 U	15.0 U	15.0 UJ	19.0 U	27.0 U	30.0 U	NA	NA	18.0 U	16.0 U	17.0 U
Acetone	19.0 U	15.0 U	15.0 UJ	19.0 U	27.0 U	30.0 U	NA	NA	48.0 U	26.0 U	17.0 U
Benzene	14.0 U	15.0 U	15.0 UJ	19.0 U	27.0 U	30.0 U	NA	NA	18.0 U	16.0 U	17.0 U
Bromodichloromethane	14.0 U	15.0 U	15.0 UJ	19.0 U	27.0 U	30.0 U	NA	NA	18.0 U	16.0 U	17.0 U
Bromoform	14.0 U	15.0 U	15.0 UJ	19.0 U	27.0 U	30.0 U	NA	NA	18.0 U	16.0 U	17.0 U
Bromomethane	14.0 U	15.0 U	15.0 UJ	19.0 U	27.0 U	30.0 U	NA	NA	18.0 U	16.0 U	17.0 U
Carbon disulfide	14.0 U	15.0 U	15.0 UJ	19.0 U	27.0 U	30.0 U	NA	NA	18.0 U	16.0 U	17.0 U
Carbon tetrachloride	14.0 U	15.0 U	15.0 UJ	19.0 U	27.0 U	30.0 U	NA	NA	18.0 U	16.0 U	17.0 U
Chlorobenzene	14.0 U	15.0 U	15.0 UJ	19.0 U	27.0 U	30.0 U	NA	NA	18.0 U	16.0 U	17.0 U
Chloroethane	14.0 U	15.0 U	15.0 UJ	19.0 U	27.0 U	30.0 U	NA	NA	18.0 U	16.0 U	17.0 U
Chloroform	14.0 U	15.0 U	15.0 UJ	19.0 U	27.0 U	30.0 U	NA	NA	18.0 U	16.0 U	17.0 U
Chloromethane	14.0 U	15.0 U	15.0 UJ	19.0 U	27.0 U	30.0 U	NA	NA	18.0 U	16.0 U	17.0 U
Cumene	NA	NA	NA	19.0 U	27.0 U	30.0 U	NA	NA	NA	NA	NA
Cyclohexane	NA	NA	NA	19.0 U	27.0 U	30.0 U	NA	NA	NA	NA	NA
Dibromochloromethane	14.0 U	15.0 U	15.0 UJ	19.0 U	27.0 U	30.0 U	NA	NA	18.0 U	16.0 U	17.0 U
Dichlorodifluoromethane	NA	NA	NA	19.0 U	27.0 U	30.0 U	NA	NA	NA	NA	NA
Ethylbenzene	14.0 U	15.0 U	15.0 UJ	19.0 U	27.0 U	30.0 U	NA	NA	18.0 U	16.0 U	17.0 U
Methyl acetate	NA	NA	NA	19.0 U	27.0 U	30.0 U	NA	NA	NA	NA	NA
Methyl-tert-butyl ether (MTBE)	NA	NA	NA	19.0 U	27.0 U	30.0 U	NA	NA	NA	NA	NA
Methylcyclohexane	NA	NA	NA	19.0 U	27.0 U	30.0 U	NA	NA	NA	NA	NA
Methylene chloride	14.0 U	15.0 U	6.70 B	5.20 B	27.0 U	7.70 B	NA	NA	18.0 U	16.0 U	17.0 U
Styrene	14.0 U	15.0 U	15.0 UJ	19.0 U	27.0 U	30.0 U	NA	NA	18.0 U	16.0 U	17.0 U
Tetrachloroethene	14.0 U	15.0 U	15.0 UJ	19.0 U	27.0 U	30.0 U	NA	NA	18.0 U	16.0 U	17.0 U
Toluene	14.0 U	15.0 U	15.0 UJ	19.0 U	27.0 U	30.0 U	NA	NA	18.0 U	16.0 U	17.0 U
Trichloroethene	14.0 U	15.0 U	15.0 UJ	19.0 U	27.0 U	30.0 U	NA	NA	18.0 U	16.0 U	17.0 U
Trichlorofluoromethane	NA	NA	NA	19.0 U	27.0 U	30.0 U	NA	NA	NA	NA	NA
Vinyl chloride	14.0 U	15.0 U	15.0 UJ	19.0 U	27.0 U	30.0 U	NA	NA	18.0 U	16.0 U	17.0 U
Xylene, total	14.0 U	15.0 U	15.0 UJ	19.0 U	27.0 U	30.0 U	NA	NA	18.0 U	16.0 U	17.0 U
cis-1,2-Dichloroethene	NA	NA	15.0 UJ	19.0 U	27.0 U	30.0 U	NA	NA	NA	NA	NA
cis-1,3-Dichloropropene	14.0 U	15.0 U	15.0 UJ	19.0 U	27.0 U	30.0 U	NA	NA	18.0 U	16.0 U	17.0 U
m- and p-Xylene	NA	NA	15.0 UJ	NA	NA	NA	NA	NA	NA	NA	NA
o-Xylene	NA	NA	15.0 UJ	19.0 U	27.0 U	30.0 U	NA	NA	NA	NA	NA
trans-1,2-Dichloroethene	NA	NA	15.0 UJ	19.0 U	27.0 U	30.0 U	NA	NA	NA	NA	NA
trans-1,3-Dichloropropene	14.0 U	15.0 U	15.0 UJ	19.0 U	27.0 U	30.0 U	NA	NA	18.0 U	16.0 U	17.0 U
Other Parameters											
% Solids	NA	NA	NA	NA	35.7	NA	70.5	59.8	NA	NA	NA
Total organic carbon (mg/kg)	NA	NA	NA	NA	78,000	NA	16,000	20,000	NA	NA	NA
pH	NA	NA	NA	NA	6.90	NA	7.30	7.20	NA	NA	NA

Table G-2
Analytical Data - Sediment - Focused RI/FS
Site 5 Allegany Ballistics Laboratory
Rocket Center, West Virginia

	5SD-2/5SW-2					5SD-2/5SW-2	5SD-2A	5SD-2B	5SD-3/5SW-3		
Chemical	AS05-5SD02P-R01 05/08/98	AS05-5SD02-R05 08/03/00	AS05-5SD02P-R05 08/03/00	AS05-5SD02-R06 06/20/01	AS05-5SD02P-R06 06/20/01	AS05-5SD02-R07 02/25/02	AS05-5SD02A 02/27/02	AS05-5SD02B 02/27/02	AS05-5SD03-R05 08/03/00	AS05-5SD03-R06 06/20/01	AS05-5SD03-R07 02/26/02
Inorganics (MG/KG)											
Aluminum	NA	8,290	8,460	10,400	11,700	6,750	4,130	5,090	5,780	11,200	6,300
Antimony	NA	2.20 U	2.10 U	1.60 J	1.20 U	1.80 U	0.76 UL	0.77 UL	4.80 U	1.80 U	1.90 U
Arsenic	NA	16.4	12.7	16.3	18.8	14.4	6.60	8.20	9.70 J	16.2	9.00
Barium	NA	117	111	144	146	139	46.4 J	70.9	111 J	208	66.6 J
Beryllium	NA	2.30 J	2.20	2.40	2.60	1.80	1.10 J	1.10 J	1.80 J	2.60	2.00
Boron	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cadmium	NA	0.55 B	0.77 B	1.00 U	0.98 U	0.61 U	0.068 U	0.069 U	0.45 B	1.40 U	0.65 U
Calcium	NA	64,000	94,100	3,640	3,590	25,300	1,060 J	2,420	5,890	4,520	2,700
Chromium	NA	54.3	80.9	23.5	24.7	17.9	12.3	11.5	4.50 J	17.6	14.0
Cobalt	NA	46.2	47.9	39.2	36.3	36.1	25.9	31.5	51.9	72.6	42.1
Copper	NA	60.6	62.8	46.5	50.7	35.7	15.9	16.2	28.9	40.3	35.7
Cyanide	NA	1.10 U	1.10 U	0.86 U	0.83 U	0.90 U	NA	NA	2.50 U	1.23 U	1.00 U
Iron	NA	22,900	20,700	30,700	33,600	26,700	28,000 J	28,100 J	20,500	33,900	18,300
Lead	NA	32.3	26.3	32.5	33.8	24.3	26.6 K	14.0 K	27.3	37.2	24.0
Magnesium	NA	2,600	3,620	1,050 J	1,050 J	1,220 J	557 J	1,070 J	1,140 J	1,810 J	714 J
Manganese	NA	1,050	1,020	1,110	892	1,330	598 K	1,040 K	1,420	1,700	131
Mercury	NA	4.80	1.70	0.17 U	0.17 U	0.18 UL	0.048 K	0.042 U	1.40	0.23 U	0.28 L
Nickel	NA	76.4	85.2	64.9	62.9	61.7	49.7	50.5	78.0	110	68.0
Potassium	NA	650 J	801 J	953 J	984 J	651 J	732 J	731 J	657 J	1,320 J	441 J
Selenium	NA	1.00 U	1.10 B	1.70 U	1.60 U	1.40 U	0.59 U	0.58 U	2.20 U	2.40 U	1.50 U
Silver	NA	0.27 UL	0.25 UL	1.70 U	1.60 U	0.21 U	0.22 UL	0.23 UL	0.59 UL	2.40 U	0.23 U
Sodium	NA	1,190 J	1,890 J	168 U	161 J	414 J	113 J	252 J	899 B	236 U	249 J
Thallium	NA	1.00 U	0.97 U	2.00 U	1.90 U	1.80 U	1.10 J	1.90 J	2.30 U	2.70 U	1.90 U
Vanadium	NA	16.4 J	14.4 J	19.3	20.9	16.4 J	15.5	15.5	19.4 J	25.1	14.9 J
Zinc	NA	299	343	227	236	184	147 J	143 J	255	334	201
Semivolatile Organic Compounds (UG/KG)											
1,1-Biphenyl	NA	NA	NA	570 U	560 U	590 U	NA	NA	NA	810 U	650 U
1-Methylnaphthalene	NA	NA	NA	NA	NA	17.0	5.20	6.30	NA	NA	22.0
2,2'-Oxybis(1-chloropropane)	NA	760 U	710 U	570 U	560 U	590 UJ	NA	NA	1,700 U	810 U	650 U
2,4,5-Trichlorophenol	NA	1,900 U	1,800 U	1,400 U	1,400 U	1,500 U	NA	NA	4,200 U	2,000 U	1,600 U
2,4,6-Trichlorophenol	NA	760 U	710 U	570 U	560 U	590 U	NA	NA	1,700 U	810 U	650 U
2,4-Dichlorophenol	NA	760 U	710 U	570 U	560 U	590 U	NA	NA	1,700 U	810 U	650 U
2,4-Dimethylphenol	NA	760 U	710 U	570 U	560 U	590 U	NA	NA	1,700 U	810 U	650 U
2,4-Dinitrophenol	NA	1,900 UJ	1,800 UJ	1,400 U	1,400 U	1,500 U	NA	NA	4,200 UJ	2,000 U	1,600 U
2-Chloronaphthalene	NA	760 U	710 U	570 U	560 U	590 U	NA	NA	1,700 U	810 U	650 U
2-Chlorophenol	NA	760 U	710 U	570 U	560 U	590 U	NA	NA	1,700 U	810 U	650 U
2-Methylnaphthalene	NA	760 U	710 U	570 U	560 U	85.0 J	12.0	17.0	1,700 U	810 U	110 J
2-Methylphenol	NA	760 U	710 U	570 U	560 U	590 U	NA	NA	1,700 U	810 U	650 U
2-Nitroaniline	NA	1,900 U	1,800 U	1,400 U	1,400 U	1,500 U	NA	NA	4,200 U	2,000 U	1,600 U
2-Nitrophenol	NA	760 U	710 U	570 U	560 U	590 U	NA	NA	1,700 U	810 U	650 U
3,3'-Dichlorobenzidine	NA	760 U	710 U	570 U	560 U	590 U	NA	NA	1,700 U	810 U	650 U
3- and 4-Methylphenol	NA	760 U	710 U	570 U	560 U	220 J	NA	NA	1,700 U	7,800	NA
3-Nitroaniline	NA	1,900 U	1,800 U	1,400 U	1,400 U	1,500 U	NA	NA	4,200 U	2,000 U	1,600 U
4,6-Dinitro-2-methylphenol	NA	1,900 U	1,800 U	1,400 U	1,400 U	1,500 U	NA	NA	4,200 U	2,000 U	1,600 U
4-Bromophenyl-phenylether	NA	760 U	710 U	570 U	560 U	590 U	NA	NA	1,700 U	810 U	650 U
4-Chloro-3-methylphenol	NA	760 U	710 U	570 U	560 U	590 U	NA	NA	1,700 U	810 U	650 U
4-Chloroaniline	NA	760 U	710 U	570 U	560 U	590 U	NA	NA	1,700 U	810 U	650 U
4-Chlorophenyl-phenylether	NA	760 U	710 U	570 U	560 U	590 U	NA	NA	1,700 U	810 U	650 U
4-Methylphenol	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	330 J

Table G-2
Analytical Data - Sediment - Focused RI/FS
Site 5 Allegany Ballistics Laboratory
Rocket Center, West Virginia

	5SD-2/5SW-2					5SD-2/5SW-2	5SD-2A	5SD-2B	5SD-3/5SW-3		
Chemical	**AS05-5SD02P-R01 05/08/98**	**AS05-5SD02-R05 08/03/00**	**AS05-5SD02P-R05 08/03/00**	**AS05-5SD02-R06 06/20/01**	**AS05-5SD02P-R06 06/20/01**	**AS05-5SD02-R07 02/25/02**	**AS05-5SD02A 02/27/02**	**AS05-5SD02B 02/27/02**	**AS05-5SD03-R05 08/03/00**	**AS05-5SD03-R06 06/20/01**	**AS05-5SD03-R07 02/26/02**
4-Nitroaniline	NA	1,900 U	1,800 U	1,400 U	1,400 U	1,500 U	NA	NA	4,200 U	2,000 U	1,600 U
4-Nitrophenol	NA	1,900 U	1,800 U	1,400 U	1,400 U	1,500 U	NA	NA	4,200 U	2,000 U	1,600 U
Acenaphthene	NA	760 U	710 U	570 U	560 U	6.60	12.0	2.00 J	1,700 U	810 U	90.0 J
Acenaphthylene	NA	760 U	710 U	570 U	560 U	9.70	0.69 J	2.30 J	1,700 U	810 U	15.0
Acetophenone	NA	NA	NA	570 U	560 U	590 U	NA	NA	NA	810 U	650 U
Anthracene	NA	760 U	710 U	570 U	560 U	15.0	25.0	2.80	1,700 U	810 U	31.0
Atrazine	NA	NA	NA	570 U	560 U	590 U	NA	NA	NA	810 U	650 U
Benzaldehyde	NA	NA	NA	570 U	560 U	540 J	NA	NA	NA	810 U	680
Benzo(a)anthracene	NA	760 U	710 U	570 U	560 U	82.0	43.0	6.60	1,700 U	810 U	200 J
Benzo(a)pyrene	NA	760 U	710 U	570 U	560 U	77.0	43.0	10.0	1,700 U	810 U	170 J
Benzo(b)fluoranthene	NA	760 U	710 U	570 U	560 U	83.0	38.0	12.0	1,700 U	810 U	260 J
Benzo(g,h,i)perylene	NA	760 U	710 U	570 U	560 U	60.0	32.0	13.0	1,700 U	810 U	100
Benzo(k)fluoranthene	NA	760 U	710 U	570 U	560 U	76.0	33.0	9.40	1,700 U	810 U	140
Butylbenzylphthalate	NA	760 U	710 U	570 U	560 U	590 U	NA	NA	1,700 U	810 U	650 U
Caprolactam	NA	NA	NA	570 R	560 R	590 U	NA	NA	NA	1,600 R	650 U
Carbazole	NA	760 U	710 U	570 U	560 U	590 U	NA	NA	1,700 U	810 U	650 U
Chrysene	NA	760 U	710 U	570 U	560 U	130 J	37.0	7.90	1,700 U	810 U	290 J
Di-n-butylphthalate	NA	760 U	120 J	570 U	560 U	1,000	NA	NA	260 J	95.0 J	650 U
Di-n-octylphthalate	NA	760 U	710 U	570 U	560 U	590 U	NA	NA	1,700 U	810 U	650 U
Dibenz(a,h)anthracene	NA	760 U	710 U	570 U	560 U	20.0	9.30	5.70	1,700 U	810 U	36.0
Dibenzofuran	NA	760 U	710 U	570 U	560 U	590 U	NA	NA	1,700 U	810 U	650 U
Diethylphthalate	NA	760 U	710 U	570 U	560 U	590 U	NA	NA	1,700 U	810 U	200 J
Dimethyl phthalate	NA	760 U	710 U	570 U	560 U	590 U	NA	NA	1,700 U	810 U	650 U
Fluoranthene	NA	760 U	710 U	570 U	560 U	190 J	90.0	9.30	1,700 U	810 U	390 J
Fluorene	NA	760 U	710 U	570 U	560 U	17.0	12.0	4.30	1,700 U	810 U	25.0
Hexachlorobenzene	NA	760 U	710 U	570 U	560 U	590 U	NA	NA	1,700 U	810 U	650 U
Hexachlorobutadiene	NA	760 U	710 U	570 U	560 U	590 U	NA	NA	1,700 U	810 U	650 U
Hexachlorocyclopentadiene	NA	760 U	710 U	570 U	560 U	590 U	NA	NA	1,700 U	810 U	650 U
Hexachloroethane	NA	760 U	710 U	570 U	560 U	590 U	NA	NA	1,700 U	810 U	650 U
Indeno(1,2,3-cd)pyrene	NA	760 U	710 U	570 U	560 U	52.0	26.0	12.0	1,700 U	810 U	90.0
Isophorone	NA	760 U	710 U	570 U	560 U	590 U	NA	NA	1,700 U	810 U	650 U
Naphthalene	NA	760 U	710 U	570 U	560 U	14.0	7.20	8.70	1,700 U	810 U	81.0 J
Pentachlorophenol	NA	1,900 U	1,800 U	1,400 U	1,400 U	1,500 U	NA	NA	4,200 U	2,000 U	1,600 U
Phenanthrene	NA	760 U	710 U	570 U	560 U	230 J	94.0	18.0	1,700 U	810 U	380 J
Phenol	NA	760 U	710 U	570 U	560 U	590 U	NA	NA	1,700 U	510 J	650 U
Pyrene	NA	760 U	710 U	570 U	560 U	170	110	9.90	1,700 U	810 U	420 J
bis(2-Chloroethoxy)methane	NA	760 U	710 U	570 U	560 U	590 U	NA	NA	1,700 U	810 U	650 U
bis(2-Chloroethyl)ether	NA	760 U	710 U	570 U	560 U	590 U	NA	NA	1,700 U	810 U	650 U
bis(2-Ethylhexyl)phthalate	NA	760 U	710 U	570 U	560 U	370 B	NA	NA	1,700 U	95.0 J	250 B
n-Nitroso-di-n-propylamine	NA	760 U	710 U	570 U	560 U	590 U	NA	NA	1,700 U	810 U	650 U
n-Nitrosodiphenylamine	NA	760 U	710 U	570 U	560 U	590 U	NA	NA	1,700 U	810 U	650 U
Explosives (UG/KG)											
2,4-Dinitrotoluene	NA	760 U	710 U	570 U	560 U	590 U	NA	NA	1,700 U	810 U	650 U
2,6-Dinitrotoluene	NA	760 U	710 U	570 U	560 U	590 U	NA	NA	1,700 U	810 U	650 U
Nitrobenzene	NA	760 U	710 U	570 U	560 U	590 U	NA	NA	1,700 U	810 U	650 U
Volatile Organic Compounds (UG/KG)											
1,1,1-Trichloroethane	18.0 U	23.0 UJ	21.0 UJ	11.0 B	11.0 B	18.0 U	NA	NA	50.0 UJ	8.00 B	19.0 U
1,1,2,2-Tetrachloroethane	18.0 UJ	23.0 UJ	21.0 UJ	17.0 U	17.0 U	18.0 U	NA	NA	50.0 UJ	25.0 U	19.0 U
1,1,2-Trichloro-1,2,2-trifluoroethane	NA	NA	NA	17.0 U	17.0 U	18.0 U	NA	NA	NA	25.0 U	19.0 U
1,1,2-Trichloroethane	18.0 U	23.0 UJ	21.0 UJ	17.0 U	17.0 U	18.0 U	NA	NA	50.0 UJ	25.0 U	19.0 U

Table G-2
Analytical Data - Sediment - Focused RI/FS
Site 5 Allegany Ballistics Laboratory
Rocket Center, West Virginia

	5SD-2/5SW-2					5SD-2/5SW-2	5SD-2A	5SD-2B	5SD-3/5SW-3		
Chemical	**AS05-5SD02P-R01 05/08/98**	**AS05-5SD02-R05 08/03/00**	**AS05-5SD02P-R05 08/03/00**	**AS05-5SD02-R06 06/20/01**	**AS05-5SD02P-R06 06/20/01**	**AS05-5SD02-R07 02/25/02**	**AS05-5SD02A 02/27/02**	**AS05-5SD02B 02/27/02**	**AS05-5SD03-R05 08/03/00**	**AS05-5SD03-R06 06/20/01**	**AS05-5SD03-R07 02/26/02**
1,1-Dichloroethane	18.0 U	23.0 UJ	21.0 UJ	17.0 U	17.0 U	18.0 U	NA	NA	50.0 UJ	25.0 U	19.0 U
1,1-Dichloroethene	18.0 U	23.0 UJ	21.0 UJ	17.0 U	17.0 U	18.0 U	NA	NA	50.0 UJ	25.0 U	19.0 U
1,2,4-Trichlorobenzene	NA	760 U	710 U	17.0 U	17.0 U	18.0 U	NA	NA	1,700 U	25.0 U	19.0 U
1,2-Dibromo-3-chloropropane	NA	NA	NA	17.0 U	17.0 U	18.0 U	NA	NA	NA	25.0 U	19.0 U
1,2-Dibromoethane	NA	NA	NA	17.0 U	17.0 U	18.0 U	NA	NA	NA	25.0 U	19.0 U
1,2-Dichlorobenzene	NA	760 U	710 U	17.0 U	17.0 U	18.0 U	NA	NA	1,700 U	25.0 U	19.0 U
1,2-Dichloroethane	18.0 U	23.0 UJ	21.0 UJ	17.0 U	17.0 U	18.0 U	NA	NA	50.0 UJ	25.0 U	19.0 U
1,2-Dichloroethene (total)	18.0 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2-Dichloropropane	18.0 U	23.0 UJ	21.0 UJ	17.0 U	17.0 U	18.0 U	NA	NA	50.0 UJ	25.0 U	19.0 U
1,3-Dichlorobenzene	NA	760 U	710 U	17.0 U	17.0 U	18.0 U	NA	NA	1,700 U	25.0 U	19.0 U
1,4-Dichlorobenzene	NA	760 U	710 U	17.0 U	17.0 U	18.0 U	NA	NA	1,700 U	25.0 U	19.0 U
2-Butanone	18.0 U	23.0 UJ	21.0 UJ	17.0 U	17.0 U	18.0 U	NA	NA	50.0 UJ	25.0 U	19.0 U
2-Hexanone	18.0 UJ	23.0 UJ	21.0 UJ	17.0 U	17.0 U	18.0 U	NA	NA	50.0 UJ	25.0 U	19.0 U
4-Methyl-2-pentanone	18.0 UJ	23.0 UJ	21.0 UJ	17.0 U	17.0 U	18.0 U	NA	NA	50.0 UJ	25.0 U	19.0 U
Acetone	18.0 U	23.0 UJ	21.0 UJ	17.0 U	17.0 U	18.0 U	NA	NA	50.0 UJ	25.0 U	19.0 U
Benzene	18.0 U	23.0 UJ	21.0 UJ	17.0 U	17.0 U	18.0 U	NA	NA	50.0 UJ	25.0 U	19.0 U
Bromodichloromethane	18.0 U	23.0 UJ	21.0 UJ	17.0 U	17.0 U	18.0 U	NA	NA	50.0 UJ	25.0 U	19.0 U
Bromoform	18.0 U	23.0 UJ	21.0 UJ	17.0 U	17.0 U	18.0 U	NA	NA	50.0 UJ	25.0 U	19.0 U
Bromomethane	18.0 U	23.0 UJ	21.0 UJ	17.0 U	17.0 U	18.0 U	NA	NA	50.0 UJ	25.0 U	19.0 U
Carbon disulfide	18.0 U	23.0 UJ	21.0 UJ	17.0 U	17.0 U	18.0 U	NA	NA	50.0 UJ	25.0 U	19.0 U
Carbon tetrachloride	18.0 U	23.0 UJ	21.0 UJ	17.0 U	17.0 U	18.0 U	NA	NA	50.0 UJ	25.0 U	19.0 U
Chlorobenzene	18.0 UJ	23.0 UJ	21.0 UJ	17.0 U	17.0 U	18.0 U	NA	NA	50.0 UJ	25.0 U	19.0 U
Chloroethane	18.0 U	23.0 UJ	21.0 UJ	17.0 U	17.0 U	18.0 U	NA	NA	50.0 UJ	25.0 U	19.0 U
Chloroform	18.0 U	23.0 UJ	21.0 UJ	17.0 U	17.0 U	18.0 U	NA	NA	50.0 UJ	25.0 U	19.0 U
Chloromethane	18.0 UJ	23.0 UJ	21.0 UJ	17.0 U	17.0 U	18.0 U	NA	NA	50.0 UJ	25.0 U	19.0 U
Cumene	NA	NA	NA	17.0 U	17.0 U	18.0 U	NA	NA	NA	25.0 U	19.0 U
Cyclohexane	NA	NA	NA	17.0 U	17.0 U	18.0 U	NA	NA	NA	25.0 U	19.0 U
Dibromochloromethane	18.0 U	23.0 UJ	21.0 UJ	17.0 U	17.0 U	18.0 U	NA	NA	50.0 UJ	25.0 U	19.0 U
Dichlorodifluoromethane	NA	NA	NA	17.0 U	17.0 U	18.0 U	NA	NA	NA	25.0 U	19.0 U
Ethylbenzene	18.0 UJ	23.0 UJ	21.0 UJ	17.0 U	17.0 U	18.0 U	NA	NA	50.0 UJ	25.0 U	19.0 U
Methyl acetate	NA	NA	NA	17.0 U	17.0 U	18.0 U	NA	NA	NA	25.0 U	19.0 U
Methyl-tert-butyl ether (MTBE)	NA	NA	NA	17.0 U	17.0 U	18.0 U	NA	NA	NA	25.0 U	19.0 U
Methylcyclohexane	NA	NA	NA	17.0 U	17.0 U	18.0 U	NA	NA	NA	25.0 U	19.0 U
Methylene chloride	32.0	23.0 UJ	7.40 B	4.50 B	4.70 B	18.0 U	NA	NA	50.0 UJ	7.60 B	5.70 B
Styrene	18.0 UJ	23.0 UJ	21.0 UJ	17.0 U	17.0 U	18.0 U	NA	NA	50.0 UJ	25.0 U	19.0 U
Tetrachloroethene	18.0 UJ	23.0 UJ	21.0 UJ	17.0 U	17.0 U	18.0 U	NA	NA	50.0 UJ	25.0 U	19.0 U
Toluene	18.0 UJ	23.0 UJ	21.0 UJ	17.0 U	17.0 U	18.0 U	NA	NA	50.0 UJ	25.0 U	19.0 U
Trichloroethene	18.0 U	23.0 UJ	21.0 UJ	17.0 U	17.0 U	18.0 U	NA	NA	50.0 UJ	25.0 U	19.0 U
Trichlorofluoromethane	NA	NA	NA	17.0 U	17.0 U	18.0 U	NA	NA	NA	25.0 U	19.0 U
Vinyl chloride	18.0 U	23.0 UJ	21.0 UJ	17.0 U	17.0 U	18.0 U	NA	NA	50.0 UJ	25.0 U	19.0 U
Xylene, total	18.0 UJ	23.0 UJ	21.0 UJ	17.0 U	17.0 U	18.0 U	NA	NA	50.0 UJ	25.0 U	19.0 U
cis-1,2-Dichloroethene	NA	23.0 UJ	21.0 UJ	17.0 U	17.0 U	18.0 U	NA	NA	50.0 UJ	25.0 U	19.0 U
cis-1,3-Dichloropropene	18.0 U	23.0 UJ	21.0 UJ	17.0 U	17.0 U	18.0 U	NA	NA	50.0 UJ	25.0 U	19.0 U
m- and p-Xylene	NA	23.0 UJ	21.0 UJ	NA	NA	NA	NA	NA	50.0 UJ	NA	NA
o-Xylene	NA	23.0 UJ	21.0 UJ	17.0 U	17.0 U	18.0 U	NA	NA	50.0 UJ	25.0 U	19.0 U
trans-1,2-Dichloroethene	NA	23.0 UJ	21.0 UJ	17.0 U	17.0 U	18.0 U	NA	NA	50.0 UJ	25.0 U	19.0 U
trans-1,3-Dichloropropene	18.0 U	23.0 UJ	21.0 UJ	17.0 U	17.0 U	18.0 U	NA	NA	50.0 UJ	25.0 U	19.0 U
Other Parameters											
% Solids	NA	NA	NA	NA	NA	55.2	69.1	66.1	NA	NA	47.3
Total organic carbon (mg/kg)	NA	NA	NA	NA	NA	100,000	6,400	8,600	NA	NA	67,000
pH	NA	NA	NA	NA	NA	7.50	7.50	7.30	NA	NA	6.50

Table G-2
Analytical Data - Sediment - Focused RI/FS
Site 5 Allegany Ballistics Laboratory
Rocket Center, West Virginia

Chemical	5SD-3A	5SD-3B	5SD-4/5SW-4			5SD-5		5SD-5A	5SD-6	5SD-6A	5SD-7	5SD-7A
	AS05-5SD03A	AS05-5SD03B	AS05-5SD04-R05	AS05-5SD04-R06	AS05-5SD04-R07	AS05-5SD05	AS05-5SD05P	AS05-5SD05A	AS05-5SD06	AS05-5SD06A	AS05-5SD07	AS05-5SD07A
	02/27/02	02/27/02	08/03/00	06/20/01	02/25/02	02/25/02	02/25/02	02/27/02	02/25/02	02/27/02	02/25/02	02/27/02
Inorganics (MG/KG)												
Aluminum	5,370	4,470	3,520	5,870	7,280	5,470	5,150	3,950	2,950	6,580	3,200	5,580
Antimony	0.67 UL	0.69 UL	1.20 U	1.10 U	3.30 U	1.40 UL	0.96 UL	0.68 UL	0.81 UL	0.85 UL	0.69 UL	0.67 UL
Arsenic	6.90	9.10	7.30	10.5	11.6	8.40	7.50	6.40	4.40	11.2	5.30	6.10
Barium	63.3	47.9	35.5 J	119	147	60.9 J	60.9 J	41.7 J	31.5 J	65.1	41.0 J	70.2
Beryllium	1.30	1.40	1.30	1.50	2.00 J	1.40 J	1.30 J	1.10 J	0.82 J	1.40 J	0.86 J	1.20
Boron	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cadmium	0.060 U	0.062 U	0.10 U	0.89 U	1.10 U	0.17 J	0.13 J	0.061 U	0.19 J	0.076 U	0.062 U	0.060 U
Calcium	1,480	1,440	908 J	2,720	5,790	2,370	1,890	953 J	1,440	2,320	674 J	4,820
Chromium	13.3	15.7	7.60	13.0	12.7	13.1	15.2	12.5	6.60	12.4	9.80	18.7
Cobalt	29.1	29.6	29.5	39.3	60.1	25.6	23.8	26.8	18.2	31.3	17.5	24.2
Copper	15.9	19.5	16.1	25.4	34.3	26.3	31.4	17.6	11.2	19.5	10.2	13.7
Cyanide	NA	NA	0.63 U	0.76 U	1.70 U	NA	NA	NA	NA	NA	NA	NA
Iron	35,700 J	40,800 J	22,200	28,100	31,300	21,200 J	21,200 J	30,600 J	10,700 J	32,200 J	19,400 J	38,900 J
Lead	13.7 K	21.2 K	18.5	27.7	31.6	18.4 K	22.5 K	18.9 K	10.1 K	21.0 K	11.9 K	14.7 K
Magnesium	661 J	554 J	494 J	896 J	1,330 J	707 J	583 J	469 J	357 J	756 J	599 J	1,590
Manganese	1,250 K	686 K	237	916	893	332 K	349 K	458 K	334 K	929 K	239 K	1,340 K
Mercury	0.037 U	0.037 U	0.13 B	0.15 U	0.31 UL	0.073 U	0.14 K	0.067 K	0.19 K	0.042 U	0.036 U	0.035 U
Nickel	45.9	52.9	48.4	60.9	98.3	45.2	43.2	48.9	26.6	57.9	31.6	40.8
Potassium	615 J	668 J	400 J	806 J	766 J	777 J	711 J	639 J	388 J	1,030 J	416 J	554 J
Selenium	0.51 U	0.55 U	0.54 U	1.50 U	2.60 U	1.00 U	0.99 U	0.52 U	0.61 U	2.10	0.53 U	0.51 U
Silver	0.20 UL	0.21 UL	0.15 UL	1.50 U	0.40 U	0.40 UL	0.28 UL	0.20 UL	0.24 UL	0.25 UL	0.21 UL	0.20 UL
Sodium	360 J	168 J	249 B	145 U	458 J	237 J	149 J	102 J	135 J	184 J	92.7 J	198 J
Thallium	1.30 J	1.80 J	1.90 B	1.70 U	3.30 U	1.90 U	1.40 U	1.30 J	1.10 U	1.90 J	1.20 J	1.40 J
Vanadium	14.9	17.9	11.1 J	15.5	22.4 J	14.1 J	13.1 J	14.9	7.90 J	17.6	9.10 J	33.2
Zinc	135 J	166 J	149	188	277	149 J	143 J	148 J	76.4 J	157 J	114 J	129 J
Semivolatile Organic Compounds (UG/KG)												
1,1-Biphenyl	NA	NA	NA	510 U	NA	NA	NA	NA	NA	NA	NA	NA
1-Methylnaphthalene	2.20 J	4.40	NA	NA	28.0 L	17.0	12.0	6.30	11.0	7.30 L	2.70	1.50 J
2,2'-Oxybis(1-chloropropane)	NA	NA	420 U	510 U	NA	NA	NA	NA	NA	NA	NA	NA
2,4,5-Trichlorophenol	NA	NA	1,100 U	1,300 U	NA	NA	NA	NA	NA	NA	NA	NA
2,4,6-Trichlorophenol	NA	NA	420 U	510 U	NA	NA	NA	NA	NA	NA	NA	NA
2,4-Dichlorophenol	NA	NA	420 U	510 U	NA	NA	NA	NA	NA	NA	NA	NA
2,4-Dimethylphenol	NA	NA	420 U	510 U	NA	NA	NA	NA	NA	NA	NA	NA
2,4-Dinitrophenol	NA	NA	1,100 UJ	1,300 U	NA	NA	NA	NA	NA	NA	NA	NA
2-Chloronaphthalene	NA	NA	420 U	510 U	NA	NA	NA	NA	NA	NA	NA	NA
2-Chlorophenol	NA	NA	420 U	510 U	NA	NA	NA	NA	NA	NA	NA	NA
2-Methylnaphthalene	5.50	11.0	420 U	510 U	44.0 L	26.0	17.0	13.0	20.0	17.0 L	4.10	3.30
2-Methylphenol	NA	NA	420 U	510 U	NA	NA	NA	NA	NA	NA	NA	NA
2-Nitroaniline	NA	NA	1,100 U	1,300 U	NA	NA	NA	NA	NA	NA	NA	NA
2-Nitrophenol	NA	NA	420 U	510 U	NA	NA	NA	NA	NA	NA	NA	NA
3,3'-Dichlorobenzidine	NA	NA	420 U	510 U	NA	NA	NA	NA	NA	NA	NA	NA
3- and 4-Methylphenol	NA	NA	420 U	63.0 J	NA	NA	NA	NA	NA	NA	NA	NA
3-Nitroaniline	NA	NA	1,100 U	1,300 U	NA	NA	NA	NA	NA	NA	NA	NA
4,6-Dinitro-2-methylphenol	NA	NA	1,100 U	1,300 U	NA	NA	NA	NA	NA	NA	NA	NA
4-Bromophenyl-phenylether	NA	NA	420 U	510 U	NA	NA	NA	NA	NA	NA	NA	NA
4-Chloro-3-methylphenol	NA	NA	420 U	510 U	NA	NA	NA	NA	NA	NA	NA	NA
4-Chloroaniline	NA	NA	420 U	510 U	NA	NA	NA	NA	NA	NA	NA	NA
4-Chlorophenyl-phenylether	NA	NA	420 U	510 U	NA	NA	NA	NA	NA	NA	NA	NA
4-Methylphenol	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table G-2
Analytical Data - Sediment - Focused RI/FS
Site 5 Allegany Ballistics Laboratory
Rocket Center, West Virginia

Chemical	5SD-3A	5SD-3B	5SD-4/5SW-4			5SD-5		5SD-5A	5SD-6	5SD-6A	5SD-7	5SD-7A
	AS05-5SD03A 02/27/02	AS05-5SD03B 02/27/02	AS05-5SD04-R05 08/03/00	AS05-5SD04-R06 06/20/01	AS05-5SD04-R07 02/25/02	AS05-5SD05 02/25/02	AS05-5SD05P 02/25/02	AS05-5SD05A 02/27/02	AS05-5SD06 02/25/02	AS05-5SD06A 02/27/02	AS05-5SD07 02/25/02	AS05-5SD07A 02/27/02
4-Nitroaniline	NA	NA	1,100 U	1,300 U	NA	NA	NA	NA	NA	NA	NA	NA
4-Nitrophenol	NA	NA	1,100 U	1,300 U	NA	NA	NA	NA	NA	NA	NA	NA
Acenaphthene	2.30 U	0.98 J	420 U	510 U	13.0 L	4.00 J	2.10 J	3.80 J	3.10	2.10 L	0.57 J	2.10 U
Acenaphthylene	2.30 U	3.00	420 U	510 U	19.0 L	5.60	4.50	4.30 J	5.30	1.20 L	0.84 J	2.10 U
Acetophenone	NA	NA	NA	510 U	NA	NA	NA	NA	NA	NA	NA	NA
Anthracene	0.49 J	2.60	420 U	510 U	36.0 L	12.0	7.30	16.0	8.00	2.50 L	1.00 J	2.10 U
Atrazine	NA	NA	NA	510 U	NA	NA	NA	NA	NA	NA	NA	NA
Benzaldehyde	NA	NA	NA	510 U	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(a)anthracene	2.50	15.0	420 U	510 U	230 L	64.0	50.0	74.0	45.0	7.10 L	5.70	2.30
Benzo(a)pyrene	2.50	16.0	420 U	510 U	260 L	72.0	52.0	64.0	51.0	8.70 L	5.40	2.00 J
Benzo(b)fluoranthene	3.30	18.0	420 U	510 U	240 L	95.0	57.0	64.0	56.0	12.0 L	6.70	2.50
Benzo(g,h,i)perylene	1.70 J	13.0	420 U	510 U	170 L	65.0	45.0	45.0	47.0	9.20 L	3.80	1.10 J
Benzo(k)fluoranthene	1.60 J	14.0	420 U	510 U	250 L	69.0	54.0	58.0	52.0	8.50 L	4.80	1.00 J
Butylbenzylphthalate	NA	NA	420 U	510 U	NA	NA	NA	NA	NA	NA	NA	NA
Caprolactam	NA	NA	NA	510 R	NA	NA	NA	NA	NA	NA	NA	NA
Carbazole	NA	NA	420 U	510 U	NA	NA	NA	NA	NA	NA	NA	NA
Chrysene	3.40	17.0	420 U	510 U	260 L	83.0	57.0	66.0	54.0	15.0 L	6.30	2.00 J
Di-n-butylphthalate	NA	NA	110 J	510 U	NA	NA	NA	NA	NA	NA	NA	NA
Di-n-octylphthalate	NA	NA	420 U	510 U	NA	NA	NA	NA	NA	NA	NA	NA
Dibenz(a,h)anthracene	1.80 J	5.30	420 U	510 U	56.0 L	21.0	15.0	18.0	16.0	3.00 L	2.50	1.50 J
Dibenzofuran	NA	NA	420 U	510 U	NA	NA	NA	NA	NA	NA	NA	NA
Diethylphthalate	NA	NA	420 U	510 U	NA	NA	NA	NA	NA	NA	NA	NA
Dimethyl phthalate	NA	NA	420 U	510 U	NA	NA	NA	NA	NA	NA	NA	NA
Fluoranthene	3.40	17.0	420 U	510 U	330 L	88.0	67.0	140	64.0	14.0 L	8.10	2.80
Fluorene	1.60 J	3.40	420 U	510 U	35.0 L	11.0	6.70	12.0	11.0	6.60 L	1.40 J	1.00 J
Hexachlorobenzene	NA	NA	420 U	510 U	NA	NA	NA	NA	NA	NA	NA	NA
Hexachlorobutadiene	NA	NA	420 U	510 U	NA	NA	NA	NA	NA	NA	NA	NA
Hexachlorocyclopentadiene	NA	NA	420 U	510 U	NA	NA	NA	NA	NA	NA	NA	NA
Hexachloroethane	NA	NA	420 U	510 U	NA	NA	NA	NA	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	2.40	12.0	420 U	510 U	160 L	53.0	39.0	43.0	39.0	7.20 L	4.30	1.90 J
Isophorone	NA	NA	420 U	510 U	NA	NA	NA	NA	NA	NA	NA	NA
Naphthalene	2.60	5.10	420 U	510 U	27.0 L	16.0	11.0	8.90	9.40	9.00 L	2.30	1.90 B
Pentachlorophenol	NA	NA	1,100 U	1,300 U	NA	NA	NA	NA	NA	NA	NA	NA
Phenanthrene	6.50	18.0	420 U	510 U	210 L	80.0	49.0	110	50.0	28.0 L	8.10	3.80
Phenol	NA	NA	420 U	510 U	NA	NA	NA	NA	NA	NA	NA	NA
Pyrene	3.50	21.0	420 U	510 U	340 L	110	88.0	140	74.0	15.0 L	8.50	2.60
bis(2-Chloroethoxy)methane	NA	NA	420 U	510 U	NA	NA	NA	NA	NA	NA	NA	NA
bis(2-Chloroethyl)ether	NA	NA	420 U	510 U	NA	NA	NA	NA	NA	NA	NA	NA
bis(2-Ethylhexyl)phthalate	NA	NA	420 U	510 U	NA	NA	NA	NA	NA	NA	NA	NA
n-Nitroso-di-n-propylamine	NA	NA	420 U	510 U	NA	NA	NA	NA	NA	NA	NA	NA
n-Nitrosodiphenylamine	NA	NA	420 U	510 U	NA	NA	NA	NA	NA	NA	NA	NA
Explosives (UG/KG)												
2,4-Dinitrotoluene	NA	NA	420 U	510 U	NA	NA	NA	NA	NA	NA	NA	NA
2,6-Dinitrotoluene	NA	NA	420 U	510 U	NA	NA	NA	NA	NA	NA	NA	NA
Nitrobenzene	NA	NA	420 U	510 U	NA	NA	NA	NA	NA	NA	NA	NA
Volatile Organic Compounds (UG/KG)												
1,1,1-Trichloroethane	NA	NA	13.0 UJ	10.0 B	33.0 U	NA	NA	NA	NA	NA	NA	NA
1,1,2,2-Tetrachloroethane	NA	NA	13.0 UJ	15.0 U	33.0 U	NA	NA	NA	NA	NA	NA	NA
1,1,2-Trichloro-1,2,2-trifluoroethane	NA	NA	NA	15.0 U	33.0 U	NA	NA	NA	NA	NA	NA	NA
1,1,2-Trichloroethane	NA	NA	13.0 UJ	15.0 U	33.0 U	NA	NA	NA	NA	NA	NA	NA

Table G-2
Analytical Data - Sediment - Focused RI/FS
Site 5 Allegany Ballistics Laboratory
Rocket Center, West Virginia

	5SD-3A	5SD-3B	5SD-4/5SW-4			5SD-5		5SD-5A	5SD-6	5SD-6A	5SD-7	5SD-7A
	AS05-5SD03A	AS05-5SD03B	AS05-5SD04-R05	AS05-5SD04-R06	AS05-5SD04-R07	AS05-5SD05	AS05-5SD05P	AS05-5SD05A	AS05-5SD06	AS05-5SD06A	AS05-5SD07	AS05-5SD07A
Chemical	02/27/02	02/27/02	08/03/00	06/20/01	02/25/02	02/25/02	02/25/02	02/27/02	02/25/02	02/27/02	02/25/02	02/27/02
1,1-Dichloroethane	NA	NA	13.0 UJ	15.0 U	33.0 U	NA	NA	NA	NA	NA	NA	NA
1,1-Dichloroethene	NA	NA	13.0 UJ	15.0 U	33.0 U	NA	NA	NA	NA	NA	NA	NA
1,2,4-Trichlorobenzene	NA	NA	420 U	15.0 U	33.0 U	NA	NA	NA	NA	NA	NA	NA
1,2-Dibromo-3-chloropropane	NA	NA	NA	15.0 U	33.0 U	NA	NA	NA	NA	NA	NA	NA
1,2-Dibromoethane	NA	NA	NA	15.0 U	33.0 U	NA	NA	NA	NA	NA	NA	NA
1,2-Dichlorobenzene	NA	NA	420 U	15.0 U	33.0 U	NA	NA	NA	NA	NA	NA	NA
1,2-Dichloroethane	NA	NA	13.0 UJ	15.0 U	33.0 U	NA	NA	NA	NA	NA	NA	NA
1,2-Dichloroethene (total)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2-Dichloropropane	NA	NA	13.0 UJ	15.0 U	33.0 U	NA	NA	NA	NA	NA	NA	NA
1,3-Dichlorobenzene	NA	NA	420 U	15.0 U	33.0 U	NA	NA	NA	NA	NA	NA	NA
1,4-Dichlorobenzene	NA	NA	420 U	15.0 U	33.0 U	NA	NA	NA	NA	NA	NA	NA
2-Butanone	NA	NA	13.0 UJ	15.0 U	33.0 U	NA	NA	NA	NA	NA	NA	NA
2-Hexanone	NA	NA	13.0 UJ	15.0 U	33.0 U	NA	NA	NA	NA	NA	NA	NA
4-Methyl-2-pentanone	NA	NA	13.0 UJ	15.0 U	33.0 U	NA	NA	NA	NA	NA	NA	NA
Acetone	NA	NA	13.0 UJ	15.0 U	33.0 U	NA	NA	NA	NA	NA	NA	NA
Benzene	NA	NA	13.0 UJ	15.0 U	33.0 U	NA	NA	NA	NA	NA	NA	NA
Bromodichloromethane	NA	NA	13.0 UJ	15.0 U	33.0 U	NA	NA	NA	NA	NA	NA	NA
Bromoform	NA	NA	13.0 UJ	15.0 U	33.0 U	NA	NA	NA	NA	NA	NA	NA
Bromomethane	NA	NA	13.0 UJ	15.0 U	33.0 U	NA	NA	NA	NA	NA	NA	NA
Carbon disulfide	NA	NA	13.0 UJ	15.0 U	33.0 U	NA	NA	NA	NA	NA	NA	NA
Carbon tetrachloride	NA	NA	13.0 UJ	15.0 U	33.0 U	NA	NA	NA	NA	NA	NA	NA
Chlorobenzene	NA	NA	13.0 UJ	15.0 U	33.0 U	NA	NA	NA	NA	NA	NA	NA
Chloroethane	NA	NA	13.0 UJ	15.0 U	33.0 U	NA	NA	NA	NA	NA	NA	NA
Chloroform	NA	NA	13.0 UJ	15.0 U	33.0 U	NA	NA	NA	NA	NA	NA	NA
Chloromethane	NA	NA	13.0 UJ	15.0 U	33.0 U	NA	NA	NA	NA	NA	NA	NA
Cumene	NA	NA	NA	15.0 U	33.0 U	NA	NA	NA	NA	NA	NA	NA
Cyclohexane	NA	NA	NA	15.0 U	33.0 U	NA	NA	NA	NA	NA	NA	NA
Dibromochloromethane	NA	NA	13.0 UJ	15.0 U	33.0 U	NA	NA	NA	NA	NA	NA	NA
Dichlorodifluoromethane	NA	NA	NA	15.0 U	33.0 U	NA	NA	NA	NA	NA	NA	NA
Ethylbenzene	NA	NA	13.0 UJ	15.0 U	33.0 U	NA	NA	NA	NA	NA	NA	NA
Methyl acetate	NA	NA	NA	15.0 U	33.0 U	NA	NA	NA	NA	NA	NA	NA
Methyl-tert-butyl ether (MTBE)	NA	NA	NA	15.0 U	33.0 U	NA	NA	NA	NA	NA	NA	NA
Methylcyclohexane	NA	NA	NA	15.0 U	33.0 U	NA	NA	NA	NA	NA	NA	NA
Methylene chloride	NA	NA	5.00 B	4.60 B	7.20 B	NA	NA	NA	NA	NA	NA	NA
Styrene	NA	NA	13.0 UJ	15.0 U	33.0 U	NA	NA	NA	NA	NA	NA	NA
Tetrachloroethene	NA	NA	13.0 UJ	15.0 U	33.0 U	NA	NA	NA	NA	NA	NA	NA
Toluene	NA	NA	13.0 UJ	15.0 U	33.0 U	NA	NA	NA	NA	NA	NA	NA
Trichloroethene	NA	NA	13.0 UJ	15.0 U	33.0 U	NA	NA	NA	NA	NA	NA	NA
Trichlorofluoromethane	NA	NA	NA	15.0 U	33.0 U	NA	NA	NA	NA	NA	NA	NA
Vinyl chloride	NA	NA	13.0 UJ	15.0 U	33.0 U	NA	NA	NA	NA	NA	NA	NA
Xylene, total	NA	NA	13.0 UJ	15.0 U	33.0 U	NA	NA	NA	NA	NA	NA	NA
cis-1,2-Dichloroethene	NA	NA	13.0 UJ	15.0 U	33.0 U	NA	NA	NA	NA	NA	NA	NA
cis-1,3-Dichloropropene	NA	NA	13.0 UJ	15.0 U	33.0 U	NA	NA	NA	NA	NA	NA	NA
m- and p-Xylene	NA	NA	13.0 UJ	NA	NA	NA	NA	NA	NA	NA	NA	NA
o-Xylene	NA	NA	13.0 UJ	15.0 U	33.0 U	NA	NA	NA	NA	NA	NA	NA
trans-1,2-Dichloroethene	NA	NA	13.0 UJ	15.0 U	33.0 U	NA	NA	NA	NA	NA	NA	NA
trans-1,3-Dichloropropene	NA	NA	13.0 UJ	15.0 U	33.0 U	NA	NA	NA	NA	NA	NA	NA
Other Parameters												
% Solids	73.5	73.5	NA	NA	37.2	37.7	51.2	73.1	60.9	65.3	76.0	78.4
Total organic carbon (mg/kg)	4,900	7,800	NA	NA	91,000	130,000	120,000	7,000	62,000	19,000	9,000	3,700
pH	7.40	7.40	NA	NA	7.00	7.30	7.30	7.10	7.10	7.40	7.20	7.60

Table G-3
Analytical Data - Fish Tissue Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Chemical	BIOTA7	BIOTA8	BIOTA9	
	AS05-S701(02)-R01	AS05-S801(02)-R01	AS05-S901(02)-R01	AS05-S901P(02)-R01
	02/26/02	02/26/02	02/26/02	02/26/02
Inorganics (MG/KG Wet Weight)				
Aluminum	13.2 B	12.3 B	24.6 B	26.0 B
Antimony	0.55 U	0.56 U	0.55 U	0.53 U
Arsenic	0.51 UL	0.52 UL	0.51 UL	0.49 UL
Barium	1.10 B	0.55 B	2.60 J	3.00 J
Beryllium	0.055 U	0.056 U	0.055 U	0.053 U
Cadmium	0.050 U	0.050 U	0.049 U	0.047 U
Calcium	13,400	11,600	5,400	5,620
Chromium	0.28 J	0.23 J	0.21 U	0.24 J
Cobalt	0.16 K	0.16 K	0.14 K	0.19 K
Copper	0.48 B	0.36 B	0.92 B	1.00 B
Iron	25.9	14.7 J	37.3	45.2
Lead	0.27 U	0.27 U	0.26 U	0.25 U
Magnesium	383 B	374 B	302 B	307 B
Manganese	18.9 L	11.3 L	22.4 L	19.4 L
Mercury	0.028 U	0.029 J	0.028 U	0.028 U
Nickel	0.30 U	0.31 U	0.34 B	0.29 U
Potassium	2,610 B	2,620 B	2,810 B	2,830 B
Selenium	1.20	1.10	1.50	1.60 B
Silver	0.16 U	0.17 U	0.16 U	0.16 U
Sodium	1,060 B	1,050	722 B	776 B
Thallium	0.78 U	0.94 J	0.77 U	0.75 U
Vanadium	0.35 J	0.21 U	0.21 U	0.25 J
Zinc	21.8 B	19.4 B	28.7	28.1
Other Parameters (Percent)				
Moisture	74.8	74.8	73.6	NA
Lipids	4.20	3.90	6.60	NA

Table G-4
Analytical Data - Groundwater Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

	5GW07			5GW09			5GW11			5GW17		
Chemical	AS05-5GW07-R05 08/07/00	AS05-5GW07-R06 04/11/01	AS05-5GW07-R07 02/01/02	AS05-5GW09-R05 08/03/00	AS05-5GW09-R06 04/17/01	AS05-5GW09-R07 02/06/02	AS05-5GW11-R05 08/02/00	AS05-5GW11-R06 04/11/01	AS05-5GW11-R07 02/07/02	AS05-5GW17-R05 08/10/00	AS05-5GW17P-R05 08/10/00	AS05-5GW17-R06 04/06/01
Inorganics (UG/L)												
Aluminum	22.6 B	NA	63.6 J	136 B	NA	17.2 U	83.7 B	NA	5,260	412	348	NA
Antimony	4.90 U	NA	5.00 U	4.90 U	NA	5.00 U	4.90 U	NA	5.00 U	4.90 U	4.90 U	NA
Arsenic	4.30 B	NA	5.10 U	4.10 B	NA	5.10 U	3.80 U	NA	6.90 J	3.80 U	3.80 U	NA
Barium	63.6 J	NA	78.3 J	32.8 J	NA	47.2 J	25.4 J	NA	305	99.8 J	87.7 J	NA
Beryllium	0.10 U	NA	0.10 U	0.10 U	NA	0.10 U	0.10 U	NA	0.46 J	0.10 U	0.10 U	NA
Boron	NA	NA	40.4 J	83.6	NA	36.9 J	50.0 R	NA	28.4 J	50.0 U	50.0 U	NA
Cadmium	0.40 U	NA	1.70 U	0.40 UL	NA	1.70 U	0.40 U	NA	1.70 U	0.40 UL	0.40 UL	NA
Calcium	47,000	NA	56,800	90,700	NA	55,200	33,300	NA	39,000	58,700	60,600	NA
Chromium	0.96 B	NA	1.40 J	0.70 UL	NA	2.70 B	0.70 UL	NA	20.5 B	7.10 J	6.40 B	NA
Cobalt	31.5 J	NA	40.3 J	8.80 J	NA	72.3	8.30 J	NA	4.80 J	4.00 B	3.50 B	NA
Copper	4.00 B	NA	1.50 U	0.70 U	NA	2.30 J	13.6 L	NA	39.0	1.50 B	2.20 B	NA
Cyanide	10.0 U	10.0 U	10.0 U	10.0 U	19.0	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U
Iron	10,600 J	NA	13,200	562	NA	9,400	15.9 U	NA	13,800	786 J	609 J	NA
Lead	5.40 B	NA	2.90 U	2.00 U	NA	3.30	2.00 U	NA	17.4	2.00 U	2.00 U	NA
Magnesium	21,300	NA	25,200	32,400	NA	22,000	13,600	NA	14,400	15,100	15,600	NA
Manganese	1,030	NA	1,260	1,990	NA	2,200	214	NA	65.1	579	597	NA
Mercury	0.10 U	NA	0.20 UL	0.10 U	NA	0.20 U	0.14 B	NA	0.20 U	0.10 U	0.10 U	NA
Molybdenum	NA	NA	10.0 U	10.0 U	NA	10.0 U	10.0 U	NA	10.0 U	10.0 U	10.0 U	NA
Nickel	84.4	NA	91.8	23.6 J	NA	24.2 J	36.6 J	NA	43.7	16.0 J	15.3 J	NA
Potassium	2,730 J	NA	2,430 J	3,980 K	NA	2,940 J	1,920 J	NA	4,820 J	926 J	902 J	NA
Selenium	2.30 B	NA	4.00 U	2.20 U	NA	4.00 U	2.20 U	NA	4.00 U	2.20 U	2.20 U	NA
Silver	0.60 U	NA	0.60 U	0.60 UL	NA	0.60 U	0.60 UL	NA	1.30 J	0.60 U	0.96 B	NA
Sodium	16,500	NA	17,100	16,700	NA	14,000	7,190	NA	6,840	7,630	7,970	NA
Thallium	2.30 UL	NA	5.00 U	2.30 U	NA	5.00 U	2.30 UL	NA	5.00 U	2.30 UL	2.30 UL	NA
Vanadium	1.00 U	NA	0.80 U	1.00 U	NA	1.20 B	1.00 U	NA	11.8 J	1.00 U	1.00 U	NA
Zinc	121	NA	121 B	39.0 B	NA	47.8	133	NA	79.3 B	28.6	30.6	NA
Dissolved Metals (UG/L)												
Aluminum	19.2 U	70.3 B	NA	92.0 B	79.6 B	NA	NA	110 B	NA	19.2 U	19.2 U	50.8 B
Antimony	4.90 U	3.10 U	NA	4.90 U	3.10 U	NA	NA	3.40 J	NA	4.90 U	4.90 U	3.10 U
Arsenic	7.60 B	3.50 B	NA	4.10 B	2.50 U	NA	NA	2.90 B	NA	3.80 U	3.80 U	3.40 B
Barium	63.3 J	74.0 B	NA	35.1 J	33.4 J	NA	NA	38.7 J	NA	67.9 J	67.3 J	57.1 J
Beryllium	0.10 U	0.36 B	NA	0.10 U	0.10 U	NA	NA	0.43 B	NA	0.10 U	0.10 U	0.33 B
Boron	NA	98.1	NA	57.5	112	NA	NA	71.0	NA	50.0 U	50.0 U	50.0 U
Cadmium	0.40 U	0.60 B	NA	0.40 U	0.40 U	NA	NA	0.73 B	NA	0.40 UL	0.40 UL	0.65 B
Calcium	49,700	51,200	NA	96,100	122,000	NA	NA	40,800	NA	64,100	63,700	71,000
Chromium	0.70 U	0.80 U	NA	0.70 U	0.80 U	NA	NA	0.80 U	NA	2.30 B	2.70 B	0.80 U
Cobalt	33.5 J	37.2 J	NA	8.90 J	5.30 J	NA	NA	5.00 J	NA	2.90 B	3.30 B	1.80 J
Copper	0.70 UL	2.70 J	NA	0.70 UL	1.70 J	NA	NA	8.90 J	NA	0.70 U	0.70 U	0.80 U
Iron	10,600	12,100	NA	461	464	NA	NA	298	NA	15.9 U	15.9 U	46.2 J
Lead	2.00 U	2.50 U	NA	4.20 B	2.50 U	NA	NA	2.50 U	NA	2.00 U	2.00 U	2.50 U
Magnesium	22,200	23,500	NA	30,800	36,300	NA	NA	13,400	NA	16,400	16,200	19,500
Manganese	1,080	1,100	NA	2,110	1,990	NA	NA	43.8	NA	636	644	502
Mercury	0.10 U	1.00 B	NA	0.10 U	0.20 U	NA	NA	0.20 UL	NA	0.10 U	0.17 B	0.20 UL
Molybdenum	NA	10.0 U	NA	10.0 U	10.0 U	NA	NA	10.0 U	NA	10.0 U	10.0 U	10.0 U
Nickel	88.6	95.3	NA	29.1 J	24.1 J	NA	NA	11.6 J	NA	11.7 K	11.8 K	12.1 K
Potassium	3,850 J	3,250 J	NA	4,050 J	4,550 J	NA	NA	2,270 J	NA	913 J	928 J	885 B
Selenium	2.20 UL	3.20 U	NA	16.3 B	3.20 U	NA	NA	3.20 U	NA	4.40 B	4.50 B	3.20 U
Silver	0.60 U	1.30 U	NA	1.30 B	1.30 U	NA	NA	1.30 U	NA	0.60 U	0.70 B	1.30 U
Sodium	18,800	19,300	NA	17,600 J	19,500 J	NA	NA	13,000	NA	8,600	8,780	10,100
Thallium	2.30 UL	3.90 U	NA	2.30 U	3.90 U	NA	NA	6.00 B	NA	2.30 UL	2.30 UL	5.20 K
Vanadium	1.00 U	34.9 U	NA	1.00 U	34.9 U	NA	NA	34.9 U	NA	1.00 U	1.00 U	34.9 U
Zinc	105	139 B	NA	33.3 B	46.7 J	NA	NA	77.1 B	NA	16.2 J	16.9 J	40.3 B

Table G-4
Analytical Data - Groundwater Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

	5GW07			5GW09			5GW11			5GW17		
Chemical	AS05-5GW07-R05 08/07/00	AS05-5GW07-R06 04/11/01	AS05-5GW07-R07 02/01/02	AS05-5GW09-R05 08/03/00	AS05-5GW09-R06 04/17/01	AS05-5GW09-R07 02/06/02	AS05-5GW11-R05 08/02/00	AS05-5GW11-R06 04/11/01	AS05-5GW11-R07 02/07/02	AS05-5GW17-R05 08/10/00	AS05-5GW17P-R05 08/10/00	AS05-5GW17-R06 04/06/01
Volatile Organic Compounds (UG/L)												
1,1,1-Trichloroethane	1.00 U	1.00 U	1.00 U	0.50 J	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
1,1,2,2-Tetrachloroethane	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
1,1,2-Trichloroethane	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
1,1-Dichloroethane	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
1,1-Dichloroethene	1.00 U	1.00 U	1.00 U	1.00 UJ	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
1,2,4-Trichlorobenzene	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
1,2-Dibromo-3-chloropropane	1.00 UJ	1.00 R	1.00 U	1.00 UJ	5.00 R	1.00 U	1.00 UJ	1.00 R	1.00 U	1.00 UJ	1.00 UJ	1.00 R
1,2-Dibromoethane	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
1,2-Dichlorobenzene	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
1,2-Dichloroethane	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
1,2-Dichloropropane	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
1,3-Dichlorobenzene	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
1,4-Dichlorobenzene	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
2-Butanone	5.00 R	5.00 R	5.00 U	5.00 R	25.0 R	5.00 U	5.00 R	5.00 R	5.00 U	5.00 R	5.00 R	5.00 U
2-Hexanone	5.00 UJ	5.00 U	5.00 U	5.00 UJ	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U
4-Methyl-2-pentanone	5.00 U	5.00 U	5.00 U	5.00 UJ	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U
Acetone	5.00 R	5.00 R	5.00 U	5.00 R	25.0 R	5.00 U	5.00 R	5.00 R	5.00 U	5.00 R	5.00 R	5.00 R
Benzene	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
Bromochloromethane	1.00 U	1.00 U	1.00 U	1.00 UJ	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
Bromodichloromethane	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
Bromoform	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
Bromomethane	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
Carbon disulfide	1.00 U	1.00 U	1.00 U	1.00 UJ	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
Carbon tetrachloride	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
Chlorobenzene	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
Chloroethane	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
Chloroform	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
Chloromethane	1.00 U	1.00 U	1.00 U	1.00 UJ	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
Dibromochloromethane	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
Ethylbenzene	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
Methylene chloride	0.70 B	0.60 B	1.40 B	1.20 B	2.00 U	0.60 B	2.00 U	0.50 B	2.00 U	2.00 UJ	2.00 UJ	0.60 B
Styrene	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
Tetrachloroethene	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
Toluene	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
Trichloroethene	1.00 U	1.00 U	1.00 U	48.0	46.0	26.0	1.00 U	1.00 U	1.00 U	10.0	11.0	17.0
Vinyl chloride	1.00 U	1.00 U	1.00 U	1.00 UJ	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
Xylene, total	1.00 U	NA	NA	1.00 U	NA	NA	1.00 U	NA	NA	1.00 U	1.00 U	NA
cis-1,2-Dichloroethene	1.00 U	1.00 U	1.00 U	7.10	4.00	3.50	1.00 U	1.00 U	1.00 U	1.30	1.30	0.90 J
cis-1,3-Dichloropropene	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
m- and p-Xylene	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
o-Xylene	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
trans-1,2-Dichloroethene	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
trans-1,3-Dichloropropene	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
Other Parameters (MG/L)												
Hardness	210	225	250	360	454	230	140	157	160	210	220	258

Table G-4
Analytical Data - Groundwater Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

	5GW17	5GW19			5GW20		5GW20	5GW24		
	AS05-5GW17-R07	AS05-5GW19-R05	AS05-5GW19-R06	AS05-5GW19-R07	AS05-5GW20-R05	AS05-5GW20-R06	AS05-5GW20-R07	AS05-5GW24-R05	AS05-5GW24-R06	AS05-5GW24-R07
Chemical	02/06/02	08/09/00	04/05/01	02/04/02	08/09/00	04/04/01	02/06/02	08/07/00	04/09/01	02/05/02
Inorganics (UG/L)										
Aluminum	61.4 J	16,300	NA	447	7,090	NA	185 J	94.1 B	NA	134 J
Antimony	5.00 U	4.90 U	NA	5.00 U	5.70 B	NA	5.00 U	4.90 U	NA	5.00 U
Arsenic	5.10 U	7.40 B	NA	5.10 U	4.80 B	NA	5.10 U	5.00 B	NA	5.10 U
Barium	38.9 J	366	NA	101 J	185 J	NA	103 J	72.3 J	NA	62.5 J
Beryllium	0.10 U	1.10 J	NA	0.10 U	0.54 J	NA	0.10 U	0.11 B	NA	0.10 U
Boron	27.7 J	50.0 U	NA	17.5 J	50.0 U	NA	27.7 J	NA	NA	26.3 J
Cadmium	1.70 U	0.40 UL	NA	1.70 U	0.40 UL	NA	1.70 U	0.42 B	NA	1.70 U
Calcium	66,100	31,400	NA	25,900	42,900	NA	58,100	124,000	NA	115,000
Chromium	3.40 B	33.8	NA	3.00 J	15.9	NA	2.60 B	0.96 B	NA	0.92 B
Cobalt	2.10 J	41.4 J	NA	1.30 U	15.2 J	NA	1.30 U	1.10 U	NA	1.30 U
Copper	1.50 U	37.2	NA	1.50 U	15.0 J	NA	1.50 U	3.30 B	NA	2.20 J
Cyanide	10.0 U	10.0 U	1.00	10.0 U	10.0 U	1.00	10.0 U	10.0 U	10.0 U	10.0 U
Iron	50.6 B	28,500 J	NA	730	14,500 J	NA	218	405 J	NA	261
Lead	2.90 U	29.9	NA	2.90 U	10.2	NA	2.90 U	2.10 B	NA	2.90 U
Magnesium	17,400	8,710	NA	5,780	10,200	NA	7,760	21,200	NA	26,800
Manganese	535	2,900	NA	145	672	NA	19.0	44.3	NA	17.0
Mercury	0.20 U	0.21 B	NA	0.20 U	0.10 U	NA	0.20 U	0.10 U	NA	0.20 U
Molybdenum	10.0 U	10.0 U	NA	10.0 U	10.0 U	NA	10.0 U	NA	NA	10.0 U
Nickel	9.40 J	61.2	NA	3.00 J	27.2 J	NA	2.10 U	2.80 B	NA	2.10 U
Potassium	698 J	2,840 J	NA	548 J	2,160 J	NA	347 J	2,980 J	NA	1,150 J
Selenium	4.00 U	2.20 U	NA	4.00 U	2.20 U	NA	4.00 U	2.20 UL	NA	4.00 U
Silver	0.60 U	0.84 B	NA	0.60 U	0.60 U	NA	0.60 U	0.60 U	NA	0.60 U
Sodium	9,780	3,470 B	NA	3,320 J	4,480 B	NA	6,380	6,070	NA	5,420 J
Thallium	5.00 U	2.30 UL	NA	5.00 U	2.30 UL	NA	5.00 U	2.30 UL	NA	5.00 U
Vanadium	1.50 B	32.9 J	NA	0.89 J	12.4 J	NA	1.10 B	1.00 U	NA	0.80 U
Zinc	15.2 B	150	NA	34.2 B	72.4	NA	12.5 B	31.4	NA	22.1 B
Dissolved Metals (UG/L)										
Aluminum	NA	19.2 U	58.1 B	NA	19.2 U	259	NA	19.2 U	26.6 B	NA
Antimony	NA	6.20 B	3.10 U	NA	4.90 U	3.10 U	NA	4.90 U	3.10 U	NA
Arsenic	NA	3.80 U	3.40 K	NA	3.80 U	2.60 K	NA	3.80 U	3.20 B	NA
Barium	NA	75.6 J	78.5 J	NA	82.9 J	92.6 J	NA	72.7 J	72.9 B	NA
Beryllium	NA	0.10 U	0.21 B	NA	0.10 U	0.26 B	NA	0.10 U	0.10 U	NA
Boron	NA	50.0 U	50.0 U	NA	50.0 U	50.0 U	NA	NA	51.4	NA
Cadmium	NA	0.40 UL	0.40 U	NA	0.40 UL	0.58 B	NA	0.40 U	0.40 U	NA
Calcium	NA	26,900	29,200	NA	38,200	51,000	NA	132,000	121,000	NA
Chromium	NA	1.70 B	0.80 U	NA	2.20 B	4.60 J	NA	0.70 U	0.80 U	NA
Cobalt	NA	1.10 B	1.00 U	NA	1.80 B	1.00	NA	1.10 U	1.00 U	NA
Copper	NA	0.70 U	1.80 J	NA	0.70 U	4.70 B	NA	0.70 UL	1.40 B	NA
Iron	NA	15.9 U	41.5 J	NA	15.9 U	455	NA	15.9 U	14.7 U	NA
Lead	NA	2.00 U	2.50 U	NA	2.00 U	2.50 U	NA	3.50	2.50 U	NA
Magnesium	NA	5,800	5,990	NA	8,480	6,680	NA	22,500	19,800	NA
Manganese	NA	117	13.4 J	NA	46.6	29.7	NA	16.2	2.60 B	NA
Mercury	NA	0.10 U	0.20 UL	NA	0.10 U	0.20 UL	NA	0.11 B	1.20 L	NA
Molybdenum	NA	10.0 U	10.0 U	NA	10.0 U	10.0 U	NA	NA	10.0 U	NA
Nickel	NA	8.30 B	2.40 J	NA	6.20 B	6.10 J	NA	2.00 U	1.80 B	NA
Potassium	NA	637 J	585 J	NA	853 J	388 J	NA	4,330 J	4,160 J	NA
Selenium	NA	2.20 U	3.20 U	NA	2.20 U	3.20 U	NA	2.30 B	3.20 U	NA
Silver	NA	0.60 U	1.30 U	NA	0.60 U	1.30 U	NA	0.60 U	1.30 U	NA
Sodium	NA	3,940 B	3,540 J	NA	5,320	5,170	NA	6,600	11,400	NA
Thallium	NA	2.30 UL	5.80 K	NA	2.30 U	4.70 K	NA	2.30 UL	5.50 B	NA
Vanadium	NA	1.10 B	34.9 U	NA	1.00 U	34.9 U	NA	1.00 U	34.9 U	NA
Zinc	NA	14.5 B	35.0 B	NA	11.3 B	34.0 B	NA	8.90 J	27.0 B	NA

Table G-4
Analytical Data - Groundwater Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

	5GW17	5GW19			5GW20		5GW20	5GW24		
Chemical	AS05-5GW17-R07 02/06/02	AS05-5GW19-R05 08/09/00	AS05-5GW19-R06 04/05/01	AS05-5GW19-R07 02/04/02	AS05-5GW20-R05 08/09/00	AS05-5GW20-R06 04/04/01	AS05-5GW20-R07 02/06/02	AS05-5GW24-R05 08/07/00	AS05-5GW24-R06 04/09/01	AS05-5GW24-R07 02/05/02
Volatile Organic Compounds (UG/L)										
1,1,1-Trichloroethane	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
1,1,2,2-Tetrachloroethane	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
1,1,2-Trichloroethane	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
1,1-Dichloroethane	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
1,1-Dichloroethene	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
1,2,4-Trichlorobenzene	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
1,2-Dibromo-3-chloropropane	1.00 U	1.00 UJ	1.00 R	1.00 U	1.00 UJ	1.00 R	1.00 U	1.00 UJ	1.00 R	1.00 U
1,2-Dibromoethane	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
1,2-Dichlorobenzene	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
1,2-Dichloroethane	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
1,2-Dichloropropane	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
1,3-Dichlorobenzene	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
1,4-Dichlorobenzene	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
2-Butanone	5.00 U	5.00 U	5.00 R	5.00 U	5.00 U	5.00 R	5.00 U	5.00 R	5.00 U	5.00 U
2-Hexanone	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 UJ	5.00 U	5.00 U
4-Methyl-2-pentanone	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U	5.00 U
Acetone	5.00 U	5.00 R	5.00 R	5.00 U	5.00 R	5.00 R	5.00 U	5.00 R	5.00 R	5.00 U
Benzene	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
Bromochloromethane	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
Bromodichloromethane	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
Bromoform	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
Bromomethane	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
Carbon disulfide	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	2.10 B	1.00 U	1.00 U
Carbon tetrachloride	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
Chlorobenzene	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
Chloroethane	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
Chloroform	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
Chloromethane	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
Dibromochloromethane	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
Ethylbenzene	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
Methylene chloride	0.60 B	4.10	0.70 B	0.70 B	3.60	0.60 B	0.60 B	0.60 B	1.80 B	2.60 B
Styrene	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
Tetrachloroethene	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
Toluene	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
Trichloroethene	27.0	1.00 U	1.00 U	2.00	3.60	14.0	28.0	1.00 U	1.00 U	1.00 U
Vinyl chloride	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
Xylene, total	NA	1.00 U	NA	NA	1.00 U	NA	NA	1.00 U	NA	NA
cis-1,2-Dichloroethene	1.80	1.00 U	1.00 U	1.00 U	0.70 J	0.90 J	2.30	1.00 U	1.00 U	1.00 U
cis-1,3-Dichloropropene	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
m- and p-Xylene	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
o-Xylene	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
trans-1,2-Dichloroethene	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
trans-1,3-Dichloropropene	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U
Other Parameters (MG/L)										
Hardness	240	110	100	88.0	150	160	180	400	380	400

Appendix H
Applicable or Relevant and Appropriate Requirements (ARARs)

Table H-1
Chemical-Specific ARARs
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Chemicals & Relevant Media	Requirement	Prerequisites	Citation	ARAR or TBC	Comments
Groundwater, residential water supplies	Meet National Primary Standards for maximum contaminant levels (MCLs).	Drinking water source or potential source	Safe Drinking Water Act (SDWA): 40 CFR 141 National Primary Drinking Water Regulations, CERCLA, RCRA	Relevant and appropriate	Regulation does not apply where groundwater quality has concentrations of total dissolved solids (TDS) greater than 2,500 mg/L. In these instances, the Medium-Specific Concentration for groundwater may be multiplied by 100. MCL used as PRG for groundwater.
Surface water	Water Management Program approval for short-term discharges and NPDES for long-term discharges.	None.	CWA: 40 CFR 122-123 NPDES permit program	TBC	This regulation is applicable for remedial actions that may affect surface water quality in the State of Maryland.
Surface waters of the State	Protect and maintain the quality of surface water in the State of Maryland. Criteria and standards for discharges. Limitations and policy for antidegradation of the State's surface water.	Activities that will pollute the State's surface waters	COMAR 26.08, chapters 1 through 7	TBC	This regulation is applicable for remedial actions that may affect surface water quality in the State of Maryland.
Surface water	Ambient Water Quality Criteria established to protect aquatic life and human consumers of water or aquatic life.	Activities that affect or may affect the surface water onsite	40 CFR 129	Applicable	Used in the development of PRGs.
Carcinogens in groundwater	Not to exceed media-specific concentration that causes a lifetime cancer risk no to exceed 1 in 10,000	Potential exposure	CERCLA, RCRA	TBC	Used to calculate site-specific PRGs for groundwater.
Systemic toxicants in groundwater	Not to exceed media-specific levels where people could be exposed by direct ingestion or inhalation on a daily basis without appreciable risk of deleterious effects.	Potential exposure	CERCLA, RCRA	TBC	Used to calculate site-specific PRGs for groundwater.
Air	Emissions limitations related to attainment of National Ambient Air Quality Standards and Emission Standards for Hazardous Air Pollutants.	Air emissions	Clean Air Act (CAA)	Applicable	Treatment alternatives such as air stripping will involve air emissions.

ARAR - Applicable or relevant and appropriate requirement
CAA - Clean Air Act
RCRA - Resource Conservation and Recovery Act
CFR - Code for Federal Regulations
CWA - Clean Water Act
EPA - U.S. Environmental Protection Agency
NPDES - National Pollutant Discharge Elimination System.
OSHA - Occupational Safety and Health Administration
CERCLA - Comprehensive Environmental Response, Compensation, and Liability Act
SDWA - Safe Drinking Water Act
SMCLs - Secondary Maximum Contaminant Levels
TBC - To be considered

Table H-2
Location-Specific ARARs
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Location	Requirement	Prerequisite	Citation	Applicability Determination	Comments
Federal Location-Specific ARARs					
Historic Sites, Buildings, and Antiquities Act					
Historic sites	Avoid undesirable impacts on landmarks.	Areas designated as historic sites.	16 USC 461-467; 40 CFR 6.301 (a)	Relevant and Appropriate	The regulations are relevant and appropriate in situations where remedial actions may adversely affect the historical structures located on the site.
Fish and Wildlife Coordination Act, Fish and Wildlife Improvement Act of 1978, Fish and Wildlife Conservation Act of 1980					
Area affecting streams or other water body	Provides protection for actions that would affect streams, wetlands, other water bodies or protected habitats. Any action taken should protect fish or wildlife.	Diversion, channeling or other activity that modifies a stream or other water body and affects fish or wildlife.	16 USC 661; 16 USC 662; 16 USC 742a; 16 USC 2901; 50 CFR 83	Applicable	Response actions will incorporate protection against any area water body, wetlands, or protected habitats.
Clean Water Act, Section 404					
Surface Water	Ambient Water Quality Criteria established to protect aquatic life and human consumers of water aquatic life.	Activities that affect or may affect the surface water onsite	40 CFR 129	Applicable	These regulations were used in the development of the PRGs for the site.
Hazardous Waste Control Act (HWCA)					
Within 100-year floodplain	Facility must be designed, constructed, operated, and maintained to avoid washout.	RCRA hazardous waste; treatment, storage, or disposal of hazardous waste.	40 CFR 264.18 (b)	TBC	Portions of the site are within the 100-year flood zones. However, actions are not expected to involve hazardous waste. This would be TBC for nonhazardous waste.
Executive Order 11988, Protection of Floodplains					
Within floodplain	Actions taken should avoid adverse effects, minimize potential harm, restore and preserve natural and beneficial values.	Action that will occur in a floodplain, i.e., lowlands, and relatively flat areas adjoining inland and coastal waters and other flood-prone areas.	40 CFR 6, Appendix A; excluding Sections 6(a)(2), 6(a)(4), 6(a)(6); 40 CFR 6.302	Applicable	Portions of the site are within the 100-year flood zones, therefore the requirements of this regulation are applicable for any response actions that might involve the use of these areas.
Maryland State Location-Specific ARARs					
Threatened and Endangered Species					
Critical habitat upon which endangered species or threatened species depend.	Requires action to conserve endangered or threatened fish species and the critical habitats they depend on. May not reduce the likelihood of either the survival or recovery of a listed species in the wild by reducing the reproduction, numbers or distribution of a listed species or otherwise adversely affect the species.	Determination of effect upon endangered or threatened species or its habitat.	COMAR 08.03.08	Potentially applicable	Requires action to conserve endangered fish species and the critical habitats they depend on.
Threatened and Endangered Fish Species					
Critical habitat upon which endangered or threatened fish species depend.	Requires action to conserve endangered or threatened fish species and the critical habitats they depend on.	Determination of effect upon endangered or threatened fish species or its habitat.	COMAR 08.02.12	Potentially applicable	These regulations are applicable if remedial actions may jeopardize endangered or threatened fish species. Currently, there are no federal or state endangered fish species at ABL.
Fish and Fisheries					
Fisheries, locations where species of fish exist	Requirements to conserve species of fish for human enjoyment, for scientific purposes and to ensure their perpetuation as viable components of their ecosystems.	Determination of effect upon fish species or its habitat.	Annotated Code of Maryland Title 4	Applicable	Fish species inhabit the North Branch Potomac River. If response actions affect these species, the requirements of this title are applicable.
Wildlife					
Areas inhabited by wildlife	Requirements to conserve species of wildlife for human enjoyment, for scientific purposes and to ensure their perpetuation as viable components of their ecosystems.	Determination of effect upon wildlife species or its habitat.	Annotated Code of Maryland Title 10	Potentially applicable	Wildlife species are present at ABL. If response actions may affect wildlife species, the requirements of this title are applicable.
Construction on Nontidal Waters and Floodplains					
Nontidal waters and floodplains	Protect and maintain nontidal waterways and/or state of Maryland floodplains must follow these regulations	Activities that affect nontidal waterways and floodplains	COMAR 08.05.03	Potentially Applicable	Any remedial actions involving alteration to the streams bounding the site or floodplains (including temporary construction) are subject to these requirements.
Water Pollution Control Law					
Waters of the State	Establishes effective programs and provides additional and cumulative remedies to prevent, abate, and control pollution of the waters in the state.	Activities that will pollute the waters in the state.	COMAR 9, Parts 301-351	Potentially Applicable	This regulation is applicable for remedial actions that may affect water quality in local streams.
Maryland Water Pollution Control Regulations					

Table H-2
Location-Specific ARARs
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Location	Requirement	Prerequisite	Citation	Applicability Determination	Comments
Surface waters of the State	Protect and maintain the quality of surface water in the State of Maryland. Criteria and standards for discharges limitations and policy for antidegradation of the State's limitations and policy for antidegradation of the State's surface water.	Activities that will pollute the surface waters of the state.	COMAR 26.08, Chapters 01-07	Potentially Applicable	This regulation is applicable for remedial actions that may affect surface water quality in the State of Maryland.
Water Management					
Water resources of the State	Provides for the conservation and protection of the water resources of the State by requiring that any land-clearing, grading, or other earth disturbances require an erosion- and sediment-control plan. Also provides that stormwater must be managed to prevent offsite sedimentation and maintain current site conditions.	Activities that affect the water resources of the State.	COMAR 26.17.01 COMAR 26.17.02, Annotated Code of Maryland Title 4	Applicable	The design for the remedial actions will incorporate the requirements of this regulation.
West Virginia State Location-Specific ARARs					
Air Pollution Control Act and the Hazardous Waste Management Act					
Air Emissions	Provides requirements for the facility design, construction, maintenance, and operation to minimize the release of hazardous waste constituents to the air.	Applies to all owners and operators of hazardous waste storage, treatment, or disposal facilities.	45CSR25-4.3	Relevant and Appropriate	
Air Pollution Control Act					
Air Emissions	Adopts by reference Table 25-A of the Code of Federal Regulations	Applies to all owners and operators of hazardous waste storage, treatment, or disposal facilities.	45CSR25-3.2	Relevant and Appropriate	
Air Emissions	Adoption of Best Available Technology requirements for the discharge of emissions of Toxic Air Pollutants	For the prevention and control of the discharge of toxic air pollutants requiring the application of best available technology from a "Chemical Processing Unit" meaning an assembly of reactors, tanks, distillation columns, heat exchangers, vaporizers, compressors, dryers, decanters, and/or other equipment used to treat, store, manufacture, or use toxic air pollutants.	45CSR27-3.1 to 3.5	Applicable	
Air Emissions	Adoption of Best Available Technology requirements for the discharge of Fugitiva Emissions of Toxic Air Pollutants	For the prevention and control of the discharge of toxic air pollutants requiring the application of best available technology from a "Chemical Processing Unit" meaning an assembly of reactors, tanks, distillation columns, heat exchangers, vaporizers, compressors, dryers, decanters, and/or other equipment used to treat, store, manufacture, or use toxic air pollutants.	45CSR27-4.1 to 4.2	Applicable	
Air Emissions	Permits for the Construction, Modification, Relocation, and Operation of Stationary Sources of Air Pollutants, Norfication Requirements, and Temporary Permits	Sets forth the procedures and the criteria for obtaining a permit to construct and operate a new stationary source which is not a major stationary source.	45CSR13	Relevant and Appropriate	Can apply to air-stripping remedial alternative
Air Emissions	Establishes the requirements to obtain an operating air permit	Any major source or Any source, including an area source, subject to a standard or other requirements promulgated under §111 of the Clean Air Act;	45CSR30	Potentially Relevant and Appropriate	
Groundwater Pollution Control Act					
Groundwater	Achieve standards for purity and quality for groundwater in the State	Except as provided in Sections 3.2 and 3.3, the standards of purity and quality for groundwater in the state shall be the constituent concentrations found in Appendix A.	46CSR12-3.1 to 3.3	Applicable	
Groundwater	Constituents in groundwater shall not cause a violation of the standards found at 46 CSR Series I in any surface water		46CSR12-3.3	Applicable	
Groundwater	Subsurface borings shall be constructed, operated and closed in a manner that protects groundwater		47CSR58-4.2	Applicable	
Groundwater	New areas used for storage shall be designed, constructed and operated to prevent release of contaminants. Groundwater monitoring stations may be necessary to assure protection of the groundwater resource.		47CSR58-4.3.b	Potentially Relevant and Appropriate	

Table H-2
Location-Specific ARARs
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Location	Requirement	Prerequisite	Citation	Applicability Determination	Comments
Groundwater	Loading and unloading stations including but not limited to drums, trucks and railcars shall have spill prevention and control facilities and procedures as well as secondary containment.		47CSR58-4.4.a	Potentially Relevant and Appropriate	
Groundwater	New impoundments shall be designed and operated to prevent contamination of groundwater.		47CSR58-4.5.b	Potentially Relevant and Appropriate	
Groundwater	Pipelines conveying contaminants shall preferentially be installed above ground. Ditches conveying contaminants must have appropriate liners. Pumps and related equipment must be installed to prevent or contain any leaks or spills.		47CSR58-4.7 to 4.7.d	Potentially Relevant and Appropriate	
Groundwater	Requirements for secondary containment for sumps and above ground tanks		47CSR58-4.8 to 4.8.e	Potentially Relevant and Appropriate	
Groundwater	Groundwater monitoring stations shall be located and constructed in a manner that allows accurate determination of groundwater quality and levels, and prevents contamination of groundwater through the finished welll hole or casing. All groundwater monitoring stations shall be accurately located utilizing latitude and longitude by surveying,or other acceptable means, and coordinates shall be included with all data collected.		47CSR58-4.79.c to 4.9.g	Applicable	
Groundwater	Each industrial establishment shall have a comprehensive groundwater protection plan (GPP) including inventory of all operations that may reasonably be expected to contaminate the groundwater resourcesand procedures designed to protect groundwater, a summary of all activities carried out under other regulatory programs that have relevance to groundwater protection, a discussion of all available information reasonably available to the facility/activity regarding existing groundwater quality and provisions for employee training and quarterly inspections		47CSR58-4.11	Relevant and Appropriate	
Groundwater	Clean up actions shall be permanent and shall not rely primarily on dilution and dispersion if active remedial measures are technically and economically feasible.		47CSR58-8.1.a to 8.1.c	Relevant and Appropriate	
Groundwater	Facility or activity design must adequately address the issues arising from locating in karst, wetlands, faults, subsidence, delineated wellhead pro+B105tection areas determined vulnerable.	Sensitive natural resource or geologic areas	47CSR58-4.10	Applicable	
Groundwater	Rule governing the certification of monitoring well drillers and monitoring well installations and alterations.	Well installation	47CSR59-4.1 to 4.7	Applicable	
Groundwater	Requirements and procedures governing the installation and development and/or redevelopment and reconditioning or abandonment of temporary or permanent monitoring well(s), piezometer(s), recovery well(s), well(s), and boreholes.	Boring installation	47CSR60-5 to 22	Applicable	

Table H-3
Action-Specific ARARs
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Action	Requirement	Prerequisite	Citation	ARAR Determination	Comments
Federal Action-Specific ARARs					
Resource Conservation and Recovery Act (RCRA) 42 USC 6901 et seq.*					
Onsite waste generation	Waste generator shall determine if waste is hazardous waste.	Generator of hazardous waste.	40 CFR 262.10 (a), 262.11	Applicable	Applicable for any operation where waste is generated. Remedial alternatives for the site may generate contaminated wastes.
Hazardous waste accumulation	Generator may accumulate waste on site for 90 days or less or must comply with requirements for operating a storage facility.	Accumulate hazardous waste.	40 CFR 262.34	Potentially applicable	If waste generated at ABL is determined to be hazardous, any storage of the hazardous waste will not exceed 90 days. Accumulation of hazardous wastes onsite for longer than 90 days would be subject to the substantive RCRA requirements for storage facilities.
Recordkeeping	Generator must keep records of types and quantities of wastes generated.	Generate hazardous waste.	40 CFR 262.40	Potentially applicable	Administrative requirements are not ARARs for onsite CERCLA actions.
Excavation	Movement of excavated materials to new location and placement in or on land will trigger land disposal restrictions for the excavated waste or closure requirements for the unit in which the waste is being placed.	Materials containing RCRA hazardous wastes subject to land disposal restrictions are placed in another unit.	40 CFR 268.40	Potentially applicable	Applicable to disposal of soil to a new location and placement in or on land containing land-disposal-restricted RCRA hazardous waste. The wastes generated from response actions at ABL may be RCRA hazardous wastes.
Safe Drinking Water Act					
Actions that affect drinking water supply	Promulgates National Primary Drinking Water Standard Maximum Contaminant Levels (MCLs)	Actions that affect drinking water supply	40 CFR 141	Relevant and appropriate	These regulations are ARARs for remedial actions at the site that affect the groundwater.
U.S. Department of Transportation, 49 USC 1802, et seq.*					
Hazardous Materials Transportation	No person shall represent that a container or package is safe unless it meets the requirements of 49 USC 1802, et seq. or represent that a hazardous material is present in a package or motor vehicle if it is not.	Interstate carriers transporting hazardous waste and substances by motor vehicle. Transportation of hazardous material under contract with any department of the executive branch of the Federal Government.	49 CFR 171.2(f)	Potentially applicable	Offsite transport of hazardous materials must comply with both substantive and administrative requirements.
	No person shall unlawfully alter or deface labels, placards, or descriptions, packages, containers, or motor vehicles used for transportation of hazardous materials.		49 CFR 171.2(g)	Potentially applicable	
Hazardous Materials Marking, Labeling, and Placarding	Each person who offers hazardous material for transportation or each carrier that transports it shall mark each package, container, and vehicle in the manner required.	Person who offers hazardous material for transportation; carries hazardous material; or packages, labels, or packages, labels, or placards hazardous material.	49 CFR 172.300	Potentially applicable	To be determined. Offsite transport of hazardous materials must comply with both substantive and administrative requirements.
	Each person offering non-bulk hazardous materials for transportation shall mark the proper shipping name and identification number (technical name) and consignee's name and address.		49 CFR 172.301	Potentially applicable	
	Hazardous materials for transportation in bulk packages must be labeled with proper identification (ID) number, specified in 49 CFR 172.101 table, with required size of print. Packages must remain marked until cleaned or refilled with material requiring other marking.	Person who offers hazardous material for transportation; carries hazardous material; or packages, labels, or placards hazardous material.	49 CFR 172.302	Potentially applicable	

Table H-3
Action-Specific ARARs
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Action	Requirement	Prerequisite	Citation	ARAR Determination	Comments
Hazardous Materials Marking, Labeling, and Placarding (cont.)	No package marked with a proper shipping name or ID number may be offered for transport or transported unless the package contains the identified hazardous material or its residue.	None	49 CFR 172.303	Potentially applicable	To be determined. Offsite transport of hazardous materials must comply with both substantive and administrative requirements.
	The marking must be durable, in English, in contrasting colors, unobscured, and away from other markings.		49 CFR 172.304	Potentially applicable	
	Labeling of hazardous material packages shall be as specified in the list.	Person who offers hazardous material for transportation; carries hazardous material; or packages, labels, or placards hazardous material.	49 CFR 172.400	Potentially applicable	
	Non-bulk combination packages containing liquid hazardous materials must be packed with closures upward, and marked with arrows pointing upward.		49 CFR 172.312	Potentially applicable	
	Each bulk packaging or transport vehicle containing any quantity of hazardous material must be placarded on each side and each end with the type of placards listed in Tables 1 and 2 of 49 CFR 172.504.		49 CFR 172.504	Potentially applicable	
Occupational Safety and Health Administration (OSHA)					
Hazardous waste work	Requirements for hazardous waste workers such as training, personal protective equipment (PPE), and clothing must be met.	Hazardous waste work.	29 CFR 1904, 29 CFR 1910, 29 CFR 1926	Applicable	Remedial action activities at ABL will involve hazardous waste workers; therefore the requirements of OSHA must be met.
Maryland State Action-Specific ARARs					
Air Quality					
Actions that involve emissions to air	Provides ambient air quality standards, general emissions standards, and restrictions for air emissions from construction activities, vents, and treatment technologies such as incinerators. Also includes nuisance and odor control. Construction activities may emit particulate matter into the ambient air. Remedial activities must follow regulations.	Actions that involve emissions to air above specific limits.	COMAR 26.11	Applicable	May apply to the alternative that includes air stripping as a treatment component for extracted groundwater.
West Virginia State Action-Specific ARARs					
Air Pollution Control Act and the Hazardous Waste Management Act					
Release of emissions of hazardous waste constituents	Provides requirements for the facility design, construction, maintenance, and operation to minimize the release of hazardous waste constituents to the air.	Applies to all owners and operators of hazardous waste storage, treatment, or disposal facilities.	45CSR25-4.3	Relevant and Appropriate	
Air Pollution Control Act					
Release of fugitive or toxic air pollutants	Adopts by reference Table 25-A of the Code of Federal Regulations	Applies to all owners and operators of hazardous waste storage, treatment, or disposal facilities.	45CSR25-3.2	Relevant and Appropriate	

Table H-3
Action-Specific ARARs
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Action	Requirement	Prerequisite	Citation	ARAR Determination	Comments
	Adoption of Best Available Technology requirements for the discharge of emissions of Toxic Air Pollutants	For the prevention and control of the discharge of toxic air pollutants requiring the application of best available technology from a "Chemical Processing Unit" meaning an assembly of reactors, tanks, distillation columns, heat exchangers, vaporizers, compressors, dryers, decanters, and/or other equipment used to treat, store, manufacture, or use toxic air pollutants.	45CSR27-3.1 to 3.5	Applicable	
	Adoption of Best Available Technology requirements for the discharge of Fugitiva Emissions of Toxic Air Pollutants	For the prevention and control of the discharge of toxic air pollutants requiring the application of best available technology from a "Chemical Processing Unit" meaning an assembly of reactors, tanks, distillation columns, heat exchangers, vaporizers, compressors, dryers, decanters, and/or other equipment used to treat, store, manufacture, or use toxic air pollutants.	45CSR27-4.1 to 4.2	Applicable	
	Permits for the Construction, Modification, Relocation, and Operation of Stationary Sources of Air Pollutants, Norfication Requirements, and Temporary Permits	Sets forth the procedures and the criteria for obtaining a permit to construct and operate a new stationary source which is not a major stationary source.	45CSR13	Relevant and Appropriate	Can apply to the alternative that includes air stripping as a treatment component for extracted groundwater.
	Establishes the requirements to obtain an operating air permit	Any major source or Any source, including an area source, subject to a standard or other requirements promulgated under §111 of the Clean Air Act;	45CSR30	Potentially Relevant and Appropriate	
Groundwater Pollution Control Act					
Protection of groundwater quality - establishing acceptable constituent criteria	Achieve standards for purity and quality for groundwater in the State	Except as provided in Sections 3.2 and 3.3, the standards of purity and quality for groundwater in the state shall be the constituent concentrations found in Appendix A.	46CSR12-3.1 to 3.3	Applicable	
	Constituents in groundwater shall not cause a violation of the standards found at 46 CSR Series I in any surface water		46CSR12-3.3	Applicable	
Installation of groundwater well	Subsurface borings shall be constructed, operated and closed in a manner that protects groundwater		47CSR58-4.2	Applicable	
Construction of groundwater wells and associated storage/treatment facilities	New areas used for storage shall be designed, constructed and operated to prevent release of contaminants. Groundwater monitoring stations may be necessary to assure protection of the groundwater resource.		47CSR58-4.3.b	Potentially Relevant and Appropriate	
	Loading and unloading stations including but not limited to drums, trucks and railcars shall have spill prevention and control facilities and procedures as well as secondary containment.		47CSR58-4.4.a	Potentially Relevant and Appropriate	

Table H-3
Action-Specific ARARs
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Action	Requirement	Prerequisite	Citation	ARAR Determination	Comments
	New impoundments shall be designed and operated to prevent contamination of groundwater.		47CSR58-4.5.b	Potentially Relevant and Appropriate	
	Pipelines conveying contaminants shall preferentially be installed above ground. Ditches conveying contaminants must have appropriate liners. Pumps and related equipment must be installed to prevent or contain any leaks or spills.		47CSR58-4.7 to 4.7.d	Potentially Relevant and Appropriate	
	Requirements for secondary containment for sumps and above ground tanks		47CSR58-4.8 to 4.8.e	Potentially Relevant and Appropriate	
	Groundwater monitoring stations shall be located and constructed in a manner that allows accurate determination of groundwater quality and levels, and prevents contamination of groundwater through the finished welll hole or casing. All groundwater monitoring stations shall be accurately located utilizing latitude and longitude by surveying,or other acceptable means, and coordinates shall be included with all data collected.		47CSR58-4.79.c to 4.9.g	Applicable	
Installation of groundwater well	Rule governing the certification of monitoring well drillers and monitoring well installations and alterations.	Well installation	47CSR59-4.1 to 4.7	Applicable	
Installation of groundwater well	Requirements and procedures governing the installation and development and/or redevelopment and reconditioning or abandonment of temporary or permanent monitoring well(s), piezometer(s), recovery well(s), well(s), and boreholes.	Boring installation	47CSR60-5 to 22	Applicable	
Establishment of industrial activities with the potential to contaminate groundwater	Each industrial establishment shall have a comprehensive groundwater protection plan (GPP) including inventory of all operations that may reasonably be expected to contaminate the groundwater resourcesand procedures designed to protect groundwater, a summary of all activities carried out under other regulatory programs that have relevance to groundwater protection, a discussion of all available information reasonably available to the facility/activity regarding existing groundwater quality and provisions for employee training and quarterly inspections		47CSR58-4.11	Relevant and Appropriate	
Groundwater Remediation	Clean up actions shall be permanent and shall not rely primarily on dilution and dispersion if active remedial measures are technically and economically feasible.		47CSR58-8.1.a to 8.1.c	Relevant and Appropriate	
	Facility or activity design must a+B81dequately address the issues arising from locating in karst, wetlands, faults, subsidence, delineated wellhead protection areas determined vulnerable.	Sensitive natural resource or geologic areas	47CSR58-4.10	Applicable	

Appendix I
Preliminary Remediation Goals (PRGs) Development

Table I-1

Risk- Based Preliminary Remediation Goals

Groundwater, Adult Residential Scenario

Focused RI/FS

Site 5, Allegany Ballistics Laboratory

Rocket Center, West Virginia

Chemical	Chronic Oral RfD (RfDo) (mg/kg-day)	Chronic Dermal RfD (RfDd) (mg/kg-day)	Chronic Inhalation RfD (RfDi) (mg/kg-day)	Target Organ	Shower Exposure (L/day)	Noncarcinogen Groundwater PRG		
						HQ = 0.1 (mg/L)	HQ = 0.5 (mg/L)	HQ = 1 (mg/L)
VOCs								
Trichloroethene	3.00E-04	3.00E-04	1.00E-02	Liver, Kidney	5.5E-03	1.1E-03	5.5E-03	1.1E-02
Inorganics								
Iron	3.00E-01	3.00E-01	NA	GI		1.1E+00	5.5E+00	1.1E+01
Manganese	2.00E-02	8.00E-04	NV	CNS		7.3E-02	3.7E-01	7.3E-01

Noncarcinogenic calculations:

$$\textbf{Groundwater RBC (mg/L)} = \frac{THQ \times BW \times AT_n}{EF \times ED \times (An + Bn + Cn)}$$

An = 1/RfDo x IR

Bn = 1/RfDd x SA x DAevent

Cn = 1/RfDi x Shower Exposure (Calculated for VOCs only)

EXPOSURE ASSUMPTIONS	
BW - Body weight (kilograms)	70
ATnc - Averaging time for noncarcinogens (days)	8,760
ATc - Averaging time for carcinogens (days)	25,550
EF - Exposure frequency (days/year)	350
ED - Exposure duration (year)	24
IR - Ingestion rate (L/day)	2

Notes:

NA - No reference dose or slope factor available.

NV - Not volatile.

Shower exposure calculated on Table B-1a.

Table I-1a

Inhalation Exposure Concentrations from Foster and Chrostowski Shower Model

Focused RI/FS

Site 5, Allegany Ballistics Laboratory

Rocket Center, West Virginia

Chemical	Molecular weight (MW) (g/mole)	Henry's Law Constant (H) (atm-m^3/mole)	Kg (VOC) (cm/hr)	Kl(VOC) (cm/hr)	KL (cm/hr)	Kal (cm/hr)	Cwd	S (L/m^3 - min)	Inhalation Exposure (InExp) (L/kg-shower)	Shower Exposure (InExp X BW) (L/day)
Trichloroethene	131	1.0E-02	1.1E+03	1.2E+01	1.1E+01	1.5E+01	4.0E-01	2.7E+00	7.8E-05	5.5E-03

Variables	**Units**	**Exposure Assumptions**
Kg(VOC) = gas-film mass transfer coefficient	cm/hr	Solved by Eq 1
Kl(VOC) = liquid-film mass transfer coefficient	cm/hr	Solved by Eq 2
KL = overall mass transfer coefficient	cm/hr	Solved by Eq 3
Kal = adjusted overall mass transfer coeff.	cm/hr	Solved by Eq 4
Tl = Calibration temp. of water	K (20C +273)	293
Ts = Shower water temperature	k (45C)	318
Us = water viscosity at Ts	centipoise	0.596
Ul = water viscosity at Tl	cp	1.002
Cwd = conc. leaving droplets after time sdt		Solved by Eq 5
sdt = shower droplet drop time	sec	2
d = shower droplet diameter	mm	1
FR = shower water flow rate	l/min	20
SV = shower room air volume	m^3	3
S = indoor VOC generation rate	L/m^3-min	Solved by Eq 6
VR = ventilation rate	l/min	13.8
BW = body weight	kg	70
Ds = duration of shower	min	12
Dt = total duration in shower room	min	20
R = air exchange rate	min^{-1}	0.0167
Ca = indoor air concentration of VOCs	L-ug/mg-m^3	Solved by Eq 7
Einh = inhalation exposure per shower	L/kg-shower	Solved by Eq 8

Equation 1:	Kg(VOC) =	3000 * (18 / MW)$^{0.5}$
Equation 2:	Kl(VOC) =	20 * (44 / MW)$^{0.5}$
Equation 3:	KL =	((1 / Kl(VOC)) + (0.024 / (Kg (VOC) * H)))$^{-1}$
Equation 4:	Kal =	(KL * (((Tl * Us) / (Ts * Ul))$^{-0.5}$))
Equation 5:	Cwd =	((1-EXP((-1 * Kal * sdt)/(60 * d))))
Equation 6:	S =	(Cwd * FR / SV)
Equation 7:	see time series example on Table I-GW-6	
Equation 8:	Einh =	If t>Ds (((VR * S) / (BW * R * 1000000)) * ((Ds + (EXP(-R * Dt) / R)-(EXP(R * (Ds - Dt))) / R)))

Table I-2

Risk- Based Preliminary Remediation Goals

Groundwater, Child Residential Scenario

Focused RI/FS

Site 5, Allegany Ballistics Laboratory

Rocket Center, West Virginia

Chemical	Chronic Oral RfD (RfDo) (mg/kg-day)	Chronic Dermal RfD (RfDd) (mg/kg-day)	Chronic Inhalation RfD (RfDi) (mg/kg-day)	Target Organ	DAevent (L/cm^2-day)	Noncarcinogen Groundwater PRG HQ = 0.1 (mg/L)	HQ = 0.5 (mg/L)	HQ = 1 (mg/L)
VOCs								
Trichloroethene	3.00E-04	3.00E-04	1.00E-02	Liver, Kidney	1.5E-05	3.7E-04	1.9E-03	3.7E-03
Inorganics								
Iron	3.00E-01	3.00E-01	NA	GI	3.3E-07	4.0E-01	2.0E+00	4.0E+00
Manganese	2.00E-02	8.00E-04	NV	CNS	3.3E-07	2.6E-02	1.3E-01	2.6E-01

Noncarcinogenic calculations:

$$\textbf{Groundwater RBC (mg/L)} = \frac{THQ \times BW \times AT_n}{EF \times ED \times (An + Bn)}$$

An = 1/RfDo x IR

Bn = 1/RfDd x SA x DAevent

EXPOSURE ASSUMPTIONS	
BW - Body weight (kilograms)	16.6
ATnc - Averaging time for noncarcinogens (days)	2,190
ATc - Averaging time for carcinogens (days)	25,550
EF - Exposure frequency (days/year)	350
ED - Exposure duration (year)	6
IR - Ingestion rate (L/day)	1.29
SA - Skin surface area (cm^2)	7,213

Notes:

NA - No reference dose or slope factor available.

NV - Not volatile.

DAevent calculated on Table B-2a.

Table I-2a
Calculation of DAevent
Groundwater, Child
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Chemical of Potential Concern	Permeability Constant (Kp) (cm/hr)	Fraction Absorbed Water (FA) (dimensionless)	Lag Time (t) (hr)	Duration of Event (ET) (hr)	t* (hr)	B dimensionless	DAevent (L/cm^2-day)	Eq
VOCs								
Trichloroethene	1.2E-02	1.0	0.58	0.33	1.39	0.1	1.5E-05	2
Inorganics								
Iron	1.0E-03		N/A	3.3E-01	N/A	N/A	3.3E-07	1
Manganese	1.0E-03		N/A	3.3E-01	N/A	N/A	3.3E-07	1

Inorganics: DAevent (mg/cm2-event) =
Kp x ET x CF2 (eq 1)

Organics: DAevent (mg/cm2-event) =

ET<t*: DAevent (mg/cm2-event) =
2 x FA x Kp x (sqrt((6 x t x ET)/3.1415))
x CF2 (eq 2)

Notes:
Permeability constants from EPA 2001, Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment). EPA/540/R/99/005.
NA - not applicable.

Table I-3

Risk- Based Preliminary Remediation Goals

Groundwater, Lifetime Residential Scenario

Focused RI/FS

Site 5, Allegany Ballistics Laboratory

Rocket Center, West Virginia

Chemical	Oral Slope Factor (CSFo) (kg-day/mg)	Dermal Slope Factor (CSFd) (kg-day/mg)	Inhalation Slope Factor (CSFi) (kg-day/mg)	DAevent (L/cm^2-day)	Shower Exposure (L/day)	Carcinogen PRG Risk = 1E-06 (mg/L)	Carcinogen PRG Risk = 1E-05 (mg/L)	Carcinogen PRG Risk = 1E-04 (mg/L)
VOCs								
Trichloroethene	4.00E-01	4.0E-01	4.00E-01	1.5E-05	5.5E-03	1.5E-04	1.5E-03	1.5E-02
Inorganics								
Iron	NA	NA	NA	3.3E-07				
Manganese	NA	NA	NA	3.3E-07				

Carcinogen calculations:

$$\textbf{Groundwater RBC (mg/L)} = \frac{TR \times AT_c}{EF \times (Ac + Bc + Cc)}$$

Ac = CSFo x IRadj

Bc = CSFd x SAc x DAevent x EDc x 1/BWc

Cc = CSFi x Shower Exposure x EDa x 1/Bwa (Calculated for VOCs only)

EXPOSURE ASSUMPTIONS	Lifetime	Adult (a)	Child (c)
BW - Body weight (kilograms)		70	16.6
ATnc - Averaging time for noncarcinogens (days)		8,760	2,190
ATc - Averaging time for carcinogens (days)		25,550	25,550
EF - Exposure frequency (days/year)		350	350
ED - Exposure duration (year)		24	6
IR - Ingestion rate (L/day)		2	1.29
IRdj - Ingestion rate (L-year/kg-day)	1.15		
SA - Skin surface area (cm^2)			7,213
ET - Exposure Time (hours/day)			0.33

Notes:

NA - No reference dose or slope factor available.

NV - Not volatile.

Table I-4
Recommended Risk-Based Preliminary Remediation Goals
Groundwater, Residential Scenario

Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Chemical	Recommended PRG (mg/L)	Basis
VOCs		
Trichloroethene	5.0E-03	SDWA MCL
Inorganics		
Iron	4.0E+00	Child, HI = 1
Manganese	2.6E-01	Child, HI = 1

Notes:
Child scenario selected for noncarcinogenic PRGs since child scenario more conservative (lower PRGs).
Applicabe HI chosen to keep total HI for each target organ below 1.

Appendix J
Preliminary Evaluation of Natural Attenuation Potential

Preliminary Evaluation of Natural Attenuation Potential at Allegany Ballistics Laboratory, Site 5 - Inert Landfill

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DATE: September 9, 2004

1. Introduction

This technical memorandum presents a preliminary evaluation of natural attenuation of chlorinated solvents [more specifically, chlorinated aliphatic hydrocarbons (CAHs)] in groundwater at Site 5, the former Inert Landfill, at Allegany Ballistics Laboratory in Rocket Center, West Virginia. This evaluation is based primarily on alluvial groundwater data collected in October 2002, but also discusses earlier data. The bedrock aquifer is not addressed in this assessment because CAH levels were very low or non-detectable in that groundwater zone [the highest concentration measured in October 2002 was 7.4 µg/L of trichloroethylene (TCE)].

2. Background

Natural attenuation is the result of naturally occurring processes that cause a reduction in the mass, concentration, volume, toxicity, or mobility of contaminants in soil or groundwater. These processes may include biodegradation, dispersion, dilution, sorption, volatilization, and chemical or biological stabilization, transformation, or destruction of contaminants (EPA, 1997).

Biodegradation is the principal destructive process contributing to natural attenuation of CAHs. The most important biodegradation process for CAHs under typical groundwater conditions is biological reductive dechlorination (RD). RD is an anaerobic process in which chlorine is sequentially removed from a CAH molecule and replaced with hydrogen. Under suitable environmental conditions, the RD process occurs when a CAH molecule serves as an electron acceptor in conjunction with the microbial metabolism of a substrate or electron donor. Suitable electron donors include naturally occurring organic matter, anthropogenic organic carbon (such as fuel hydrocarbons or landfill leachate), and hydrogen. RD of most CAHs occurs primarily under the deeply anaerobic conditions associated with sulfate reduction and particularly methanogenesis, and is inhibited by the presence of energetically

more-favorable competing electron acceptors such as dissolved oxygen, nitrate, manganese (IV), and iron (III). Figure J-1 shows anaerobic transformation pathways for some CAHs commonly found as groundwater contaminants. These are primarily biotransformation (RD) reactions, but important abiotic reactions are also shown.

EPA's OSWER Directive 9200.4-17 (EPA, 1997) presents the Agency's policy regarding the use of monitored natural attenuation (MNA) for remediation of contaminated soil or groundwater, and lists three types of evidence that can be used to evaluate the efficacy of MNA as a remedial approach. The types of evidence are:

1. *Historical groundwater and/or soil chemistry data that demonstrate a clear and meaningful trend of decreasing contaminant mass and/or concentration over time at appropriate monitoring or sampling points. In the case of a groundwater plume, decreasing concentrations should not be solely the result of plume migration. In the case of inorganic contaminants, the primary attenuating mechanism should also be understood.*

2. *Hydrogeologic and geochemical data that can be used to demonstrate indirectly the type(s) of natural attenuation processes active at the site, and the rate at which such processes will reduce contaminant concentrations to required levels. For example, characterization data may be used to quantify the rates of contaminant sorption, dilution, or volatilization, or to demonstrate and quantify the rates of biological degradation processes occurring at the site.*

3. *Data from field or microcosm studies (conducted in or with actual contaminated site media) which directly demonstrate the occurrence of a particular natural attenuation process at the site and its ability to degrade the contaminants of concern (typically used to demonstrate biological degradation processes only). [Note: this third type of evidence is typically only necessary when the first two types are inadequate or inconclusive.]*

EPA states that MNA should be selected only where it meets all relevant remedy selection criteria, where it will be fully protective of human heath and the environment, and where it will achieve site remediation objectives within a time frame that is reasonable compared to that offered by other alternatives (EPA, 1997). Furthermore, EPA expects that MNA will be most appropriate when used in conjunction with active remedation measures (e.g., source control), or as a follow-up to active remediation measures.

EPA's guidance document (Wiedemeier et al., 1998) describes a step-wise procedure for evaluating and demonstrating MNA of CAHs. The nine steps in the procedure are listed in Table J-1.

The first step in this nine-step procedure is to review available site data, develop a site conceptual model, and determine if receptor pathways have already been completed. The second step is a preliminary assessment of the potential for MNA to be a viable remedial alternative at the site, which is the intent of this Technical Memorandum. This involves preliminary screening to determine if biodegradation is occurring and preliminary modeling to determine whether MNA has the potential to be sufficiently protective (i.e., if predictions indicate that contaminant levels will attenuate to acceptably low levels before reaching a receptor or point of compliance).

Site history, site geology and hydrogeology, nature and extent of contamination, site risk, and development of a preliminary site conceptual model are thoroughly described in the Focused RI/FS report for Site 5. . The following evaluation focuses primarily on the

evidence of CAH biodegradation at the site (Step 2 of the process outlined in EPA's guidance document [Wiedemeier et al., 1998]).

3. Preliminary MNA Evaluation

Groundwater monitoring for volatile organic compounds (VOCs) at monitoring wells across Site 5 has been conducted routinely since 1998, and some prior historical VOC data exist for certain wells that were constructed earlier. Geochemical data needed for MNA evaluation have also been collected since 1998. The alluvial data from October 2002 are summarized in Table J-2. The October 2002 monitoring results show that the CAH compounds TCE and cis-1,2-dichloroethene (cis-1,2-DCE) were detected at relatively low concentrations (maximum concentrations were 120 and 14 µg/L, respectively) in several alluvial aquifer wells at the site. The wells with the highest CAH concentrations were 5GW09, 5GW13, 5GW18, and 5GW22. Vinyl chloride (VC) was not detected at levels above the reporting limit (usually 1 µg/L) at any of the wells.

The principal anaerobic biotransformation pathway for TCE is:

$$\text{TCE} \rightarrow \text{cis-1,2-DCE} \rightarrow \text{VC} \rightarrow \text{ethene}$$

Thus, assuming that TCE is the parent CAH compound that was released to the environment via disposal in the former landfill, it would be reasonable to assume that the cis-1,2-DCE detected in Site 5 groundwater is a daughter product formed by intrinsic anaerobic biodegradation (reductive dechlorination) of TCE.

3.1 Historical CAH Data Trends

Table J-3 presents historical groundwater monitoring data for alluvial wells exhibiting the highest CAH concentrations, and Figure J-2 shows CAH levels versus time. Figure J-2 indicates that CAH concentrations in wells 5GW09, 5GW13, and 5GW18 were variable but did not exhibit any consistent trend of either increasing or decreasing levels. TCE concentrations in well 5GW22, the most downgradient of the four wells and located near the center of the alluvial plume, trended upward between 2000 and 2002, but declined in the most recent monitoring event.

Figure J-3 shows a time lapse sequence, from August 2000 to October 2002, of the approximate extent of the TCE plume in the alluvial aquifer at Site 5. This figure indicates that TCE has migrated downgradient (northward, then turning northwestward) from the landfill and may be encroaching upon the North Branch Potomac River. TCE levels measured at the well closest to the river (5GW20) have been relatively low (3.6 to 28 µg/L). The TCE concentration at 5GW20 increased after August 2000, but the October 2002 level was lower than in the two previous monitoring events. Further, TCE has not been detected in the surface water or sediment of the river adjacent to well 5GW20.

3.2 MNA Screening

EPA (Wiedemeier et al., 1998) presented a set of parameters and weighting factors for preliminary screening of intrinsic anaerobic biodegradation of CAHs. These screening criteria are shown in Table J-4, along with guidelines for interpreting resulting scores. The

screening process involves collection of field monitoring data and scoring the results from the most contaminated zone.

Table J-5 shows the scoring results for the October 2002 data from the four alluvial monitoring wells at Site 5 with the highest CAH concentrations. The total scores were 10, 6, 8, and 4, for wells 5GW09, 5GW13, 5GW18, and 5GW22, respectively. These scores indicate "limited evidence for anaerobic biodegradation" for the first three wells, and "inadequate evidence for anaerobic biodegradation" in the fourth well evaluated. A similar assessment of the August 2000 data yielded scores of 14, 15, and 1 for wells 5GW09, 5GW13, and 5GW22, respectively (well 5GW18 was not included in the previous screening). It is important to note that the decrease in scores between 2000 and 2002 is partly attributable to the fact that wells 5GW01, 5GW11, and 5GW24 were used as the background wells in the 2000 assessment, but well 5GW24, which is believed to better represent background alluvial groundwater conditions, was used for the current assessment. Changes in scores between the August 2000 and October 2002 monitoring events are also attributable to:

- 5GW09 (decrease) – the lack of sulfide data (not analyzed) in the October 2002 event, and a chloride concentration that was not two times background. [Note that background chloride was considerably lower in 2000, in part because different wells were used for background data.]
- 5GW13 (decrease) – the lack of sulfide data (not analyzed) in the October 2002 event, a slight increase in dissolved oxygen (DO) (from 0.32 to 0.65 mg/L), and an iron concentration slightly less than the 1 mg/L criterion (0.95 mg/L) in 2002.
- 5GW22 (increase) – lower nitrate and higher iron concentrations in 2002, but a chloride concentration that was not two times background.

The specific natural attenuation indicator data are discussed briefly below.

Parent/Daughter Products. Evidence for RD is provided by the presence of cis-1,2-DCE, which is presumed to exist as a degradation product of TCE. This evidence assumes that TCE was the parent compound released. Historical records of material disposed of in the former landfill support this assumption. VC and ethene, subsequent TCE breakdown products in the sequence, were detected on occasion at low levels prior to October 2002 and were not detected in October 2002.

Redox Indicators. Indicators of oxidation-reduction status in the alluvial aquifer were mixed. Recall that deeply anaerobic, highly reducing conditions are generally required for RD of CAHs to occur. Oxidation-reduction potential (ORP) values were generally higher (greater than +100 mV) than is normally considered conducive for RD. DO levels were generally low (<1.0 mg/L) in the southern portion of the alluvial groundwater plume near the landfill and the presumed contaminant source, which is suitable for RD. DO levels were higher (1.8 mg/L to 6.1 mg/L) in the northern, downgradient portion of the plume and not suitable for RD. It is important to note that DO and ORP values are somewhat difficult to measure accurately in the field.

Low nitrate levels indicate that this electron acceptor would not constitute competition for RD.

Elevated dissolved iron concentrations (using total iron as an indicator) imply that iron reduction has occurred and that conditions are reducing. Although total iron includes dissolved and particulate iron, the available data for total iron in Site 5 groundwater were used as an indicator. Because groundwater samples from Site 5 alluvium were assumed to be relatively free of particulate matter (suspended solids), due to the sampling technique used, total iron concentrations at Site 5 are an approximation of the dissolved iron concentration. In addition, dissolved ferrous iron [Fe(II)] is soluble in water, whereas ferric iron [Fe(III)] is not very soluble and precipitates out as an oxyhydroxide. Therefore, dissolved iron is largely a measure of Fe(II), and at Site 5, total iron is considered an approximation of Fe(II). However, dissolved iron concentrations may provide a more reliable picture of the actual oxidizing or reducing conditions in the field environment.

Sulfate levels were elevated, which could present competition to RD, especially for the latter steps in the sequence (DCE → VC → ethene). Although sulfide was not analyzed for in the October 2002 event, previous data showed that sulfide levels were elevated, which is indicative of reducing conditions and sulfate reduction. Methane levels were low or non-detectable in the groundwater, indicating that the most deeply reducing conditions associated with methanogenesis were absent.

TOC. The relatively low total organic carbon (TOC) levels may be one of the primary factors in limiting the extent of RD and intrinsic biodegradation of CAHs. TOC concentrations were less than 3 mg/L throughout the well network, indicating low availability of electron donors needed for RD reactions. The lack of a readily biodegradable substrate probably accounts for both the absence of more reducing, deeply anaerobic conditions as well as the limited extent of RD observed. Enhancement of biodegradation via substrate addition is one way to overcome these limitations and accelerate RD.

4. Summary and Conclusions

Historical data for the four most contaminated alluvial wells at Site 5 have not demonstrated a trend of decreasing CAH concentrations over the past 2 to 4 years. Likewise, TCE plume mapping of 2000 to 2002 data has not indicated that the plume has shrunk over that short length of time. If active remediation measures were deemed appropriate for the site, anaerobic biodegradation of CAHs could be enhanced through injection of an appropriate substrate. Substrate addition would overcome the apparent limitations, by depleting competing electron acceptors and driving down the redox potential, as well as providing an electron donor source to stimulate RD of CAHs.

Applying the EPA screening procedure to data from the four most contaminated alluvial wells yielded scores indicating:

- "limited evidence for biodegradation" at three wells near the downgradient (northern) edge of the former landfill (5GW09, 5GW13, and 5GW18), and
- "inadequate evidence for biodegradation" at one well roughly 300 ft downgradient (north) of the landfill (5GW22).

Evidence for biodegradation of TCE is provided by the presence of cis-1,2-DCE, which is the first breakdown product formed by anaerobic biotransformation of TCE (assumed to be the

parent CAH compound released at the site via disposal in the landfill). Subsequent breakdown products in the sequence, VC and ethene, were not detected. The relatively low concentrations of cis-1,2-DCE compared to TCE levels and the absence of VC and ethene suggest that only a modest amount CAH biodegradation (reductive dechlorination) has occurred at the site.

RD is probably limited by non-ideal redox conditions and low availability of readily degradable organic substrates (electron donors). Low substrate availability is indicated by the generally low TOC concentrations. Non-ideal redox conditions are indicated by the relatively high ORP levels, relatively high sulfate concentrations, absence of methane, and elevated DO (in the northern, downgradient portion of the plume). It is possible for anaerobic micro-sites to exist where RD can occur even in the absence of generally conducive conditions, but it is unlikely that much, if any, RD of CAHs is occurring in the downgradient portion of the plume because of the elevated DO levels and unfavorable redox conditions.

Even though natural biodegradation of TCE is unlikely at Site 5, other mechanisms encompassed by MNA, such as dispersion and dilution, might possibly be occurring at Site 5. Therefore, MNA may be applicable, in combination with other remedial technologies, for the reduction of TCE in groundwater.

5. References

EPA. 1997. Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites, Draft – Interim Final. OSWER Directive No. 9200.4-17. U.S. EPA, Washington D.C., December 1, 1977.

Wiedemeier, T. et al. *Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Ground Water*. EPA/600/R-98/128. U.S. EPA, Washington D.C., 1998.

TABLE J-1

Nine Steps in USEPA's MNA Evaluation Procedure

Focused RI/FS

Site 5, Allegany Ballistics Laboratory

Rocket Center, West Virginia

1	Review available site data and develop a preliminary conceptual model. Determine if receptor pathways have already been completed. Respond as appropriate.
2	If sufficient existing data of appropriate quality exist, apply the screening process to assess the potential for natural attenuation.
3	If preliminary site daya suggest natural attenuation is potentially appropriate, perform additional site characterization to further evaluate natural attenuation. If all the recommended screening parameters listed in Section 2.2 have been collected and the screening process suggest that natural attenuation is not appropriate based on the potential for natural attenuation, evaluate whether other processes can meet the cleanup objectives for the site (e.g., abiotic degredation or transformation, volatilization, or sorption) or select a remedial option other than MNA.
4	Refine conceptual model based on site characterization data, complete per-modeling calculations, and document indicators of natural attenuation.
5	Simulate, if necessary natural attenuation using analytical or numerical solute fate and transport models that allow incorporation of a biodegradation term.
6	Identify potential receptors and exposure points and conduct an exposure pathways analysis.
7	Evaluate the need for supplemental source control measures. Additional source control may allow MNA to be a viable remedial option or decrease the time needed for natural processes to attain remedial objectives.
8	Prepare a long-term monitoring and verification plan for the selected alternative. In some cases, this includes monitoring natural attenuation alone, or in other cases in concert with supplemental remediation systems.
9	Present findings of natural attenuation studies in an appropriate remedy selection document, such as a CERCLA Feasibility or RCRA Corrective Measures Study. The appropriate regulatory agencies should be consulted early in the remedy selection process to clarify the remedial objectives that are appropriate for the site and any other requirements that the remedy will be expected to meet. However, it should be noted that remedy requirements are not finalized until a decision is signed, such as a CERCLA Record of Decision or a RCRA Statemetn of Basis.

TABLE J-2
October 2002 Alluvial Groundwater Monitoring Data
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

	Station ID	5GW07	5GW09	5GW11	5GW13	5GW13	5GW17	5GW18
	Sample ID	AS05-5GW07-R08	AS05-5GW09-R08	AS05-5GW11-R08	AS05-5GW13-R08	AS05-5GW13P-R08	AS05-5GW17-R08	AS05-5GW18-R08
	Sample Date	10/17/02	10/18/02	10/17/02	10/21/02	10/21/02	10/18/02	10/18/02
Chemical Name	**Units**							
Volatile Organic Compounds								
1,1,1-Trichloroethane	µg/L	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,2-Dichloroethane	µg/L	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,2-Dichloroethene (total)	µg/L	NA	NA	NA	NA	NA	NA	NA
Carbon disulfide	µg/L	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Ethane	µg/L	NA	NA	NA	NA	NA	NA	NA
Ethene	µg/L	NA	NA	NA	NA	NA	NA	NA
Methylene chloride	µg/L	2 U	2 U	2 U	2 U	2 U	2 U	2 U
Trichloroethene	µg/L	1 U	59 DL	1 U	67	70	19	57 DL
Vinyl chloride	µg/L	1 U	1 U	1 U	1 U	1 U	1 U	1 U
cis-1,2-Dichloroethene	µg/L	1 U	4.4	1 U	3.6	3.4	1.1	7.7
Wet Chemistry								
Alkalinity	mg/L	82	170	75	310	310	78	170
Ammonia	mg/L	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.3	0.7
BOD-5day (total)	mg/L	2.43	2.13	2 U	2.12	2.24	3.19	2.47
Bicarbonate	mg/L	82	170	75	310	310	78	170
Biological oxygen demand	mg/L	NA	NA	NA	NA	NA	NA	NA
Chemical oxygen demand	mg/L	7	5 U	5 U	5 U	5 U	5 U	5 U
Chloride	mg/L	30 J	21	6 J	36	36	16	11
Conductivity	mS/cm	0.506	0.717	0.281	1.68	NA	0.467	0.403
Dissolved Oxygen	mg/L	0.5	0.49	0.61	0.65	NA	0.7	0.89
Hardness	mg/L	250	450	160	950	950	1 U	260
Iron - Total	mg/L	13,600	5,040	76.3 B	283	465	4,040	31,600
Iron - Dissolved	mg/L	NA	NA	NA	NA	NA	NA	NA
Manganese - Total	mg/L	1,280	1,940	162	8,130	8,120	614	790
Manganese - Dissolved	mg/L	NA	NA	NA	NA	NA	NA	NA
Methane	mg/L	10 U	10 U	10 U	70	330	10 U	160
Nitrate	mg/L	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Nitrate/Nitrite	mg/L	NA	NA	NA	NA	NA	NA	NA
Nitrite	mg/L	0.05 U	0.6	0.05 U	0.05 U	0.05 U	0.05 U	0.2
Nitrogen	mg/L	NA	NA	NA	NA	NA	NA	NA
Oil and Grease	mg/L	NA	NA	NA	NA	NA	NA	NA
ORP	mV	32	185	200	128	NA	184	-30
pH		6.11	6.19	5.94	6.42	NA	5.88	6.73
Sulfate	mg/L	160	200	98	200	170	150	190
Temperature	deg-C	15	16	15.92	16	NA	16	16
Total dissolved solids (TDS)	mg/L	250	440	160	770	780	290	260
Total organic carbon (TOC)	mg/L	0.72	2.87	1.96	2.77	2.9	0.99	2.52
Total recoverable phenolics	mg/L	NA	NA	NA	NA	NA	NA	NA

Notes:
J =
U =
B =
K =

TABLE J-2
October 2002 Alluvial Groundwater Monitoring Data
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

	Station ID	5GW19	5GW20	5GW21	5GW22	5GW23	5GW24
	Sample ID	AS05-5GW19-R08	AS05-5GW20-R08	AS05-5GW21-R08	AS05-5GW22-R08	AS05-5GW23-R08	AS05-5GW24-R08
	Sample Date	10/15/02	10/18/02	10/15/02	10/21/02	10/18/02	10/15/02
Chemical Name	**Units**						
Volatile Organic Compounds							
1,1,1-Trichloroethane	µg/L	1 U	1 U	1 U	1 U	1 U	1 U
1,2-Dichloroethane	µg/L	1 U	1 U	1 U	1 U	1 U	1 U
1,2-Dichloroethene (total)	µg/L	NA	NA	NA	NA	NA	NA
Carbon disulfide	µg/L	1 U	1 U	1 U	1 U	1 U	1 U
Ethane	µg/L	NA	NA	NA	NA	NA	NA
Ethene	µg/L	NA	NA	NA	NA	NA	NA
Methylene chloride	µg/L	2 U	2 U	2 U	2 U	2 U	2 U
Trichloroethene	µg/L	1 U	15	1 U	120	1.8	1 U
Vinyl chloride	µg/L	1 U	1 U	1 U	1 U	1 U	1 U
cis-1,2-Dichloroethene	µg/L	1 U	0.85 J	1 U	14	1 U	1 U
Wet Chemistry							
Alkalinity	mg/L	48	88	110	100	240	280
Ammonia	mg/L	0.2 U	0.2 U	0.2 U	0.64	0.64	0.2 U
BOD-5day (total)	mg/L	6.69	28	3.65	10	2 U	2 U
Bicarbonate	mg/L	48	88	110	100	240	280
Biological oxygen demand	mg/L	NA	NA	NA	NA	NA	NA
Chemical oxygen demand	mg/L	8	62	5 U	18	5 U	5 U
Chloride	mg/L	5	7	27	17	5.6	13
Conductivity	mS/cm	0.206	0.321	0.38	0.378	0.407	0.65
Dissolved Oxygen	mg/L	1.8	5.58	2.15	6.1	0.35	2.85
Hardness	mg/L	110	190	210	230	260	400
Iron - Total	mg/L	7,420	3,870	440	29,700	8,070	461
Iron - Dissolved	mg/L	NA	NA	NA	NA	NA	NA
Manganese - Total	mg/L	1,710	254	22.1	3,180	434	35.5
Manganese - Dissolved	mg/L	NA	NA	NA	NA	NA	NA
Methane	mg/L	10 U	10 U	10 U	10 U	70	10 U
Nitrate	mg/L	0.6	2.9	0.5 U	0.5 U	0.5 U	0.5 U
Nitrate/Nitrite	mg/L	0.7	NA	NA	NA	NA	NA
Nitrite	mg/L	0.11	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
Nitrogen	mg/L	NA	NA	NA	NA	NA	NA
Oil and Grease	mg/L	NA	NA	NA	NA	NA	NA
ORP	mV	NA	203	NA	185	-113	NA
pH		5.71	6.32	5.75	6.47	7.39	7.33
Sulfate	mg/L	98	82	39	96	140	92
Temperature	deg-C	16.49	16.35	15.39	16.37	15	17.25
Total dissolved solids (TDS)	mg/L	740	200	290	210	250	540
Total organic carbon (TOC)	mg/L	0.84	0.97	0.46	0.89	1.43	1.15
Total recoverable phenolics	mg/L	NA	NA	NA	NA	NA	NA

Notes:
J =
U =
B =
K =

TABLE J-3
Historical Monitoring Data Trends for the Most Contaminated Alluvial Wells
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Station ID	**5GW09**							
Sample ID	AS05-5GW09-R01	AS05-5GW09-R02	AS05-5GW09-R03	AS05-5GW09-R04	AS05-5GW09-R05	AS05-5GW09-R06	AS05-5GW09-R07	AS05-5GW09-R08
Sample Date	05/06/98	10/14/98	01/21/99	10/22/99	08/03/00	04/17/01	02/06/02	10/18/02
Chemical Name								
Volatile Organic Compounds (UG/L)								
1,1,1-Trichloroethane	10 U	1 U	1 U	1 U	0.5 J	1 U	1 U	1 U
1,2-Dichloroethane	10 U	0.6 J	1 U	1 U	1 U	1 U	1 U	1 U
1,2-Dichloroethene (total)	NA	NA	NA	NA	NA	NA	NA	NA
Carbon disulfide	10 U	1	1 U	1 U	1 UJ	1 U	1 U	1 U
Ethane	NA	NA	NA	NA	1.00E-03 U	0.004 U	0.004 U	NA
Ethene	NA	NA	NA	NA	1.00E-03 U	0.004 U	0.004 U	NA
Methylene chloride	1 B	1 BJ	2 U	1 U	1.2 B	2 U	0.6 B	2 U
Trichloroethene	65 J	46	NA	52	48	46	26	59 DL
Vinyl chloride	4 U	1 U	1 U	1 U	1 UJ	1 U	1 U	1 U
cis-1,2-Dichloroethene	NA	5	3.1	NA	7.1	4	3.5	4.4
Wet Chemistry (MG/L)								
Alkalinity	136	65.8	70	64	120	170	82	170
Ammonia	0.14	0.1 U	0.1 U	NA	0.22	NA	0.2 U	0.2 U
BOD-5day (total)	NA	NA	NA	NA	NA	2 U	2 U	2.13
Bicarbonate	136	65.8	2 U	63.9	120	170	82	170
Biological oxygen demand	2 U	2 U	0.2 U	3.06	2 U	NA	NA	NA
Chemical oxygen demand	5 U	8.5	5 U	5 U	5	38	10	5 U
Chloride	16.7	27.6	31.9	28.3	24	35	45	21
Hardness	NA	NA	156	266	360	454	230	450
Iron - Total	NA	64,000	3,570	163	562	NA	9,400	5,040
Iron - Dissolved	NA	317	621	105	461	464	NA	NA
Manganese - Total	NA	1,550	1,510	1,760	1,990	NA	2,200	1,940
Manganese - Dissolved	NA	1,470	1,640	1,790	2,110	1,990	NA	NA
Methane	NA	NA	NA	NA	0.0639 U	0.144	0.11	NA
Methane	NA	NA	NA	NA	NA	NA	NA	10 U
Nitrate	NA	NA	0.05 U	0.1	0.74	NA	0.5 U	0.5 U
Nitrate/Nitrite	0.77	0.05 U	NA	NA	NA	1.4	NA	NA
Nitrite	NA	NA	0.05 U	0.05 U	0.05 U	NA	0.05 U	0.6
Nitrogen	NA	NA	NA	0.1 U	NA	0.2 U	NA	NA
Oil and Grease	1 U	1 U	NA	NA	NA	NA	NA	NA
Sulfate	181	91	124	108	210	360	160	200
Total dissolved solids (TDS)	445	288	253	310	370	630	390	440
Total organic carbon (TOC)	3.1	13.7	10 U	100 U	2.4	2.5	3.2	2.87
Total recoverable phenolics	NA	NA	50 U	0.05 U	0.03 U	0.025 U	0.025 U	NA

TABLE J-3
Historical Monitoring Data Trends for the Mos
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Station ID	**5GW13**										
Sample ID	AS05-5GW13-R01	AS05-5GW13P-R02	AS05-5GW13-R02	AS05-5GW13-R03	AS05-5GW13P-R03	AS05-5GW13-R04	AS05-5GW13-R05	AS05-5GW13-R06	AS05-5GW13-R07	AS05-5GW13-R08	AS05-5GW13P-R08
Sample Date	05/07/98	10/14/98	01/21/99	01/21/99	01/21/99	10/22/99	08/09/00	04/18/01	02/07/02	10/21/02	10/21/02
Chemical Name											
Volatile Organic Compounds (UG/L)											
1,1,1-Trichloroethane	1 UJ	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,2-Dichloroethane	1 UJ	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,2-Dichloroethene (total)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Carbon disulfide	1 UJ	0.7 J	1	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Ethane	NA	NA	NA	NA	NA	NA	NA	0.004 U	0.008	NA	NA
Ethene	NA	NA	NA	NA	NA	NA	NA	0.004 U	0.005	NA	NA
Methylene chloride	1 UJ	1 BJ	1 BJ	2 U	2 U	1 U	3.6	4.1 B	0.6 B	2 U	2 U
Trichloroethene	67 J	26 B	40	43 D	37 D	61 D	81	62	62	67	70
Vinyl chloride	0.4 UJ	1 U	0.6 J	1 U	1 U	1 U	0.6 J	1 U	1 U	1 U	1 U
cis-1,2-Dichloroethene	NA	4	5	3	3.5	NA	5.2	3.2	22	3.6	3.4
Wet Chemistry (MG/L)											
Alkalinity	222	238	219	228	238	218	260	210	240	310	310
Ammonia	0.1 U	0.14	0.1 U	0.1 U	0.1 U	0.1 U	0.2 U	NA	0.2 U	0.2 U	0.2 U
BOD-5day (total)	NA	NA	NA	NA	NA	NA	NA	2 U	6.1	2.12	2.24
Bicarbonate	222	238	219	2 U	2 U	217	260	210	240	310	310
Biological oxygen demand	5.3	2 U	2 U	0.2 U	0.2 U	2.04	2 U	NA	NA	NA	NA
Chemical oxygen demand	5 U	6.6	6.3	5 U	5 U	5 U	5 U	12	6	5 U	5 U
Chloride	22.7	30.1	30.1	26.6	31.9	33.6	35	42	42	36	36
Hardness	NA	NA	NA	304	342	478	670	810	555	950	950
Iron - Total	NA	3,640	3,240	3,000	3,280	3,320	920 J	NA	3,890	283	465
Iron - Dissolved	NA	3,410	3,310	3,110	3,550	3,590	1,350	1,130	NA	NA	NA
Manganese - Total	NA	1,270	1,200	693	823	1,430	4,510	NA	2,840	8,130	8,120
Manganese - Dissolved	NA	1,290	1,280	825	950	1,550	4,050	8,030	NA	NA	NA
Methane	NA	NA	NA	NA	NA	NA	NA	0.002 U	0.13 B	NA	NA
Methane	NA	NA	NA	NA	NA	NA	NA	NA	NA	70	330
Nitrate	NA	NA	NA	0.05 U	0.05 U	0.08	0.5 U	NA	0.5 U	0.5 U	0.5 U
Nitrate/Nitrite	0.05 U	0.05 U	0.05 U	NA	NA	NA	NA	0.55 U	NA	NA	NA
Nitrite	NA	NA	NA	0.05 U	0.05 U	0.05 U	0.05 U	NA	0.05 U	0.05 U	0.05 U
Nitrogen	NA	NA	NA	NA	NA	NA	NA	0.2 U	NA	NA	NA
Oil and Grease	3	1 U	1 U	NA	NA	NA	NA	NA	NA	NA	NA
Sulfate	309	187	184	171	190	82.7	NA	800	320	200	170
Total dissolved solids (TDS)	708	528	525	416	427	510	590	1,100	780	770	780
Total organic carbon (TOC)	3.4	38.8	173	10 U	10 U	100 U	3	3.2	2.1	2.77	2.9
Total recoverable phenolics	NA	NA	NA	50 U	50 U	611	0.03 U	0.031	0.025 U	NA	NA

TABLE J-3
Historical Monitoring Data Trends for the Mos
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Station ID	**5GW18**									
Sample ID	AS05-5GW18-R01	AS05-5GW18-R02	AS05-5GW18-R03	AS05-5GW18-R04	AS05-5GW18P-R04	AS05-5GW18-R05	AS05-5GW18-R06	AS05-5GW18P-R06	AS05-5GW18-R07	AS05-5GW18-R08
Sample Date	03/07/98	10/15/98	01/21/99	10/25/99	10/25/99	08/10/00	04/19/01	04/19/01	02/06/02	10/18/02
Chemical Name										
Volatile Organic Compounds (UG/L)										
1,1,1-Trichloroethane	10 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,2-Dichloroethane	10 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,2-Dichloroethene (total)	7	NA	NA	NA	NA	NA	NA	NA	NA	NA
Carbon disulfide	10 U	1	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Ethane	NA	NA	NA	NA	NA	NA	0.004 U	0.004 U	0.004 U	NA
Ethene	NA	NA	NA	NA	NA	NA	0.004 U	0.004 U	0.011	NA
Methylene chloride	10 U	1 BJ	2 U	2 U	2 U	2 UJ	2 U	2 U	0.9 B	2 U
Trichloroethene	41	70	NA	19	20	77	48	46	44	57 DL
Vinyl chloride	10 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
cis-1,2-Dichloroethene	NA	17	14	3	3.2	9.9	11	9.6	24	7.7
Wet Chemistry (MG/L)										
Alkalinity	139	157	168	128	128	120	130	130	160	170
Ammonia	0.13	0.42	0.1 U	0.1 U	0.1 U	0.2 U	NA	NA	0.2 U	0.7
BOD-5day (total)	NA	NA	NA	NA	NA	NA	2 U	2	2 U	2.47
Bicarbonate	139	157	2 U	127	127	120	130	130	160	170
Biological oxygen demand	8.7	2 U	0.2 U	4.74	4.92	2 U	NA	NA	NA	NA
Chemical oxygen demand	11.6	6	5 U	5 U	5 U	5 U	23	18	5 U	5 U
Chloride	9.2	9.6	12.4	5 U	5 U	21	16	16	23	11
Hardness	NA	NA	213	186	179	340	340	330	290	260
Iron - Total	4,430 J	6,380	14,100	11,900	12,100	1,470 J	1,740	1,690	4,280	31,600
Iron - Dissolved	3,570 J	4,410	8,940	NA	16 U	495	1,740	1,690	NA	NA
Manganese - Total	548	632	726	463	444	91.8	394	371	448	790
Manganese - Dissolved	592	714	967	NA	412	99.7	394	371	NA	NA
Methane	NA	NA	NA	NA	NA	NA	0.02 U	0.02 U	0.8	NA
Methane	NA	NA	NA	NA	NA	NA	NA	NA	NA	160
Nitrate	NA	NA	0.05 U	0.05 U	0.25	0.5 U	NA	NA	0.5 U	0.5 U
Nitrate/Nitrite	0.18	0.14	NA	NA	NA	NA	0.55 U	0.55 U	NA	NA
Nitrite	NA	NA	0.05 U	0.05 U	0.05 U	0.05 U	NA	NA	0.05 U	0.2
Nitrogen	NA	NA	NA	NA	NA	NA	0.2 U	0.2 U	NA	NA
Oil and Grease	3	1 U	NA	NA	NA	NA	NA	NA	NA	NA
Sulfate	140	64.8	86.9	27.6	47.3	250	200	220	160	190
Total dissolved solids (TDS)	332	280	261	210	210	370	390	380	390	260
Total organic carbon (TOC)	2.5	31.9	10 U	100 U	100 U	1.3	1.2	1.2	0.89	2.52
Total recoverable phenolics	NA	NA	50 U	50 U	643	0.03 U	0.025 U	0.025 U	0.025 U	NA

TABLE J-3
Historical Monitoring Data Trends for the Mos
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Station ID	**5GW22**				
Sample ID	AS05-5GW22-R05	AS05-5GW22-R06	AS05-5GW22-R07	AS05-5GW22P-R07	AS05-5GW22-R08
Sample Date	08/08/00	04/19/01	02/07/02	02/07/02	10/21/02
Chemical Name					
Volatile Organic Compounds (UG/L)					
1,1,1-Trichloroethane	1 U	1 U	1 U	1 U	1 U
1,2-Dichloroethane	1 U	1 U	1 U	1 U	1 U
1,2-Dichloroethene (total)	NA	NA	NA	NA	NA
Carbon disulfide	1 UJ	1 U	1 U	1 U	1 U
Ethane	1.00E-03 U	0.004 U	0.004 U	0.004 U	NA
Ethene	1.00E-03 U	0.004 U	0.004 U	0.004 U	NA
Methylene chloride	1.6 B	2 U	0.5 B	0.6 B	2 U
Trichloroethene	82	96	130	150	120
Vinyl chloride	1 U	1 U	1 U	1 U	1 U
cis-1,2-Dichloroethene	13	14	20	20	14
Wet Chemistry (MG/L)					
Alkalinity	83	77	100	98	100
Ammonia	0.2 U	NA	0.2 U	0.2 U	0.64
BOD-5day (total)	NA	2.1	2 U	2 U	10
Bicarbonate	83	77	100	98	100
Biological oxygen demand	2 U	NA	NA	NA	NA
Chemical oxygen demand	5 U	18	6	5	18
Chloride	20	18	17	18	17
Hardness	140	200	170	190	230
Iron - Total	11,900 J	14.7 U	668	1,130	29,700
Iron - Dissolved	15.9 U	14.7 U	NA	NA	NA
Manganese - Total	1,350	65.1	154	177	3,180
Manganese - Dissolved	284	65.1	NA	NA	NA
Methane	0.0012	0.002 U	0.002 U	0.002 U	NA
Methane	NA	NA	NA	NA	10 U
Nitrate	1.3	NA	0.5 U	0.5 U	0.5 U
Nitrate/Nitrite	NA	0.55 U	NA	NA	NA
Nitrite	0.17	NA	0.05 U	0.05 U	0.05 U
Nitrogen	NA	0.2 U	NA	NA	NA
Oil and Grease	NA	NA	NA	NA	NA
Sulfate	71	99	110	100	96
Total dissolved solids (TDS)	170	260	290	290	210
Total organic carbon (TOC)	1 U	1 U	1.7	2.2	0.89
Total recoverable phenolics	0.03 U	0.025 U	0.025 U	0.025 U	NA

TABLE J-4
MNA Biodegradation Screening Criteria and Weighting
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Analyte	Concentration in Most Contaminated Zone	Interpretation	Value
Dissolved Oxygen (DO)	<0.5 mg/L	Tolerated, suppresses the reductive pathway at higher concentrations	3
	>5 mg/L	Not tolerated; however, VC may be oxidized aerobically	-3
Nitrate (NO3-N)	<1 mg/L	At higher concentrations may compete with reductive pathway	2
Ferrous Iron (FeII)	>1 mg/L	Reductive pathway possible; VC may be oxidized under Fe(III)-reducing conditions	3
Sulfate	<20 mg/L	At higher concentrations may compete with reductive pathway	2
Sulfide	>1 mg/L	Reductive pathway possible	3
Methane	<0.5 mg/L	VC oxidizes	0
	>0.5 mg/L	Ultimate reductive daughter product, VC accumulates	3
Oxidation-Reduction Potential (ORP)	<50 mV	Reductive pathway possible	1
	<-100 mV	Reductive pathway likely	2
pH	5<pH<9	Optimal range for reductive pathway	0
	5>pH>9	Outside optimal range for reductive pathway	-2
TOC	>20 mg/L	Carbon and energy source; drives dechlorination; can be natural or anthropogenic	2
Temperature	>20°C	At T>20°C biochemical processes are accelerated	1
Carbon Dioxide (CO2)	>2x background	Ultimate oxidative daughter product	1
Alkalinity	>2x background	Results from interaction of CO_2 with aquifer minerals	1
Chloride	>2x background	Daughter product of reductive dechlorination of chlorinated organics	2
Hydrogen	>1 nM	Reductive pathway possible; VC may accumulate	3
Hydrogen	<1 nM	VC oxidized	0
Volatile Fatty Acids (VFAs)	>0.1 mg/L	Intermediates resulting from biodegradation of complex organics; carbon and energy source	2
BTEX	>0.1 mg/L	Carbon and energy source; drives dechlorination	2
PCE		Material released	0
TCE		Material released	0
		Daughter product of PCE	2
DCE		Material released	0
		Daughter product of TCE (If cis is greater than 80% of total DCE it is likely a daughter product of TCE)	2
		1,1-DCE can be chemical reaction product of TCA	
VC		Material released	0
		Daughter product of DCE	2
Ethene/Ethane	>0.01 mg/L	Daughter product of VC/Ethene	2
	>0.1 mg/L		3
TCA		Material released	0
DCA		Material released	0
		Daughter product of TCA	2
CA		Daughter product of DCA or VC under reducing conditions	2

Total Score	Interpretation
0 to 5	Inadequate evidence for anaerobic biodegradation (reductive dechlorination) of chlorinated organics
6 to 14	Limited evidence for anaerobic biodegradation (reductive dechlorination) of chlorinated organics
15 to 20	Adequate evidence for anaerobic biodegradation (reductive dechlorination) of chlorinated organics
>20	Strong evidence for anaerobic biodegradation (reductive dechlorination) of chlorinated organics

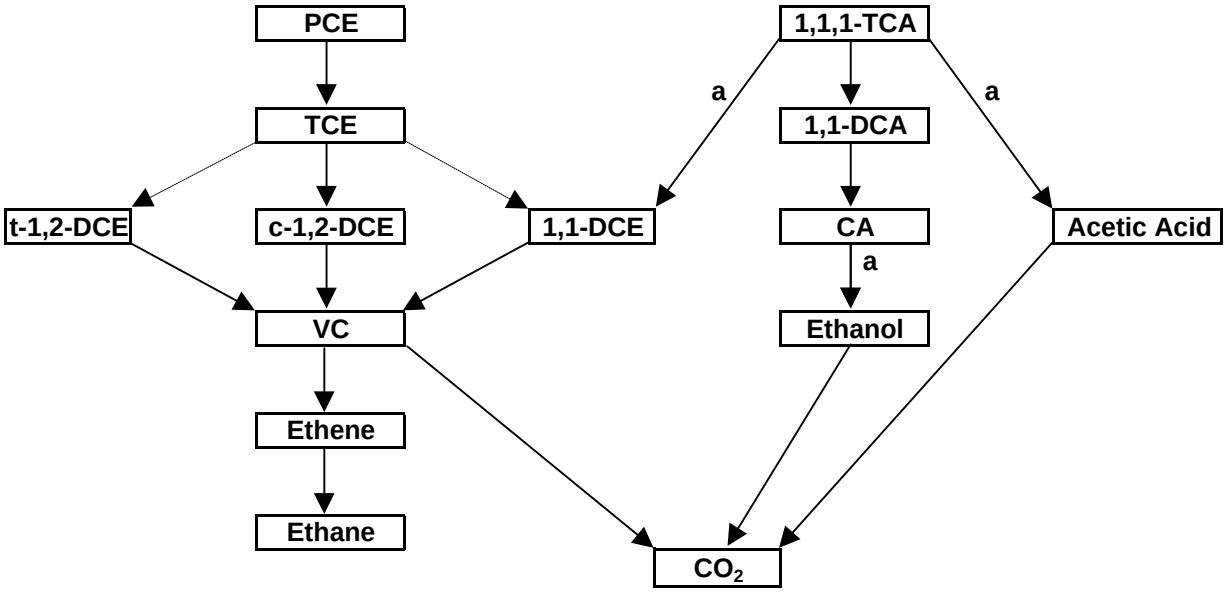
Source: Wiedemeier et al., 1998

TABLE J-5
MNA Data and Scoring
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

				Alluvial Aquifer							
				5GW09		5GW13		5GW18		5GW22	
Parameter	**Units**	**Criteria**	**Potential Points**	**Value**	**Pts**	**Value**	**Pts**	**Value**	**Pts**	**Value**	**Pts**
DO	mg/L	<0.5	3	0.46	3	0.65	0	0.89	0		
		>5	-3							6.1	-3
NO3-N	mg/L	<1	2	0.5U	2	0.5U	2	0.5U	2	0.5U	2
Fe(II)*	mg/L	>1	3	5	3	0.95	0	31.6	3	29.7	3
Sulfate	mg/L	<20	2	200	0	200	0	190	0	96	0
Methane	mg/L	<0.5	0	0.010U	0	0.07	0	0.16	0	0.010U	0
		>0.5	3								
ORP	mV	<50	1	185	0	128	0	-30	1	185	0
		<-100	2								
pH	pH units	5<pH<9	0	6.19	0	6.42	0	6.73	0	6.47	0
		5>pH>9	-2								
TOC	mg/L	>20	2	2.87	0	2.77	0	2.52	0	0.89	0
Temperature	°C	>20	1	15.85	0	15.71	0	15.74	0	16.37	0
Alkalinity	mg/L	>2X BG	1	170	0	310	0	170	0	100	0
Chloride	mg/L	>2X BG	2	21	0	36	2	11	0	17	0
VFAs	mg/L	>0.1	2	NA		NA		NA		NA	
BTEX	mg/L	>0.1	2	0.001U	0	0.001U	0	0.001U	0	0.001U	0
PCE (released)	mg/L		0	0.001U	0	0.001U	0	0.001U	0	0.001U	0
TCE (released)	mg/L		0	0.059	0	0.067	0	0.057	0	0.12	0
1,2-DCE (product)	mg/L		2	0.0044	2	0.0036	2	0.0077	2	0.014	2
VC (product)	mg/L		2	0.001U	0	0.001U	0	0.001U	0	0.001U	0
Ethene/Ethane	mg/L	>0.01	2	0.030U	0	0.030U	0	0.030U	0	0.030U	0
		>0.1	3	0.030U	0	0.030U	0	0.030U	0	0.030U	0
TCA (released)	mg/L		0	0.001U	0	0.001U	0	0.001U	0	0.001U	0
DCA (product)	mg/L		2	0.001U	0	0.001U	0	0.001U	0	0.001U	0
CA (product)	mg/L		2	0.001U	0	0.001U	0	0.001U	0	0.001U	0
Total Points					**10**		**6**		**8**		**4**

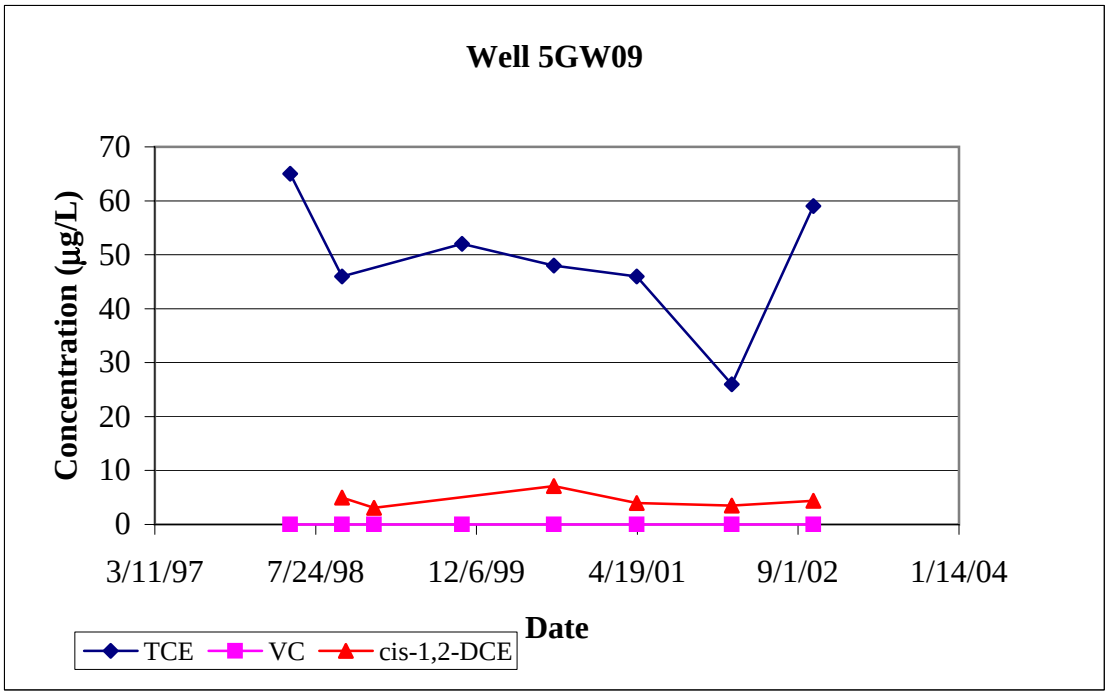
Notes:
* Fe(II) was not analyzed for. Total iron data are used as indicator of dissolved ferrous iron.
Average background chloride concentration = 13 mg/L
Average background alkalinity concentration = 280 mg/L
Background alluvial well: 5GW24
U = Not detected at specified reporting limit
NA = Not Applicable

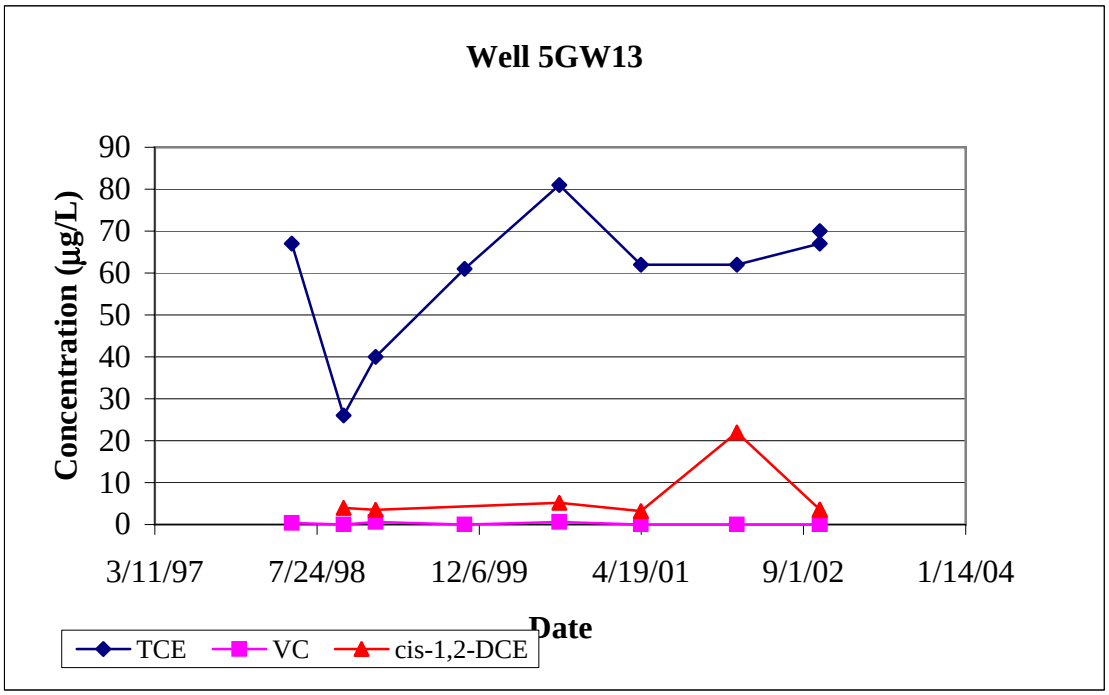
FIGURE J-1
Anaerobic Transformations of Selected CAHs
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia



a = abiotic
minor pathway

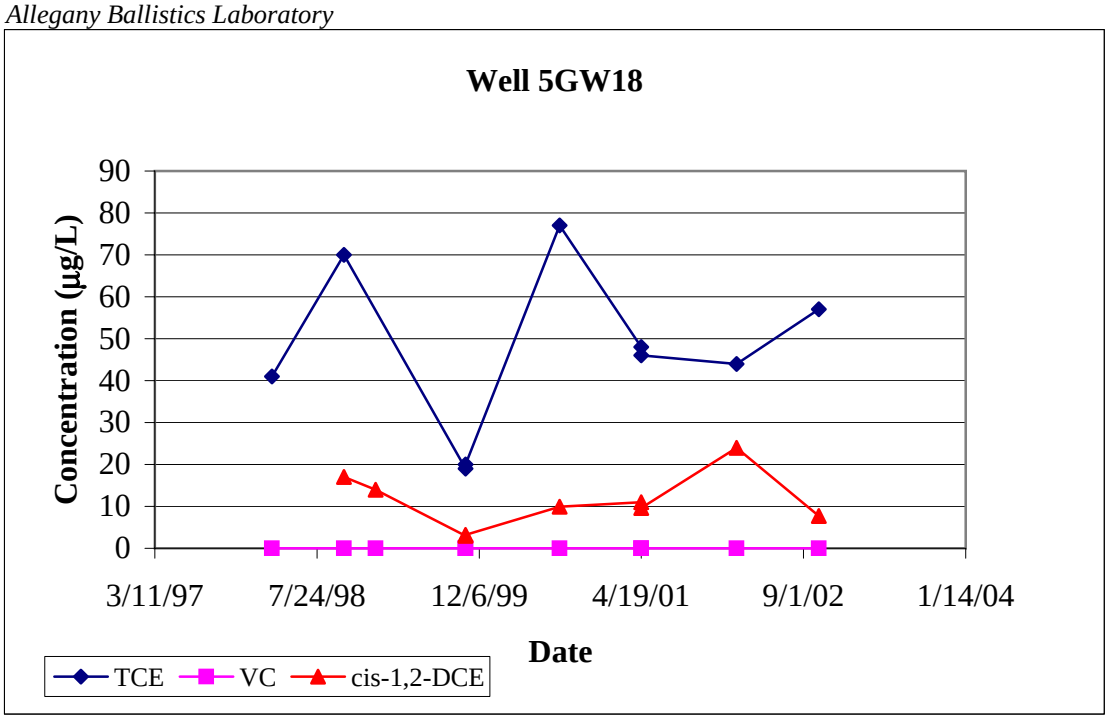
FIGURE J-2
CAH Trends For Wells 5GW09, 5GW13, 5GW18, and 5GW22
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

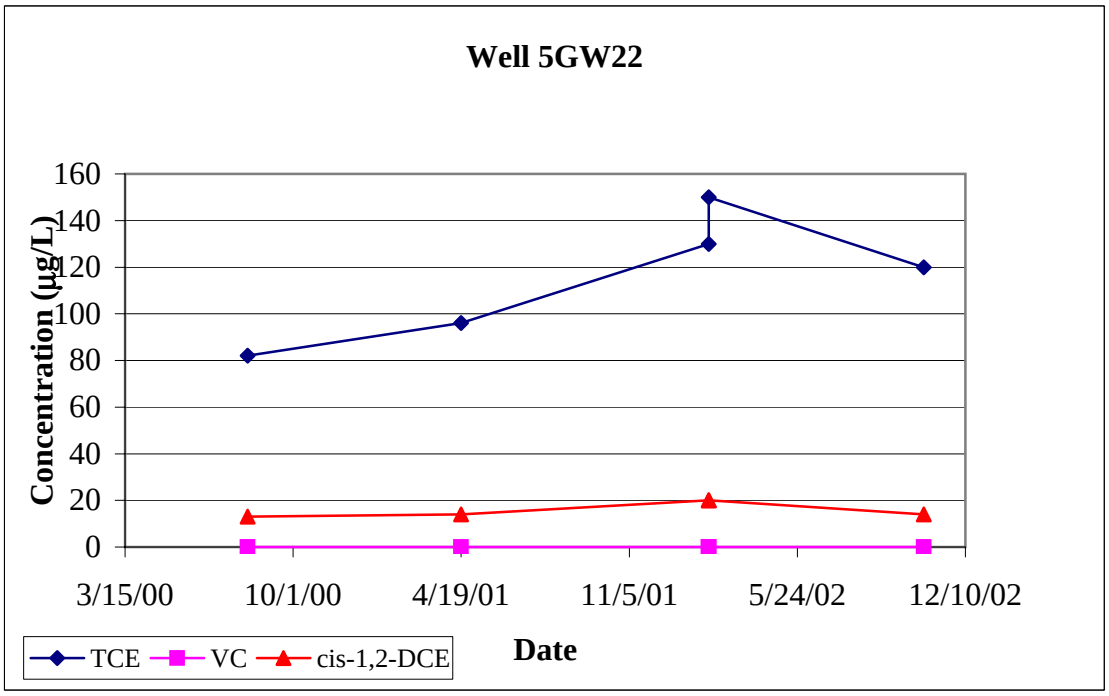




NOTE: Non-detect values shown as zero

FIGURE 2 (continued)
CAH Trends For Wells 5GW09, 5GW13, 5GW18, and 5GW22
Site 5 - Inert Landfill
Allegany Ballistics Laboratory





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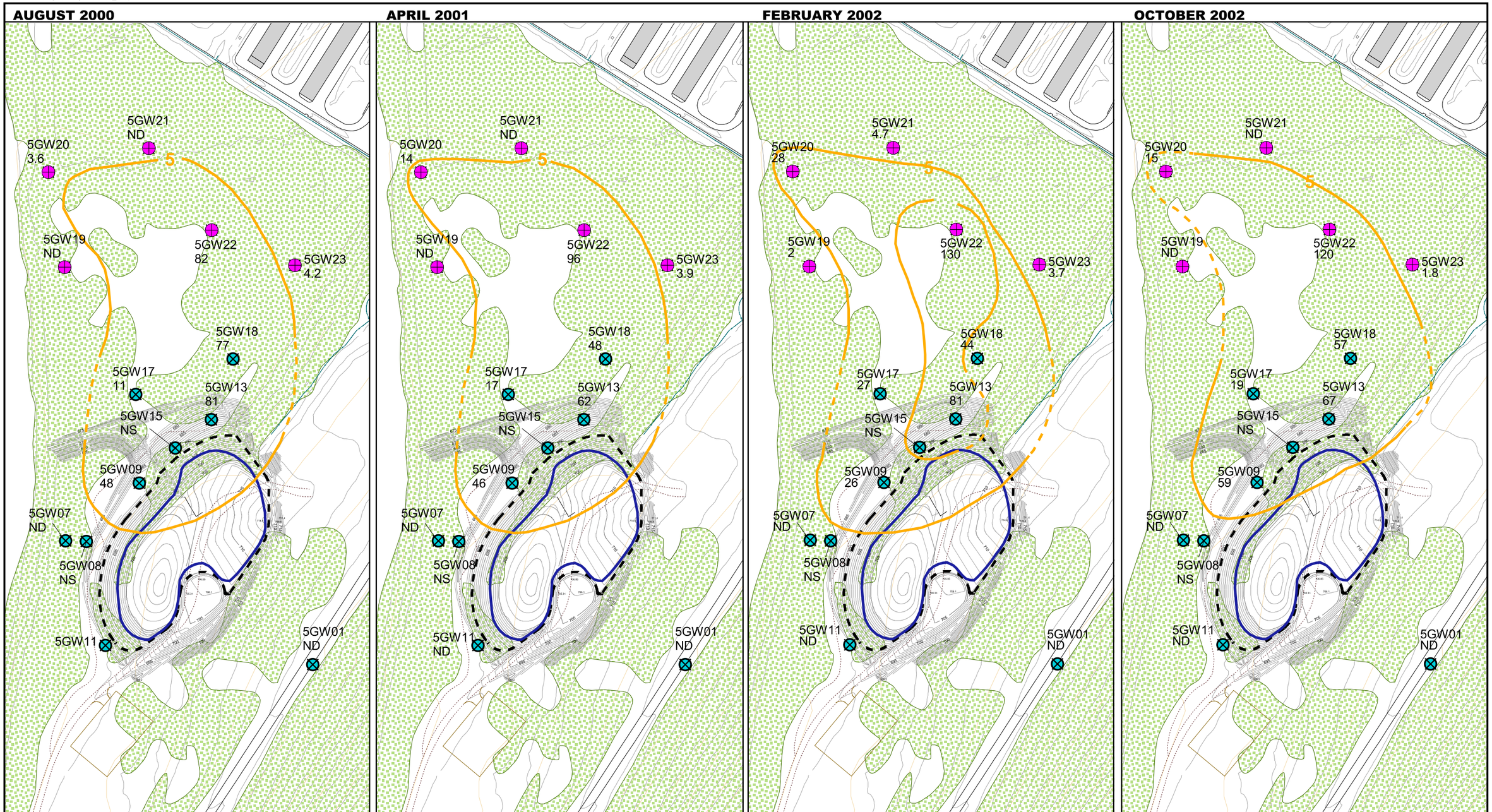

LEGEND

- Existing Monitoring Well - Alluvial
- New Monitoring Well - Alluvial
- Edge of Waste
- Edge of Landfill Cap
- Vegetation
- TCE Isoconcentration (5 ug/L)

Concentrations of TCE in ug/L

ND = Not Detected

NS = Not Sampled

N

0 200 400 Feet

Figure J-3
TCE Alluvial Groundwater Plume

Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

CH2MHILL

Appendix K
West Virginia Toxic Pollutant Control Strategy for Development of Preliminary Surface Water Discharge Limits

APPENDIX K

West Virginia Toxic Pollutant Control Strategy for Development of Preliminary Surface Water Discharge Limits

This appendix demonstrates the procedure for determining State of West Virginia surface water discharge limits, as required by the West Virginia Office of Water Resources Toxic Pollutant Control Strategy.

West Virginia Toxic Pollutant Control Strategy for Determining Limits

The toxic pollutant control strategy is based upon the 7Q10 flow of the receiving stream. The 7Q10 flow is defined as the lowest average seven consecutive day low flow with an average recurrence frequency of once in 10 years.

The toxic pollutant control strategy determines the discharge limit by allowing for dilution of the discharge into the 7Q10 flow. Existing upstream contamination is also accounted for by assuming the 7Q10 flow contains a background concentration of contaminants. Two surface water samples, 5SW-1 and 5SW-2, collected upstream of Site 5, were used to calculate an average river background concentration .

The methodology is based upon the West Virginia water quality standards in Appendix E of the state regulations. According to the state, the North Branch is classified "B1" for aquatic life, "A" for public water supply intake, and "C" for water contact recreation. Many of the water quality standards listed in Appendix E have a different value corresponding to each use classification identified above. State regulations require that the lowest water quality standard from the above classifications be used in the calculation of preliminary discharge limits.

Once the lowest water quality standard from the applicable use classifications is chosen, the water quality standard must be compared with the Federal Ambient Water Quality Criteria (FAWQC) (chronic) for each constituent. The lower of the West Virginia water quality standard and the FAWQC is the applicable water quality standard. This water quality standard is compared with the contaminant's concentration in the river (background concentration). If the background concentration is higher than the water quality standard, then the background concentration becomes the water quality standard. If neither of these standards is available for a constituent, then the EPA Region III BTAG screening level is used as the water quality standard. If the river background concentration is higher than the BTAG screening level, then the background concentration is used as the water quality standard.

Steps Used to Determine Appropriate Criteria and Calculation Approach

After the background concentration is established and the appropriate water quality standard is selected, an allowable instream load and the instream waste concentration

(IWC) are calculated. The IWC is simply a ratio of the discharge flow to the combined river and discharge flow. State guidance requires that for IWCs less than one percent, a wasteload allocation of five percent should be used. However, if the water quality standard is based upon a river use classification other than "B1" (e.g., "A" or "C"), a wasteload allocation of 20 percent should be used.

The next step in the toxic pollutant control strategy includes conversion of the WLA to an average monthly concentration (AMC), and conversion of the AMC to a daily maximum concentration. The AMC is simply a conversion of the WLA into units of micrograms per liter. The daily maximum concentration is simply the AMC multiplied by 1.5. These two values are the preliminary discharge limits for Site 5.

The state requires that the preliminary discharge limits calculated using the toxic pollutant control strategy be compared with federal BAT effluent limitations listed in 40 CFR 414.101. The BAT effluent limitations consist of maximum monthly average discharge concentrations and maximum daily discharge concentrations that cannot be exceeded. State guidance recommends the applicable discharge standard is the lower of the toxic pollutant control strategy discharge limit and the BAT effluent limitation for each contaminant of concern. Therefore, the applicable discharge limit is the lower of these two values.

Example Application of Toxic Pollutant Control Strategy

Data Requirements:

1. 7Q10 flow (river low flow, determined by the State of West Virginia) = 117.48 cfs
2. Maximum discharge flow = 26 gpm = 0.06 cfs = 0.04 MGD
3. River ("background") concentration of chemical constituents.
4. Water quality standards, from Appendix E of the West Virginia Water Quality Resources Board, Series I, Requirements Governing Water Quality Standards (1985).

Step 1 - Calculate the river ("background") concentration of site contaminants upstream from the site. Two surface water samples, 5SW-1 and 5SW-2, collected upstream of Site 5, were used to calculate an average river background concentration.

Step 2 - Determine the water quality standard for the constituents of concern. The water quality standard is the lower of the West Virginia water quality standards and the FAWQC (chronic). If the river background concentration is higher than these standards, then the background concentration is the water quality standard. If neither of these standards is available, then the EPA Region III BTAG Screening Levels are used. If the river background concentration is higher than the BTAG Screening Level, the background concentration is the water quality standard. Use Appendix E of the West Virginia Water Resources Board, Series I, Requirements Governing Water Quality Standards (1985). Appendix E defines the water quality standards based on the use classifications which are applicable to the surface water is to receive the discharge. The applicable use classification will determine the allowable assimilative capacity.

The remaining steps describe the calculations required to derive the West Virginia water quality based discharge limits. An example calculation based on the constituent TCE is

provided with each calculation. The calculations have been put into a spreadsheet format (Table K-3).

Step 3 - Calculate the **upstream assimilative capacity (Acup)**, which is the allowable instream load for each constituent in pounds per day.

$$\text{Acup (lb/day)} = 7Q10(\text{WQS-Background Conc.})/0.185$$

where:

-7Q10 is 117.48 cfs for the segment of the river adjacent to Site 5

-WQS is the WV water quality standard from Appendix E of the regulations

-Background conc. is the river's average concentration in Table K-1

-(0.185) is a conversion factor

For TCE: Allowable (lb/day) = 117.48 cfs[0.0027 mg/l-0 mg/l]/0.185 = 1.71 lb/day

Step 4 - Calculate the **wasteload allocation (WLA)**, which is the percent of the allowable daily load to be applied using an **instream waste concentration (IWC)** approach. The IWC is simply defined as a ratio of the additional discharge flow to a total flow:

$$IWC = Qd/(Qd+Qs)x100$$

where:

-Qd is the discharge flow

-Qs is the 7Q10 flow

For TCE: IWC = 0.06 cfs/(0.06 cfs + 117.48 cfs)x100 = 0.05%

According to West Virginia State guidance, for IWCs less than 1%, a WLA will be derived based on 5% of the receiving stream assimilative capacity. For IWCs greater than 1% and less than or equal to 5%, a WLA will be derived based upon 10% of the receiving stream assimilative capacity upstream of the discharge point. However, when using water quality standards corresponding to use classification "A" or "C", use 20% instead of 5 or 10%.

Based on these guidelines, the WLA is calculated as follows:

$$WLA = Qd(WQS)8.34 + (0.05 \text{ or } 0.2)(Acup)$$

For TCE: WLA = 0.04 MGD(0.0027 mg/l)8.34 + 0.2(1.71 lb/day) = 0.34 lb/day

Note that a factor of 0.2 (20%) was used to calculate the WLA for TCE because the water quality standard for TCE is based upon the public water intake use classification "A".

Step 5 - Convert the allowable pounds per day into the **average monthly concentration (AMC)**:

$$AMC(mg/l) = WLA/[8.34(Qd)]$$

For TCE: AMC = 0.34 lb/day/[8.34(0.04 MGD)] = 1 mg/l =1,000 µg/l

Step 6 - Determine the **daily maximum concentration**:

Daily maximum = 1.5(AMC)

For TCE: Daily maximum = 1.5 (1000 µg/l) = 1,500 µg/l

Step 7 - The State will allow discharges to the North Branch of the Potomac River which meet the water quality based discharge limits calculated using this procedure, unless the values exceed the effluent limitations in 40 CFR 414.101. This Federal regulation contains best available technology (BAT) effluent limitations which the State uses as "never to exceed" discharge limits. Therefore, the remaining step is to compare the values calculated using the West Virginia Toxic Pollutant Control Strategy to the BAT effluent limitations, and to choose the lower value as the governing discharge limit

The BAT AMC effluent limitation for TCE is 26 µg/l, which is lower than the calculated AMC. Therefore, the BAT effluent limitation governs for average monthly discharge from the plant.

Table K-1

Average Background River Concentrations [1]

Focused RI/FS

Site 5, Allegany Ballistics Laboratory

Rocket Center, West Virginia

Constituent	5SW-1 (mg/L)	5SW-2 (mg/L)	Average of Wells 5SW-1 and 5SW-2 (mg/L)
aluminum	0 [2]	0	0
antimony	0	0	0
arsenic	0	0	0
barium	63.8	77.8	70.8
beryllium	0	0	0
cadmium	0	0	0
calcium	66000	82100	74050
chromium (III)	0	0	0
chromium (VI)	0	0	0
cobalt	0	0	0
copper	4	4.3	4.2
cyanide	0	0	0
iron	0	0	0
lead	0	0	0
magnesium	13400	16900	15150
manganese	288	372	330
mercury	0.2	0	0.1
nickel	16.6	12.6	14.6
potassium	5200	6680	5940
selenium	0	0	0
silver	0	0	0
sodium	39400	49900	44650
thallium	0	0	0
vanadium	0	0	0
zinc	0	36.7	18.4
1,1,1-trichloroethane	0	0	0
1,1-dichloroethane	0	0	0
1,1-dichloroethene	0	0	0
1,2-dichloroethane	0	0	0
1,2-dichloroethene (total)	0	0	0
methylene chloride	0	0	0
tetrachloroethene	0	0	0
toluene	0	0	0
trichloroethene	0	0	0
vinyl chloride	0	0	0

Notes:

1. All nondetects were assumed to equal 0 mg/L.

Table K-2

Example Water Quality Standards for Site 5 Discharge to the North Branch of the Potomac River

Focused RI/FS

Site 5, Allegany Ballistics Laboratory

Rocket Center, West Virginia

Constituent	Water Quality Standard (mg/L)
aluminum	87 [1]
antimony	14 [2]
arsenic	50 [2]
barium	1000 [2]
beryllium	0.0077 [2]
cadmium	1.1 [3]
calcium	NA [6]
chromium (III)	210 [3]
chromium (VI)	11 [3]
cobalt	35000 [5]
copper	12 [3]
cyanide	5 [1]
iron	1500 [1]
lead	3.2 [3]
magnesium	NA [6]
manganese	1000 [1]
mercury	0.10 [4]
nickel	160 [3]
potassium	NA [6]
selenium	5 [1]
silver	4.1 [3]
sodium	NA [6]
thallium	1.7 [2]
vanadium	10000 [5]
zinc	100 [2]
1,1,1-trichloroethane	12000 [2]
1,1-dichloroethane	160000 [5]
1,1-dichloroethene	0.03 [2]
1,2-dichloroethane	0.035 [2]
1,2-dichloroethene (total)	11600 [5]
methylene chloride	11000 [5]
tetrachloroethene	0.8 [2]
toluene	6800 [2]
trichloroethene	2.7 [2]
vinyl chloride	2.0 [2]

Notes:

1. West Virginia WQS, use classification B1.
2. West Virginia WQS, use classification A or C.
3. Federal Ambient Water Quality Criteria (FAWQC) (chronic).
4. Background river concentration.
5. EPA Region III BTAG Screening Level (lower of flora and fauna).
6. No WV WQS, FAWQC, or BTAG is available.

Table K-3
Example Calculation of Preliminary Surface Water Discharge Limits for VOCs in Site 5 Groundwater
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Organic Constituents	Background Concentration [1] (mg/L)	Water Quality Standard (mg/L)	Treatment Plant Influent Concentration [2] (mg/L)	Water Quality Based Discharge Limit [3]		BAT Effluent Limitation [4]		Preliminary Discharge Limit (mg/L)
				Daily Max. (mg/L) A	Ave. Monthly (mg/L) A	Daily Max. (mg/L)	Avg. Monthly (mg/L)	
1,1,1-Trichloroethane	0	12000 [5]	14	7,339,374	4,892,916	127	22	22
1,1-Dichloroethane	0	160000 [6]	0	24,644,579	16,429,719	59	22	22
1,1-Dichloroethene	0	0.03 [5]	0	18.35	12.23	60	22	12.23
1,2-Dichloroethane	0	0.035 [5]	0	21.41	14.27	574	180	14.27
1,2-Dichloroethene(Tot) [7]	0	11600 [6]	13	1,786,732	1,191,155	66	25	25
Methylene Chloride [7]	0	11000 [6]	12	1,694,315	1,129,543	170	36	36
Tetrachloroethene	0	0.8 [5]	0	489	326	164	52	52
Toluene	0	6800 [5]	0	4,158,978	2,772,652	74	28	28
Trichloroethene [7]	0	2.7 [5]	110	1,651	1,101	69	26	26
Vinyl Chloride	0	2.0 [5]	0.6	1,223	815	172	97	97

Notes:

1 North Branch Potomac River upstream concentration. Value is an average based on two surface water samples collected during RI work. Sample analytical results are documented in the Phase II RI for surface water samples 5SW-1 and 5SW-2. Non-detect anlytical results were assumed to equal zero.

2 Treatment plant influent concentrations were assumed to equal the maximum detected concentration from previous sampling activities.

3 The Daily Maximum and Average Monthly Concentrations are the allowable discharge limits calculated using the State of West Virginia, Office of Water Resources Toxic Pollutant Control Strategy. The discharge limits are based on the appropriate water quality standard.

4 Best Available Technology (BAT) Effluent Limitations are reported in 40CFR414.101.

5 West Virginia water quality standards (WQS); Appendix E, Requirements Governing Water Quality Standards, Title 46, Series I (1985).

6 EPA Region III BTAG Screening Level. No West Virginia WQS or Federal Ambient Water Quality Criteria (FAWQC) are available for this constituent.

7 Chemical of Potential Concern (COPC).

Appendix L
Cost Estimates

Table L-1
Cost Estimate Details, Alternative 2
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Assumptions

1. The accuracy of the cost estimate is +50%/-30%

Detailed Capital and Operations and Maintenance Costs

Sampling/analysis of wells	15	wells
Number of HRC Injection Wells to be installed =	73	wells
The number of wells on-site to be abandoned for post-closure is	73	wells

CAPITAL COST

Item/Activity	Qty	Unit		Unit Cost		Cost	Comments and References
Preliminary Assessment / Treatability Study	1	ls	$	25,000	$	25,000	
LUCIP Preparation	1	ls	$	2,000.00	$	2,000	
Earthwork							
Mob/Demob	1	ls	$	2,200	$	2,200	
Clearing/Grubbing	0.4	ac	$	4,900	$	1,960	
Topsoil/Fine Grade/Seed	1400	sy	$	6.9	$	9,660	
Injection Well Installation							
Mob/Demob of Truck-Mounted Rig	1	ls	$	900	$	900	
8-inch augering (0 - 30 feet bgs)	2190	ft	$	25	$	54,750	73 wells x 30 feet/well
Construction of 2-inch Injection Well	2190	ft	$	16.50	$	36,135	73 wells x 30 feet/well
2-inch Schedule 40 PVC well riser	1460	ft	$	1.25	$	1,825	73 wells x 20 feet/well (allowing for stickup height)
2-inch Schedule 40 PVC well screen: 10-foot length	73	ea	$	20	$	1,460	
2-inch Schedule 40 PVC well screen: 5-foot length	0	ea	$	12.50	$	-	
Installation of Protective Casing	73	ea	$	425	$	31,025	
Per-Diem (2-Person Crew)	19	day	$	125	$	2,375	
Decontamination of Equipment	19	hr	$	150	$	2,850	
Temporary Decontamination Pad	1	ls	$	200	$	200	
IDW Transportation Costs	1	ls	$	2,250	$	2,250	Vendor Quote
IDW Disposal Costs (Hazardous Waste)	219	drum	$	175	$	38,325	Vendor Quote (assume 3 drums per borehole)
Bulldozer/Backhoe/Forklift	10	hr	$	85	$	850	
Well Permits	0	ea	$	100	$	-	
Well Survey	1	ls	$	3,000	$	3,000	BOA Rates; survey completed in two days
Field Oversight	19	day	$	755	$	14,345	Assume $105/day per-diem and $65/hour x 10 hour/day
Reagent Injection							
Mob/Demob	1	ls	$	1,000	$	1,000	
Field Crew (2 persons)	15	day	$	480	$	7,200	
Injection Subcontractor - Labor and Equipment	15	day	$	2,000	$	30,000	Assume 1 hole every 2 hours (= 15 10-hour days)
Injection Reagents (Hydrogen Release Compond)	11964	lb	$	6.00	$	71,784	From Regenesis Substrate Calculations
Reagent transport to site	11964	lb	$	0.20	$	2,393	
Sales Tax on Reagent Costs	5%	of	$	71,784	$	3,589	
Subtotal Capital Cost					$	347,076	
Site Work Allowance	5%	of	$	347,076	$	17,354	
Mechanical Allowance	0%	of	$	347,076	$	-	
Instrumentation and Controls Allowance	0%	of	$	347,076	$	-	
Electrical Allowance	0%	of	$	347,076	$	-	
Miscellaneous Equipment Allowance	2%	of	$	347,076	$	6,942	
Subtotal Capital Cost					$	371,371	
Project Management	8%	of	$	371,371	$	29,710	
Design	10%	of	$	371,371	$	37,137	
Construction Management	10%	of	$	371,371	$	37,137	
Subcontractor General Requirements	5%	of	$	371,371	$	18,569	
Subtotal Capital Cost					**$**	**493,924**	
Contingency	20%	of	$	493,924	$	98,785	
TOTAL CAPITAL COST					**$**	**593,000**	

Table L-1
Cost Estimate Details, Alternative 2
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

YEARS 1 AND 2 ANNUAL OPERATIONS AND MAINTENANCE

Item/Activity	Qty	Unit		Unit Cost		Cost	Comments and References
Analytical Costs							
Grounwater Samples							
TCL Low-concentration Volatiles by CLP (OLC03)	0	samples		$126	$	-	Sample quantities include 15 monitoring well locaitons,
Methane/Ethane/Ethene (RSK 175/147)	31	samples		$131	$	4,069	plus QA/QC samples
TAL Metals plus B and Mo (ILM04)	0	samples		$110	$	-	
Total Recoverable Phenolics (EPA 420)	0	samples		$32	$	-	
Cyanide	0	samples		$21	$	-	
Hardness (130.2)	0	samples		$16	$	-	
Chemical Oxygen Demand (COD)	24	samples		$25	$	605	
Total Organic Carbon (TOC) (415.2/ 9060)	24	samples		$34	$	806	
Nitrate (353.2/ 353.3/ 354.1)	24	samples		$21	$	504	
Ammonia-Nitrogen (350.1/ 350.2)	0	samples		$20	$	-	
Biological Oxygen Demand - 5 day (BOD)	0	samples		$25	$	-	
Nitrite (353.2/ 354.1)	24	samples		$21	$	504	
Sulfate (375.4)	24	samples		$19	$	454	
Chloride (325.1/ 325.3)	24	samples		$19	$	454	
Bicarbonate	0	samples		$16	$	-	
Total Dissolved Solids (160.1)	0	samples		$13	$	-	
Alkalinity (310.1)	24	samples		$15	$	353	
Surface Water Samples							
TCL Low-concentration Volatiles by CLP (OLC03)	8	samples		$126	$	1,008	
TAL Metals (ILM04)	7	samples		$100	$	698	
Cyanide (ILM04)	7	samples		$21	$	147	
Labor Costs (Sampling, Sample Mgt, Validation, Reporting)							
Project Manager	8	hours	$	90	$	720	
Project Scientist	80	hours	$	65	$	5,200	
GIS/Database Professional	0	hours	$	65	$	-	
Project Chemist	8	hours	$	65	$	520	
Field Technician	80	hours	$	65	$	5,200	
Data Technician	50	hours	$	65	$	3,250	
Equipment Manager	4	hours	$	55	$	220	
Other Expenses (Sampling, Sample Mgt, Validation, Reporting)							
Field Equipment	1	LS	$	5,000	$	5,000	
Reprographics	1	LS	$	250	$	250	
Data Validation	1	LS	$	1,600.00	$	1,600	
Travel	1	event	$	1,000.00	$	1,000	
Subtotal O&M Cost					$	32,561	
Project Management	8%	of	$	32,561	$	2,605	
Design	0%	of	$	32,561	$	-	
Construction Management	0%	of	$	32,561	$	-	
Subcontractor General Requirements	5%	of	$	32,561	$	1,628	
Subtotal Capital Cost					**$**	**36,794**	
Contingency	20%	of	$	36,794	$	7,359	
Total for Quarterly Monitoring Event					**$**	**44,153**	
Total for 4 Quarterly Monitoring Events	4	events	$	44,153	$	176,612	
YEARS 1 AND 2 MONITORING COST (PER YEAR)					**$**	**177,000**	

YEARS 3 THROUGH 25 OPERATIONS AND MAINTENANCE

Item/Activity	Qty	Unit		Unit Cost		Cost	Comments and References
Total for One Monitoring Event	1	event	$	44,153	$	44,153	
COST PER MONITORING EVENT (YEARS 3 THROUGH 25)					**$**	**45,000**	

Table L-1
Cost Estimate Details, Alternative 2
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

REPORTING COSTS

Item/Activity	Qty	Unit		Unit Cost		Cost	Comments and References
Labor Costs (Sampling, Sample Mgt, Validation, Reporting)							
Project Manager	8	hours	$	90	$	720	
Project Scientist	40	hours	$	65	$	2,600	
GIS/Database Professional	8	hours	$	65	$	520	
Project Chemist	0	hours	$	65	$	-	
Field Technician	0	hours	$	65	$	-	
Data Technician	40	hours	$	65	$	2,600	
Equipment Manager	0	hours	$	55	$	-	
Other Expenses (Sampling, Sample Mgt, Validation, Reporting)							
Field Equipment	0	LS	$	5,000	$	-	
Reprographics	1	LS	$	250	$	250	
Data Validation	0	LS	$	2,000.00	$	-	
Travel	0	event	$	1,310.00	$	-	
Subtotal Reporting Cost					$	6,690	
Project Management	8%	of	$	6,690	$	535	
Design	0%	of	$	6,690	$	-	
Construction Management	0%	of	$	6,690	$	-	
Subcontractor General Requirements	0%	of	$	6,690	$	-	
Subtotal Capital Cost					**$**	**7,225**	
Contingency	20%	of	$	7,225	$	1,445	
REPORTING COSTS					**$**	**9,000**	

POST CLOSURE OPERATIONS AND MAINTENANCE

Item/Activity	Qty	Unit		Unit Cost		Cost	Comments
Reporting							
Labor - Engineer/Hydrogeologist	100	hr	$	90	$	9,000	
Labor - Editor	50	hr	$	65	$	3,250	
Labor - CAD Technician	25	hr	$	65	$	1,625	
Subtotal Reporting					$	13,875	
Well Abandonment and Equipment Demobilization							
Well Abandonment Subcontractor	73	well	$	500	$	36,500	
Equipment Demobilization	1	LS	$	2,000.00	$	2,000	
Equipment Rental	3	wk	$	200	$	600	MultiRAE
Subtotal Well Abandonment					$	39,100	
Site Work Allowance	10%	of	$	39,100	$	3,910	
Mechanical Allowance	0%	of	$	39,100	$	-	
Instrumentation and Controls Allowance	0%	of	$	39,100	$	-	
Electrical Allowance	0%	of	$	39,100	$	-	
Miscellaneous Equipment Allowance	5%	of	$	39,100	$	1,955	
Subtotal Post-Closure Operations and Maintenancer					$	58,840	
Project Management	8%	of	$	58,840	$	4,707	
Technical Support	15%	of	$	58,840	$	8,826	
Construction Management	10%	of	$	58,840	$	5,884	
Subcontractor General Requirements	5%	of	$	58,840	$	2,942	
Subtotal Post-Closure Operations and Maintenance					$	81,199	
Contingency	20%	of	$	81,199	$	16,240	
TOTAL POST-CLOSURE OPERATIONS AND MAINTENANCE COST					**$**	**98,000**	

Table L-1
Cost Estimate Details, Alternative 2
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Present Worth Analysis

	Cost	Factor Applied	Present Worth Cost	
Capital Costs	$ 593,000	none	$ 593,000	
Annual Monitoring Costs (Years 1 and 2)	$ 177,000	(P/A, 3.2%, 2)	$ 337,705	
Reporting Costs (Anually for Years 1 and 2)	$ 9,000	(P/A, 3.2%, 2)	$ 17,171	
Triquarterly Monitoring Costs (Years 3 through 10)	$ 57,000	(P/A, 3.2%, 8) (P/F,3.2%,2)	$ 372,544	Assume 10 tri-quarterly events are performed over 8 yr
Biannual Monitoring Costs (Years 11 through 25)	$ 24,000	(P/A, 3.2%, 15) (P/F, 3.2%, 10)	$ 206,102	Assume 8 biannual events are performed over 25 yr
Reporting Costs (Every 3 Years for Years 3 through 25))	$ 2,000	(P/A, 3.2%, 23) (P/F,3.2%,2)	$ 30,247	Assume 8 reporting events are performed over 23 yr
Year 25 Post-Closure Cost	$ 98,000	(P/F, 3.2%, 25)	$ 44,590	
Total Present Worth			**$ 1,602,000**	

Table L-2
Cost Estimate Details, Alternative 3
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Assumptions

1. The accuracy of the cost estimate is +50%/-30%

Detailed Capital and Operations and Maintenance Costs

CAPITAL COST							
Item/Activity	**Qty**	**Unit**		**Unit Cost**		**Cost**	**Comments and References**
Preliminary Assessment / Treatability Study	1	ls	$	25,000	$	25,000	
LUCIP Preparation	1	ls	$	2,000	$	2,000	
Earthwork							
Mob/Demob	1	ls	$	2,200	$	2,200	
Clearing/Grubbing	0.4	ac	$	4,900	$	1,960	
Backfill, Common Earth	520.0	cy	$	4.4	$	2,288	
Topsoil/Fine Grade/Seed	1400	sy	$	6.9	$	9,660	
PRB Wall Construction (Vendor Costs)							
Iron Material (Delivered)	225	ton	$	425	$	95,625	Vendor Quote: 200 x 15 x 1 ft = 3,000 cf of Iron Material. Bulk
Mobilization of Trenching and Injection Equipment	1	ls	$	50,000	$	50,000	Density of Iron = 0.075 ton/cf; 3,000 cf x 0.075 ton/cf = 425 tons
Biopolymer Installation of Iron Material	1	ls	$	105,000	$	105,000	Vendor Quote
License Fee	12%	of	$	250,625	$	30,075	Vendor Quote
Waste Disposal							
Offsite Disposal of Excavated Soil as Haz. Waste	178	ton	$	145	$	25,778	Engineer's Estimate; Assume 1.6 tons/cy
Field Oversight							
Field Oversight	15	day	$	755	$	11,325	Assume $105/day per-diem and $65/hour x 10 hour/day
Subtotal Capital Cost					$	360,911	
Site Work Allowance	5%	of	$	360,911	$	18,046	
Mechanical Allowance	0%	of	$	360,911	$	-	
Instrumentation and Controls Allowance	0%	of	$	360,911	$	-	
Electrical Allowance	0%	of	$	360,911	$	-	
Miscellaneous Equipment Allowance	2%	of	$	360,911	$	7,218	
Subtotal Capital Cost					$	386,175	
Project Management	8%	of	$	386,175	$	30,894	
Design	10%	of	$	386,175	$	38,617	
Construction Management	10%	of	$	386,175	$	38,617	
Subcontractor General Requirements	5%	of	$	386,175	$	19,309	
Subtotal Capital Cost					**$**	**513,612**	
Contingency	20%	of	$	513,612	$	102,722	
TOTAL CAPITAL COST					**$**	**617,000**	

Table L-2
Cost Estimate Details, Alternative 3
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

OPERATION AND MAINTENANCE COSTS

Item/Activity	Qty	Unit		Unit Cost		Cost	Comments and References
Analytical Costs							
Grounwater Samples							
TCL Low-concentration Volatiles by CLP (OLC03)	0	samples		$126	$	-	Sample quantities include 15 monitoring well locations,
Methane/Ethane/Ethene (RSK 175/147)	31	samples		$131	$	4,069	plus QA/QC samples
TAL Metals plus B and Mo (ILM04)	0	samples		$110	$	-	(Includes both total and dissolved metals analyses)
Total Recoverable Phenolics (EPA 420)	0	samples		$32	$	-	
Cyanide	0	samples		$21	$	-	
Hardness (130.2)	0	samples		$16	$	-	
Chemical Oxygen Demand (COD)	24	samples		$25	$	605	
Total Organic Carbon (TOC) (415.2/ 9060)	24	samples		$34	$	806	
Nitrate (353.2/ 353.3/ 354.1)	24	samples		$21	$	504	
Ammonia-Nitrogen (350.1/ 350.2)	0	samples		$20	$	-	
Biological Oxygen Demand - 5 day (BOD)	0	samples		$25	$	-	
Nitrite (353.2/ 354.1)	24	samples		$21	$	504	
Sulfate (375.4)	24	samples		$19	$	454	
Chloride (325.1/ 325.3)	24	samples		$19	$	454	
Bicarbonate	0	samples		$16	$	-	
Total Dissolved Solids (160.1)	0	samples		$13	$	-	
Alkalinity (310.1)	24	samples		$15	$	353	
Surface Water Samples							
TCL Low-concentration Volatiles by CLP (OLC03)	8	samples		$126	$	1,008	
TAL Metals (ILM04)	7	samples		$100	$	698	
Cyanide (ILM04)	7	samples		$21	$	147	
Labor Costs (Sampling, Sample Mgt, Validation, Reporting)							
Project Manager	8	hours	$	90	$	720	
Project Scientist	80	hours	$	65	$	5,200	
GIS/Database Professional	0	hours	$	65	$	-	
Project Chemist	8	hours	$	65	$	520	
Field Technician	80	hours	$	65	$	5,200	
Data Technician	50	hours	$	65	$	3,250	
Equipment Manager	4	hours	$	55	$	220	
Other Expenses (Sampling, Sample Mgt, Validation, Reporting)							
Field Equipment	1	LS	$	5,000	$	5,000	
Reprographics	1	LS	$	250	$	250	
Data Validation	1	LS	$	1,600.00	$	1,600	
Travel	1	event	$	1,000.00	$	1,000	
Subtotal O&M Cost					$	32,561	
Project Management	8%	of	$	32,561	$	2,605	
Design	0%	of	$	32,561	$	-	
Construction Management	0%	of	$	32,561	$	-	
Subcontractor General Requirements	5%	of	$	32,561	$	1,628	
Subtotal Capital Cost					**$**	**36,794**	
Contingency	20%	of	$	36,794	$	7,359	
COST PER MONITORING EVENT					**$**	**45,000**	

Table L-2
Cost Estimate Details, Alternative 3
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

REPORTING COSTS

Item/Activity	Qty	Unit		Unit Cost		Cost	Comments and References
Labor Costs (Sampling, Sample Mgt, Validation, Reporting)							
Project Manager	8	hours	$	90	$	720	
Project Scientist	40	hours	$	65	$	2,600	
GIS/Database Professional	8	hours	$	65	$	520	
Project Chemist	0	hours	$	65	$	-	
Field Technician	0	hours	$	65	$	-	
Data Technician	40	hours	$	65	$	2,600	
Equipment Manager	0	hours	$	55	$	-	
Other Expenses (Sampling, Sample Mgt, Validation, Reporting)							
Field Equipment	0	LS	$	5,000	$	-	
Reprographics	1	LS	$	250	$	250	
Data Validation	0	LS	$	2,000.00	$	-	
Travel	0	event	$	1,310.00	$	-	
Subtotal Reporting Cost					$	6,690	
Project Management	8%	of	$	6,690	$	535	
Design	0%	of	$	6,690	$	-	
Construction Management	0%	of	$	6,690	$	-	
Subcontractor General Requirements	0%	of	$	6,690	$	-	
Subtotal Capital Cost					**$**	**7,225**	
Contingency	20%	of	$	7,225	$	1,445	
REPORTING COSTS					**$**	**9,000**	

POST CLOSURE OPERATIONS AND MAINTENANCE

Item/Activity	Qty	Unit		Unit Cost		Cost	Comments
Reporting							
Labor - Engineer/Hydrogeologist	100	hr	$	90	$	9,000	
Labor - Editor	50	hr	$	65	$	3,250	
Labor - CAD Technician	25	hr	$	65	$	1,625	
Subtotal Reporting					$	13,875	
Project Management	8%	of	$	13,875	$	1,110	
Technical Support	15%	of	$	13,875	$	2,081	
Construction Management	10%	of	$	13,875	$	1,388	
Subcontractor General Requirements	5%	of	$	13,875	$	694	
Subtotal Post-Closure Operations and Maintenance					$	19,148	
Contingency	20%	of	$	19,148	$	3,830	
TOTAL POST-CLOSURE OPERATIONS AND MAINTENANCE COST					**$**	**23,000**	

Table L-2
Cost Estimate Details, Alternative 3
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Present Worth Analysis

		Cost	Factor Applied		Present Worth Cost	
Capital Costs	$	617,000	none	$	617,000	
Triquarterly Monitoring Costs (Years 1 through 10)	$	63,000	(P/A, 3.2%, 10)	$	531,959	Assume 14 tri-quarterly monitoring events over 10 years
Biannual Monitoring Costs (Years 11 through 20)	$	23,000	(P/A, 3.2%, 10) (P/F, 3.2%, 10)	$	141,732	Assume 5 bi-annual monitoring events over 10 years
Reporting Costs (Every 3 Years)	$	3,000	(P/A, 3.2%, 20)	$	43,818	
Year 20 Post-Closure Cost	$	23,000	(P/F, 3.2%, 20)	$	12,250	
Total Present Worth				**$**	**1,347,000**	

Table L-3
Cost Estimate Details, Alternative 4
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

Assumptions

1. The accuracy of the cost estimate is +50%/-30%

Detailed Capital and Operations and Maintenance Costs

CAPITAL COST

Item/Activity	Qty	Unit		Unit Cost		Cost	Comments and References
LUCIP Preparation	1	ls	$	2,000	$	2,000	
Install Extraction Wells							
Mob/Demob	1	ls	$	2,200	$	2,200	
Clearing/Grubbing	0.1	ac	$	4,900	$	490	
Trench Excavation (for Distribution Piping)	1300	cy	$	3.20	$	4,160	Assume 1,950 lf of trench, 3 feet deep and 6 feet wide
Backfill/Compaction	1300	cy	$	16.30	$	21,190	
HDPE Piping	1950	lf	$	13.40	$	26,130	
Topsoil/Fine Grade/Seed	1300	sy	$	6.9	$	8,970	
Cleanouts	6	ea	$	210	$	1,260	
Security Fencing	1500	lf	$	14.30	$	21,450	
Pumps (10 gpm, with teflon head)	11	ea	$	5,800	$	63,800	
Well Vaults (Pre-fab Concrete)	11	ea	$	4,000	$	44,000	
Mob/Demob of Truck-Mounted Drill Rig	1	ls	$	900	$	900	
8-inch augering (0 - 30 feet bgs)	330	ft	$	25	$	8,250	11 wells x 30 feet/well
Construction of 4-inch Extraction Well	330	ft	$	13.00	$	4,290	11 wells x 30 feet/well
4-inch Schedule 40 PVC well riser	220	ft	$	2.50	$	550	11 wells x 20 feet/well (allowing for stickup height)
4-inch Schedule 40 PVC well screen: 10-foot length	11	ea	$	45	$	495	Assume well screen interval of 15 - 30 feet below ground surface
4-inch Schedule 40 PVC well screen: 5-foot length	11	ea	$	30.00	$	330	
Installation of Protective Casing	11	ea	$	425	$	4,675	
Per-Diem (2-Person Crew)	9	day	$	125	$	1,125	Assume 2 wells/day for installation; 4 wells/day for development
Well Development	24	hr	$	65	$	1,560	
Decontamination of Equipment	9	hr	$	150	$	1,350	
Temporary Decontamination Pad	1	ls	$	200	$	200	
Backhoe for Moving IDW Soil	2	day	$	200	$	400	
IDW Transportation Costs	1	ls	$	665	$	665	Vendor Quote
IDW Disposal Costs (Hazardous Waste)	33	drum	$	175	$	5,775	Vendor Quote (Assume 3 drums per borehole)
Bulldozer/Backhoe/Forklift	4	hr	$	85	$	340	
Well Permits	0	ea	$	100	$	-	
Well Survey	1	ls	$	1,500	$	1,500	BOA Rates; survey completed in one day
Field Oversight	9	day	$	755	$	6,795	Assume $105/day per-diem and $65/hour x 10 hour/day
Electrical / I&C (Components)	11	ea	$	25,000	$	275,000	2003 Site 10 Install costs less OH&P, less allowances for labor; additional costs for electrical vaults
Channel Reinforcement							
Reinforcement of Rip-Rap Channel	1	ls	$	25,000	$	25,000	Engineer's Estimate
Subtotal Capital Cost					$	534,850	
Site Work Allowance	12%	of	$	534,850	$	64,182	
Mechanical Allowance	15%	of	$	534,850	$	80,228	
Instrumentation and Controls Allowance	10%	of	$	534,850	$	53,485	
Electrical Allowance	10%	of	$	534,850	$	53,485	
Miscellaneous Equipment Allowance	2%	of	$	534,850	$	10,697	
Subtotal Capital Cost					$	796,927	
Project Management	8%	of	$	796,927	$	63,754	
Design	10%	of	$	796,927	$	79,693	
Construction Management	10%	of	$	796,927	$	79,693	
Subcontractor General Requirements	5%	of	$	796,927	$	39,846	
Subtotal Capital Cost					**$**	**1,059,912**	
Contingency	20%	of	$	1,059,912	$	211,982	
TOTAL CAPITAL COST					**$**	**1,272,000**	

Table L-3
Cost Estimate Details, Alternative 4
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

OPERATIONS AND MAINTENANCE COSTS							
Item/Activity	**Qty**	**Unit**		**Unit Cost**		**Cost**	**Comments and References**
Groundwater & Surface Water Monitoring Analytical Costs							
Groundwater Samples							
TCL Low-concentration Volatiles by CLP (OLC03)	0	samples		$126	$	-	Sample quantities include 15 monitoring well locations,
Methane/Ethane/Ethene (RSK 175/147)	31	samples		$131	$	4,069	plus QA/QC samples
TAL Metals plus B and Mo (ILM04)	0	samples		$110	$	-	(Includes both total and dissolved metals analyses)
Total Recoverable Phenolics (EPA 420)	0	samples		$32	$	-	
Cyanide	0	samples		$21	$	-	
Hardness (130.2)	0	samples		$16	$	-	
Chemical Oxygen Demand (COD)	24	samples		$25	$	605	
Total Organic Carbon (TOC) (415.2/ 9060)	24	samples		$34	$	806	
Nitrate (353.2/ 353.3/ 354.1)	24	samples		$21	$	504	
Ammonia-Nitrogen (350.1/ 350.2)	0	samples		$20	$	-	
Biological Oxygen Demand - 5 day (BOD)	0	samples		$25	$	-	
Nitrite (353.2/ 354.1)	24	samples		$21	$	504	
Sulfate (375.4)	24	samples		$19	$	454	
Chloride (325.1/ 325.3)	24	samples		$19	$	454	
Bicarbonate	0	samples		$16	$	-	
Total Dissolved Solids (160.1)	0	samples		$13	$	-	
Alkalinity (310.1)	24	samples		$15	$	353	
Surface Water Samples							
TCL Low-concentration Volatiles by CLP (OLC03)	8	samples		$126	$	1,008	
TAL Metals (ILM04)	7	samples		$100	$	698	
Cyanide (ILM04)	7	samples		$21	$	147	
Labor Costs (Sampling, Sample Mgt, Validation, Reporting)							
Project Manager	8	hours	$	90	$	720	
Project Scientist	80	hours	$	65	$	5,200	
GIS/Database Professional	0	hours	$	65	$	-	
Project Chemist	8	hours	$	65	$	520	
Field Technician	80	hours	$	65	$	5,200	
Data Technician	50	hours	$	65	$	3,250	
Equipment Manager	4	hours	$	55	$	220	
Other Expenses (Sampling, Sample Mgt, Validation, Reporting)							
Field Equipment	1	LS	$	5,000	$	5,000	
Reprographics	1	LS	$	250	$	250	
Data Validation	1	LS	$	1,600.00	$	1,600	
Travel	1	event	$	1,000.00	$	1,000	
Other Tri-Quarterly O&M Costs							
Miscellaneous Electrical	45,000	Kwh	$	0.06	$	2,700	
O&M - Labor	174	hours	$	55.00	$	9,570	2 days/mo maintenance + 1 week/year refurbishment (5 wells refurbished/year)
O&M - Miscellaneous Materials/Tools/Replacement	1	ls	$	9,375.00	$	9,375	
Subtotal O&M Cost					$	54,206	
Project Management	8%	of	$	54,206	$	4,336	
Design	0%	of	$	54,206	$	-	
Construction Management	0%	of	$	54,206	$	-	
Subcontractor General Requirements	5%	of	$	54,206	$	2,710	
Subtotal O&M Costs					**$**	**61,253**	
Contingency	20%	of	$	61,253	$	12,251	
TRI-QUARTERLY O&M COSTS					**$**	**74,000**	

Table L-3
Cost Estimate Details, Alternative 4
Focused RI/FS
Site 5, Allegany Ballistics Laboratory
Rocket Center, West Virginia

REPORTING COSTS

Item/Activity	Qty	Unit		Unit Cost		Cost	Comments and References
Labor Costs (Sampling, Sample Mgt, Validation, Reporting)							
Project Manager	8	hours	$	90	$	720	
Project Scientist	40	hours	$	65	$	2,600	
GIS/Database Professional	8	hours	$	65	$	520	
Project Chemist	0	hours	$	65	$	-	
Field Technician	0	hours	$	65	$	-	
Data Technician	40	hours	$	65	$	2,600	
Equipment Manager	0	hours	$	55	$	-	
Other Expenses (Sampling, Sample Mgt, Validation, Reporting)							
Field Equipment	0	LS	$	5,000	$	-	
Reprographics	1	LS	$	250	$	250	
Data Validation	0	LS	$	2,000.00	$	-	
Travel	0	event	$	1,310.00	$	-	
Subtotal Reporting Cost					$	6,690	
Project Management	8%	of	$	6,690	$	535	
Design	0%	of	$	6,690	$	-	
Construction Management	0%	of	$	6,690	$	-	
Subcontractor General Requirements	0%	of	$	6,690	$	-	
Subtotal Capital Cost					**$**	**7,225**	
Contingency	20%	of	$	7,225	$	1,445	
REPORTING COSTS					**$**	**9,000**	

POST CLOSURE OPERATIONS AND MAINTENANCE

Item/Activity	Qty	Unit		Unit Cost		Cost	Comments
Decomissioning of Groundwater Extraction System	1	ls	$	25,000	$	25,000	
Subtotal Decomissioning					$	25,000	
Reporting							
Labor - Engineer/Hydrogeologist	100	hr	$	90	$	9,000	
Labor - Editor	50	hr	$	65	$	3,250	
Labor - CAD Technician	25	hr	$	65	$	1,625	
Subtotal Reporting					$	13,875	
Project Management	8%	of	$	38,875	$	3,110	
Technical Support	15%	of	$	38,875	$	5,831	
Construction Management	10%	of	$	38,875	$	3,888	
Subcontractor General Requirements	5%	of	$	38,875	$	1,944	
Subtotal Post-Closure Operations and Maintenance					$	38,875	
Contingency	20%	of	$	38,875	$	7,775	
TOTAL POST-CLOSURE OPERATIONS AND MAINTENANCE COST					**$**	**47,000**	

Present Worth Analysis

	Cost	Factor Applied	Present Worth Cost	
Capital Costs	$ 1,272,000	none	$ 1,272,000	
Triquarterly Monitoring Costs (Years 1 through 7)	106,000	(P/A, 3.2%, 7)	$ 655,461	Assume 10 tri-quarterly monitoring over 7 years
Reporting Costs (Every 3 Years)	$ 3,000	(P/A, 3.2%, 7)	$ 18,551	
Year 7 Post-Closure Cost	$ 47,000	(P/F, 3.2%, 7)	$ 37,700	
Total Present Worth			**$ 1,984,000**	