CONCURRENCE FOR NO FURTHER ACTION

SIGNATURE PAGE

Site 5 – Grain Manufacture and X-ray Building (Building 731)

Naval Surface Warfare Center, Indian Head Division, Indian Head, MD

In 2001 and 2002, the Navy in partnership with the United States Environmental Protection Agency (USEPA) Region III and Maryland Department of the Environment (MDE) conducted a site screening assessment for Site 5 at the Naval Surface Warfare Center, Indian Head Division in Indian Head, MD. Field investigations were conducted as part of the site screening assessment. Based upon the results of the investigations, it is the consensus of the Project Managers, defined as the Department of the Navy (DoN), the USEPA Region III, MDE, and members of the Indian Head Tier I Partnership, that this site requires no further action under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended, at this site. As appropriate, constituent concentrations, pathways, and receptors were evaluated using the most recent version of USEPA Region III Risk-Based Concentrations (RBC Tables) (USEPA, April 2002), facility background, historical site data, and best professional judgment. In the event contamination posing an unacceptable risk to human health or the environment is discovered after execution of the Site SSA, the Partnership agrees to reevaluate the Site as deemed necessary.

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Final

Site Screening Assessment Report

for Site 5

Naval Surface Warfare Center
Indian Head Division
Indian Head, Maryland

Contract Task Order 0066
December 2003

Prepared for

Department of the Navy
Engineering Field Activity, Chesapeake
Naval Facilities Engineering Command

Under the

LANTDIV Clean II Program
Contract N62470-95-D-6007

Prepared by

CH2MHILL

Herndon, Virginia

SIGNATURE PAGE

Final

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for Site 5

Naval Surface Warfare Center
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Indian Head, Maryland

Contract Task Order—0066
Contract Number N62470-95-D-6007
Navy CLEAN II Program

Prepared by

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December 2003

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Executive Summary

This Site Screening Assessment (SSA) Report for the Indian Head Division–Naval Surface Warfare Center (IHDIV-NSWC), Indian Head, Maryland, was prepared in response to Contract Task Order (CTO) 0066, under the Comprehensive Long-term Environmental Action Navy (CLEAN), contract number N62470-95-D-6007. The purpose of this report is to present the results of the SSA performed at Installation Restoration (IR) Site 5.

Site 5 consists of two drainage swales or depressions originating at Building 731. Swale 1 originates on the southeast side of Building 731, and Swale 2 originates from the southwest corner of Building 731. Soil in these swales was contaminated by silver from photographic processing wastewater between 1953 and 1965. Previous investigations at Site 5 focused on soil contamination in Swale 1 and the northern portion of Swale 2, which subsequently resulted in two soil removal actions for Swale 1 in 1992–1993 and the northern portion of Swale 2 in 1994–1995.

The SSA was performed to address the shallow groundwater quality at Site 5 and sediment and surface water quality in the southern portion of Swale 2. The field investigation undertaken in August 2001 to meet these objectives comprised (1) installing and sampling three monitoring wells, (2) sampling two existing wells at adjacent IR Site 42, (3) sampling sediment, (4) sampling surface water, and (5) monitoring water level.

Since a third party data validator rejected most of the inorganic and some of the organic analytical results for the groundwater samples collected in 2001 due to elevated detections of inorganics in the equipment blank samples, a follow-up field investigation of Site 5 was conducted in 2002. This field effort included (1) resampling three monitoring wells at Site 5, (2) sampling sediment, (3) sampling surface water, and (4) monitoring water level. Two monitoring wells at an adjacent IR site (Site 42) were sampled during the same general timeframe by Tetra Tech NUS and those data were integrated into this SSA.

Analytical results of the groundwater and surface water samples collected from Site 5 in 2002 indicated the presence of many metals, including silver, both in unfiltered and in filtered samples. The analytical results of the sediment samples collected from Site 5 in 2002 also indicate the presence of silver as well as other metals.

A Human Health Risk Screening (HHRS) was performed for the site. The groundwater data were screened against the Safe Drinking Water Act (SDWA) Maximum Contaminant Levels (MCLs), the United States Environmental Protection Agency (USEPA) Region III tap water Risk-Based Concentrations (RBCs), and facility background concentrations. Surface water was compared to modified RBCs and facility background concentrations. Sediment was compared to modified RBCs and facility background concentrations.

If the maximum detected concentration of a compound or analyte exceeded the background average, the risk was determined by calculating a corresponding risk level (CRL).
The CRL values for each constituent were summed. If the cumulative apparent hazard index (CAHI) was greater than 0.5 or the cumulative apparent cancer risk (CACR) was greater than $5x10^{-5}$, each constituent was evaluated by target organ. If the CAHI or CACR by target

organ was greater than 0.5 or $5x10^{-5}$, respectively, the contaminant of potential concern (COPC) was noted as possibly requiring further evaluation.

Based on a review of the analytical data, the results of the HHRA, and the reevaluation of the COCs identified during the human health risk assessment, there are no constituents retained as COPCs in groundwater, surface water, or sediment.

The Ecological Risk Screening (ERS) compared the maximum and average detected concentrations of silver in surface water to a freshwater screening value for aquatic receptors. The ERS also compared the maximum and average detected silver concentrations in sediment to a freshwater sediment screening value for benthic invertebrates. To screen for potential risk to upper trophic level receptors, maximum exposure estimates were developed for the raccoon and green heron and compared to reference toxicity values. The potential risk was further evaluated by looking at bulk sediment toxicity tests conducted as part of the Site 42 remedial investigation (RI) and subsequent Toxicity Identification Evaluation (TIE) study at that site.

Based on a review of the analytical data and the results of the ERS, the following conclusions can be made about Site 5:

- Iron and manganese, while present at elevated levels, are likely the result of natural processes. Other inorganics pose minimal risk to surface water receptors. Inorganics in sediment pose minimal risks to benthic invertebrates.
- The comparison of food chain exposure estimates to reference toxicity values indicates that the levels of metals in surface water and sediment, accounting for background, pose minimal risks to upper trophic level receptors.

The risk screening conclusions indicate that further investigation is not warranted for this site. Therefore, Site 5 is recommended for no further action.

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Acronyms and Abbreviations

AHI	apparent hazard index
ARL	acceptable risk level
BEHP	Bis(2-ethylhexyl)phthalate
bgs	below ground surface
CACR	Cumulative Apparent Cancer Risk
CAHI	Cumulative Apparent Hazard Index
CLEAN	Comprehensive Long-term Environmental Action Navy
COPC	Chemical of Potential Concern
CRL	Corresponding Risk Level
CTO	Contract Task Order
DI	deionized
DO	dissolved oxygen
EE/CA	Engineering Evaluation/Cost Analysis
EFACHES	Department of the Navy Engineering Field Activity, Chesapeake
ERA	Ecological Risk Assessment
ERS	Ecological Risk Screening
ft/day	feet per day
GPS	global positioning system
HDPE	high-density polyethylene
HHRA	Human Health Risk Assessment
HHRS	Human Health Risk Screening
HI	hazard index
HQ	Hazard Quotient
HRS	Hazard Ranking System
IAS	Initial Assessment Study
ID	inside diameter
IDW	investigation-derived waste
IHDIV-NSWC	Indian Head Division–Naval Surface Warfare Center
IR	Installation Restoration
LOAEL	lowest observed adverse effect level
MC	maximum concentration
MCL	Maximum Contaminant Level
mg/kg	milligrams per kilogram
MS	matrix spike
MSD	matrix spike duplicate
msl	mean sea level

µg/L	micrograms per liter
NACIP	Navy Assessment and Control of Installation Pollutants
NAVFAC	Naval Facilities Engineering Command
NOAEL	no observed adverse effect level
NOS	Naval Ordnance Station
NPL	National Priorities List
NWI	National Wetlands Inventory
PVC	polyvinyl chloride
QA	quality assurance
QC	quality control
RBC	Risk-Based Concentration
RI	Remedial Investigation
SDWA	Safe Drinking Water Act
SSA	Site Screening Assessment
SVOC	semivolatile organic compound
TAL	Target Analyte List
TCL	Target Compound List
TIE	Toxicity Identification Evaluation
TOC	total organic carbon
UCL	upper confidence limit
USEPA	United States Environmental Protection Agency
VOC	volatile organic compound

SECTION 1

Introduction

1.1 Introduction

This report presents the Site Screening Assessment (SSA) results for Site 5 at the Indian Head Division–Naval Surface Warfare Center (IHDIV-NSWC), located in Indian Head, Maryland. The report is submitted to the Department of the Navy Engineering Field Activity, Chesapeake (EFACHES) Naval Facilities Engineering Command (NAVFAC) as part of Navy Contract N62470-95-D-6007 Comprehensive Long-term Environmental Action Navy (CLEAN) Contract Task Order (CTO) 0066.

The field investigation and subsequent assessment were performed in accordance with the *Final Site Screening Work Plan for Site 5* (CH2M HILL, 2001). The SSA was performed to address the shallow groundwater quality at Site 5 and sediment and surface water qualities in the southern portion of Swale 2, one of two drainage swales located at the site. Initial field activities, conducted in August 2001, included (1) installing and developing three groundwater monitoring wells, (2) sampling the three installed wells at Site 5 and two existing wells at Site 42, and (3) sampling surface water and sediment in the southern portion of Swale 2. Since a third-party validator rejected much of the 2001 groundwater analytical data because of elevated detections of inorganics in associated filtered blanks, a follow-up round of groundwater, surface water, and sediment samples was collected in February 2002. This report presents organic analytical data from the 2001 sampling event and all analytical data from the 2002 sampling event.

This report presents the data collected during the SSA, the interpretations, and the results of human-health and ecological risk screenings. This report also incorporates the analyses presented in the Appendix E technical memorandum entitled "Indian Head Site 5 Site Screening Assessment Chemicals of Concern (Revised) (CH2M HILL, November 17, 2003), which re-evaluated constituents retained as contaminants of concern during the initial human health risk screening.

1.2 Summary of Previous Investigations

1.2.1 Evaluation of Activity

In June 1982, Naval Energy and Environmental Support Activity conducted an Initial Assessment Study (IAS) – document date 1983. The study evaluated the various sites at the IHDIV-NSWC to determine if a potential threat to human health or the environment existed (FCHA, 1983). The study identified Sites 5, 6, 8, 12, and 25 as exhibiting a potential threat. A Navy Assessment and Control of Installation Pollutants (NACIP) Confirmation Study was conducted at Sites 5, 8, and 12 (CH2M HILL, 1985). Removal Actions were subsequently conducted at Sites 5 and 8 (ABB, 1993, HNUS, 1995). A remedial investigation (RI) was completed at Site 12 in July 1999 (TTNUS, 1999) and a Feasibility Study for Site 12 was

submitted in January 2001 (TTNUS, 2001). Site 25 was recently investigated as part of a five-site RI (CH2M HILL, 2001)

IHDIV-NSWC was proposed to the National Priorities List (NPL) on February 13, 1995. The Activity was officially placed on the list on September 29, 1995.

1.2.2 Site 5 Previous Investigations

As noted above, Site 5 was included as part of the 1983 IAS and the 1985 NACIP Confirmation Study. A subsequent site characterization evaluated the impact of silver concentrations in Site 5 soils on downstream ecosystems. The report concluded that areas of high silver contamination might pose a risk to aquatic invertebrates (ABB, 1991). However, risks could not be quantified on the basis of available information (i.e., the lack of surface water data). The report also concluded that impacts also were possible for ecological receptors that live in the water column and sediment in Swale 1. Similarly, impacts to terrestrial organisms may have occurred as they came into contact with contaminated surface water or sediments.

A removal action was performed on Swale 1 between November 1992 and January 1993. The removal action included the excavation and treatment of soil and sediment containing silver at concentrations exceeding an identified action level of 10 milligrams per kilogram (mg/kg). The results of the removal action were documented in the *Removal Action Findings Report* (ABB, 1993), with the conclusion that the removal of contaminated soil and sediment had been achieved.

Sampling that occurred prior to 1991 at Site 5 indicated that some soils and sediments in Swale 2 also exceeded the 10 mg/kg action level (ABB, 1991). In February 1993, additional field sampling was conducted to define the horizontal and vertical extents of silver contamination within Swale 2. The findings and conclusions of this sampling activity are contained in the *Field Sampling Report for Site 5 – Swale 2* (HNUS, 1994a). An Engineering Evaluation/Cost Analysis (EE/CA) examining possible remediation alternatives for mitigating contamination at Swale 2 was prepared (HNUS, 1994b). Subsequently, design specifications and construction documents for the selected remediation alternative were developed. Excavation began at Swale 2 in December 1994.

Approximately 1,745 cubic yards of silver–contaminated soil were excavated from Swale 2 during the removal action. Post-excavation sampling showed that the majority of silver-contaminated soil had been removed; however, five locations revealed residual silver concentrations above the 10 mg/kg action level. The areas that showed levels above the action level were re-excavated and removed. Following the removal actions, the excavations were backfilled with clean soil, and the drainage swales were reconstructed with erosion controls (HNUS, 1995).

As discussed above, these previous investigations focused on soil, sediment, and surface water contamination and the risks associated with each. Groundwater had not been studied or sampled. It should be noted, however, that at an adjacent IR site, Site 42, located on the eastern and southeastern boundary of Site 5, groundwater samples have been collected. Two of the Site 42 monitoring wells are located in or directly downgradient of Site 5. These two Site 42 wells were sampled in 1993 and 1997. The contaminant of concern, silver, was not detected in either well (TTNUS, 1999).

1.3 Document Organization

The Executive Summary presents an overview of the site and the findings of the SSA. Section 1 presents an introduction to the Site 5 SSA and a summary of the previous investigations performed at Site 5. Section 2 presents the physical and environmental settings of IHDIV-NSWC and Site 5. Section 3 presents descriptions of the field activities conducted as part of the SSA. Section 4 presents the analytical results of environmental sampling. Section 5 presents the Human Health and Ecological Risk Screenings. Section 6 presents the conclusions and recommendations. Section 7 lists the references cited. The following appendixes are presented following Section 7: Appendix A, Soil Boring Logs and Well Construction Diagrams; Appendix B, Survey Report; Appendix C, Raw Analytical Data Tables; Appendix D, Ecological Risk Tables; and Appendix E, technical memorandum entitled "Indian Head Site 5 Site Screening Assessment Chemicals of Concern (CH2M HILL, November 17, 2003). Tables and figures are provided at the end of each section.

SECTION 2

Background Description

2.1 Activity Description

2.1.1 General

IHDIV-NSWC is a military facility located in northwestern Charles County, Maryland. The facility consists of the main installation on the Cornwallis Neck Peninsula and the Stump Neck Annex (Figure 2-1). The main installation contains approximately 2,500 acres. The Stump Neck Annex located across Mattawoman Creek, covers 1,084 acres. The main installation is bounded by the Potomac River to the northwest, west, and south; Mattawoman Creek to the south and east; and the town of Indian Head to the northeast.

Both the main installation and the Stump Neck Annex are on the NPL. The main installation and Stump Neck Annex have separate United States Environmental Protection Agency (USEPA) identification numbers, and perform dissimilar operations.

2.1.2 Current and Historical Uses of IHDIV-NSWC

IHDIV-NSWC was established in 1890 and has served, at various times during its operation, as a gun and armor proving ground, a powder factory, a propellant plant, and a research facility. The U.S. Government purchased Stump Neck Annex in 1901. The Indian Head installation was enlarged by another 1,160 acres of adjacent land in 1918, during World War I. When the Dahlgren Naval Proving Ground was established as a separate command in 1932, IHDIV-NSWC was redesignated the Naval Powder Factory (Parsons, 2000).

The production of gunpowder and development of new explosives during the onset of World War II resulted in the construction of several new facilities at Indian Head, as well as the construction of Route 210 in 1943. Development and improvements at Indian Head continued throughout the 1950s and 1960s, and in 1966, IHDIV-NSWC was renamed the Naval Ordnance Station (NOS).

After the Vietnam conflict, the mission of IHDIV-NSWC shifted from primarily a production facility to a highly technical engineering support operation. In 1987, the NOS was established as a Center for Excellence to promote technological excellence in specialized fields (Parsons, 2000). Current military land use includes operations and training; production; maintenance and utilities; research, development, testing, and evaluation; explosive storage; supply and non-explosive storage; administration; community facilities, and services; housing; and open space.

Forest stands comprise approximately 47 percent, or 1,603 acres, of IHDIV-NSWC. Recreation areas at Indian Head include approximately 1,150 acres of designated hunting areas, approximately 2 miles of shoreline fishing areas, and 1.5 miles of nature trails.

2.1.3 Surrounding Land Uses

IHDIV-NSWC is generally surrounded by commercial, residential, and state park lands to the east and south. Route 210 extends from the town of Indian Head, located just east of the IHDIV-NSWC main gate, to Interstates 95/495 south. The Potomac River borders the main installation to the north and west, and Stump Neck to the west. The Mattawoman Natural Environment Area is state-owned property located along the southern edge of Mattawoman Creek east of the main installation.

The Stump Neck Annex is bordered to the north by Mattawoman Creek; to the east by General Smallwood State Park and Sweden Point Marina; and to the south by Chicamuxen Creek, agricultural lands, and low-density residential development. The Chicamuxen Wildlife Management Area is located adjacent to and south of the Stump Neck Annex.

2.1.4 Climate

IHDIV-NSWC lies in the humid temperate continental climatic zone of the eastern United States. This zone has hot, humid summers, and relatively mild winters. Due to its proximity to the Potomac River and its tributaries, IHDIV-NSWC experiences less extreme temperatures, higher precipitation, and higher humidity compared to inland areas. The average daily maximum temperature is 67.5°F and the average daily minimum temperature is 45°F. The warmest part of the year is in late July, and the coldest is in late January and early February. The growing season is approximately 190 days, from mid-April through mid-October (USDA SCS, 1974).

2.1.5 Soil

IHDIV-NSWC is underlain by the Atlantic Coastal Plain physiographic province and is underlain by unconsolidated sand, gravel, and clay from the Quaternary and Cretaceous Periods. The soils in this area consist of silty and sandy loams, with minor amounts of gravel. The soils tend to have low permeability and low shrink-swell potential. Four dominant soil associations are found at Indian Head (USDA SCS, 1974): (1) Beltsville-Gravelly Land-Bourne, (2) Beltsville-Exum-Wickham, (3) Evensboro-Keyport-Elkton, and (4) Bibb-Tidal Marsh-Swamp.

2.1.6 Hydrology

Major water bodies at IHDIV-NSWC include the Potomac River, Mattawoman Creek, and Chicamuxen Creek. The Potomac River flows almost 400 miles from its headwaters in the Allegheny Mountains of West Virginia. Near Indian Head, the Potomac broadens and becomes saltier from the increasing influence of the Chesapeake Bay. Mattawoman and Chicamuxen Creeks are tidal tributaries to the Potomac River.

The Potomac River bounds Cornwallis Neck to the north and northwest. Due to the topography of the peninsula, most of the surface water drainage on Cornwallis Neck flows into Mattawoman Creek, which forms its southeastern boundary. The Stump Neck peninsula is bounded by Mattawoman Creek to the north, the Potomac River to the northwest, and partially by Chicamuxen Creek to the southeast.

2.1.7 Geology

The facility lies in the Atlantic Coastal Plain physiographic province. The province consists of an eastward-thickening wedge of interbedded sand and clay units that range in age from Cretaceous to Quaternary (Vroblesky and Fleck, 1991).

According to the geologic map provided by Hiortdahl (1997), the site is immediately underlain by the Upper Lowland Deposits approximately 100 feet thick. They are of fluvial and estuarine origin of the early Potomac River system. They generally consist of medium- to coarse-grained sand and gravel grading upward to silt and clay.

Vroblesky and Fleck (1991) reported that the Patapsco Formation immediately underlies the Quaternary deposits in the vicinity of the site. The Patapsco is characterized by layers of fine- to medium-grained sand and silt separated by thick layers of clay.

The Patapsco is immediately underlain by the tough, massive clay of the Arundel Formation, which is then underlain by the medium- to coarse-grained sand of the Patuxent Formation. The Patuxent is subsequently underlain by gneissic, schistose, and gabbroic bedrock.

2.1.8 Hydrogeology

IHDIV-NSWC is underlain by a surficial or water table aquifer. The water table aquifer is recharged by precipitation that infiltrates the ground surface. Hiortdahl (1990) states that, although there are numerous localized water-bearing systems within the Upper Lowland Deposits, these water-bearing units are not used as a potable water source by the facility or on the Indian Head Peninsula.

The facility is the largest user of groundwater in the area and withdraws an average of 1 to 2 million gallons per day. Most of the production wells are screened in the Patapsco Formation. Ten production wells are in use at the facility at present. Hiortdahl (1990) reported that pumping in the Potomac Group aquifers has produced a cone of depression in the potentiometric surface that extends approximately 6 miles in the northeast and southwest directions and 2 to 3 miles in the northwest and southeast directions.

2.1.9 Ecological Communities

IHDIV-NSWC comprises approximately 2,500 acres of terrestrial ecological communities on Cornwallis Neck and about 1,084 acres at Stump Neck. Terrestrial habitats in these areas are classified as forested uplands, open uplands, and terrestrial cultural uplands. The forests are heavily fragmented by buildings, roads, and other structures. Terrestrial cultural uplands consist of areas that have been created, maintained, or modified by human activities. These areas are characterized as either mowed grass/landscaped areas, wildlife food plots, or successional fields and roadsides.

National Wetlands Inventory (NWI) maps identify approximately 290 acres of wetlands on IHDIV-NSWC. Of this acreage, tidal estuarine systems comprise 234 acres, forested wetlands comprise 42 acres, emergent marshes and shrub swamps comprise 5.5 acres, and lacustrine systems comprise the remaining acreage. There are also approximately 17 miles of riverine systems in this area.

The diverse ecological communities at Indian Head support many wildlife species. The Integrated Natural Resources Management Plan for IHDIV-NSWC provides list of fauna inhabiting the base (Parsons, 2000).

The Maryland Natural Heritage Program conducted a survey of rare, threatened, and endangered species in 1991–1992. Of the identified species, the bald eagle (*Haliaeetus leucocephalus*) is the only known federally listed threatened species identified on IHDIV-NSWC (MDNR, 1992). The remainder of the species listed includes five state-listed endangered plants, two state-listed threatened plants, one state-listed endangered invertebrate, and 18 species of regional concern. Three additional rare tree species were identified during the 1995 Urban Tree Inventory.

The 1991–1992 survey also identified 10 areas of ecological significance at Indian Head (totaling 614 acres) that have the potential to support the long-term protection of the rare, threatened, and endangered species (MDNR, 1992).

2.2 Site 5 Description

2.2.1 General

Site 5 is the site of the Grain Manufacture and X-ray Building (Building 731), constructed in 1953. The X-ray section of this building houses an X-ray machine that uses water to cool the X-ray tube and to rinse the X-ray photos in the developing process. Approximately 4,000 X-ray sheets per month are processed in this facility (FCHA, 1983).

Prior to 1965, process waste waters, including fixer and developer, were discharged into open ditches located south of Building 731. A combined quantity of approximately 180,000 pounds of sodium thiosulfate (fixer) and hydroquinone (developer) containing 720 pounds of silver was estimated to have been discharged over the 12-year period in which untreated wastewater was discharged from the X-ray facility (FCHA, 1983).

The site covers about 6 acres of land behind Building 731. The site consists of two depressions emanating from the southeast (Swale 1) and southwest (Swale 2) corners of Building 731 (Figure 2-2). Soils in these swales were contaminated with silver-laden photographic processing wastewater released from Building 731 between 1953 and 1965. Photographic operations are still performed in Building 731; however, the spent fixer is now collected and the silver is recovered.

2.2.2 Topography

Topography at Site 5 is generally level (Figure 2-3). The primary features at the site (other than man-made berms) are Swale 1 and Swale 2. The highest elevations occur at the peaks of the berms that surround building 731. The lowest elevations occur at the confluence of Swales 1 and 2.

2.2.3 Geology

Three soil borings were advanced during the SSA to obtain geologic information and for the purpose of installing monitoring wells at Site 5. The borings were advanced to depths

ranging from 15 feet below ground surface (bgs) to 17 feet bgs. Boring logs and monitoring well construction diagrams are presented in Appendix A.

According to the boring logs generated for Site 5, the shallow subsurface is characterized by a fine brown sand. In two of the borings, a light brown and gray clay lens was encountered between 10 and 12 feet bgs.

2.2.4 Hydrogeology

On August 21, 2001, the water table was encountered at the site at elevations ranging from 12.48 feet above mean sea level (msl) at IS42MW02, located downgradient of Site 5, to 26.18 feet above msl at IS05MW01, located upgradient of Site 5 (Figure 2-4). Note that a groundwater surface map with data from the 2002 sampling event is not presented since the groundwater elevations in wells IS05MW01 through IS05MW03 were measured 29 days after the groundwater elevations were measured in wells IS42MW02 and IS42MW07.

Groundwater flow is generally from northeast to southwest. Based on the site topography and the water table elevations recorded at the site, groundwater likely discharges in the southern portion of Swale 2.

No tests were performed to estimate the hydraulic conductivity of the natural subsurface materials. However, Domenico and Schwartz (1998) provide a range of hydraulic conductivities for fine- and medium-grained sand from about 0.05 feet per day (ft/day) to about 140 ft/day.

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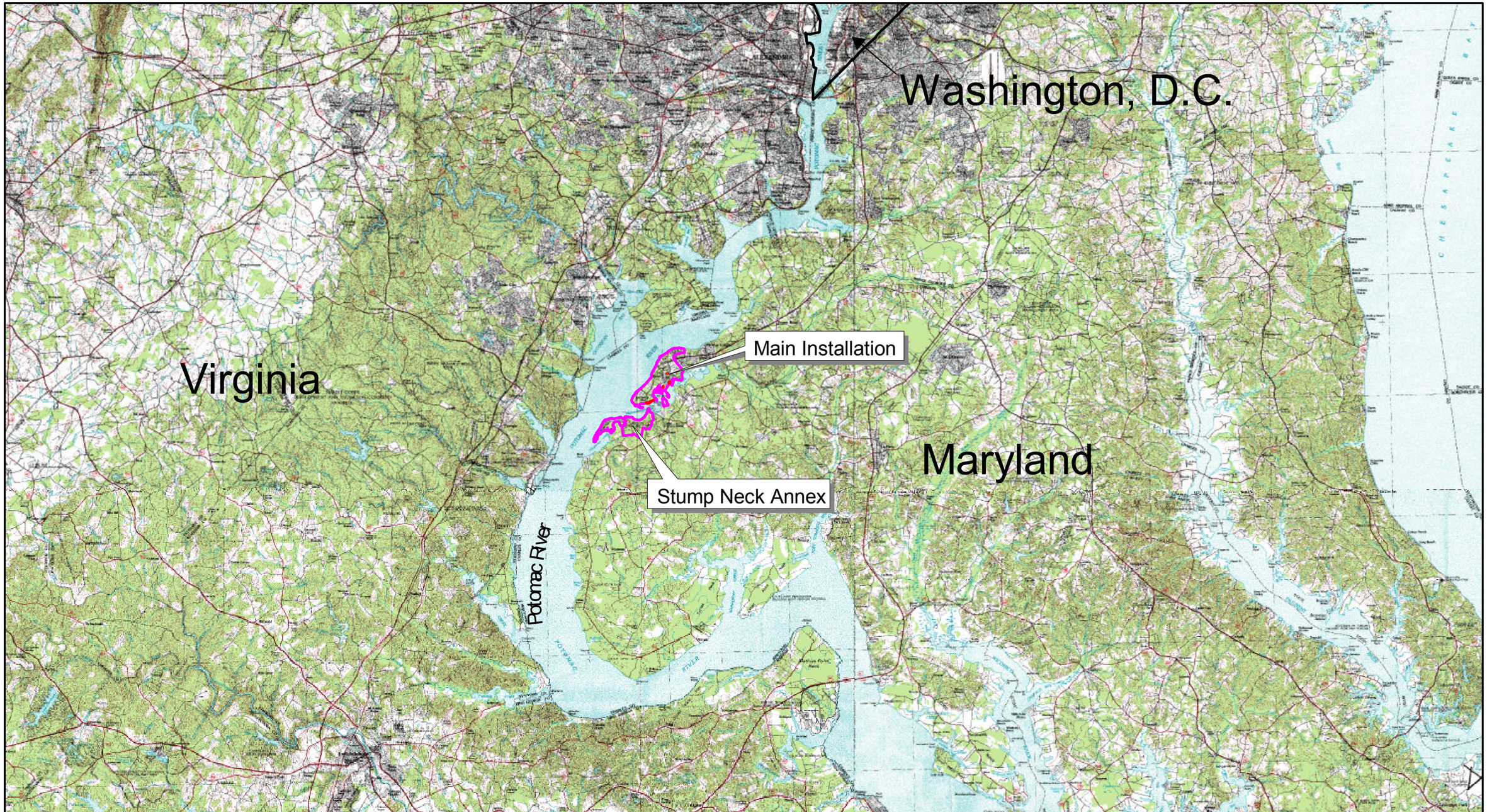

LEGEND

- Site Boundary
- District of Columbia
- Water Body

N

30000 0 30000 60000 Feet

Figure 2-1
Facility Location Map
Site 5 SSA
IHDIV-NSWC
Indian Head, Maryland

CH2MHILL

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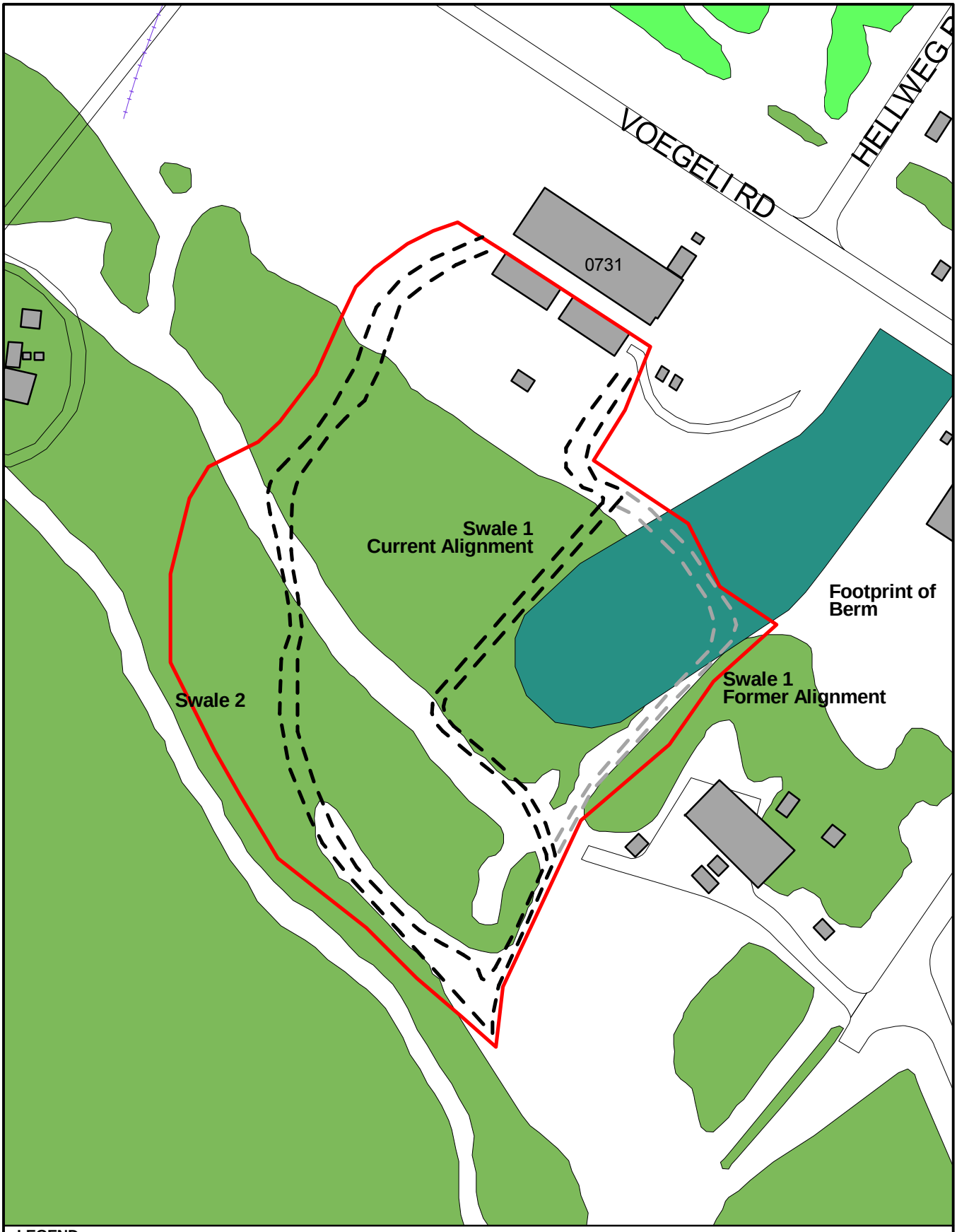

LEGEND
- Buildings
- Roads
- Vegetation
- Vegetation
- Site Boundary
- Railroads
- Swale

N

50 0 50 100 Feet

Figure 2-2
Site Map
Site 5 SSA
IHDIV-NSWC
Indian Head, Maryland

CH2MHILL

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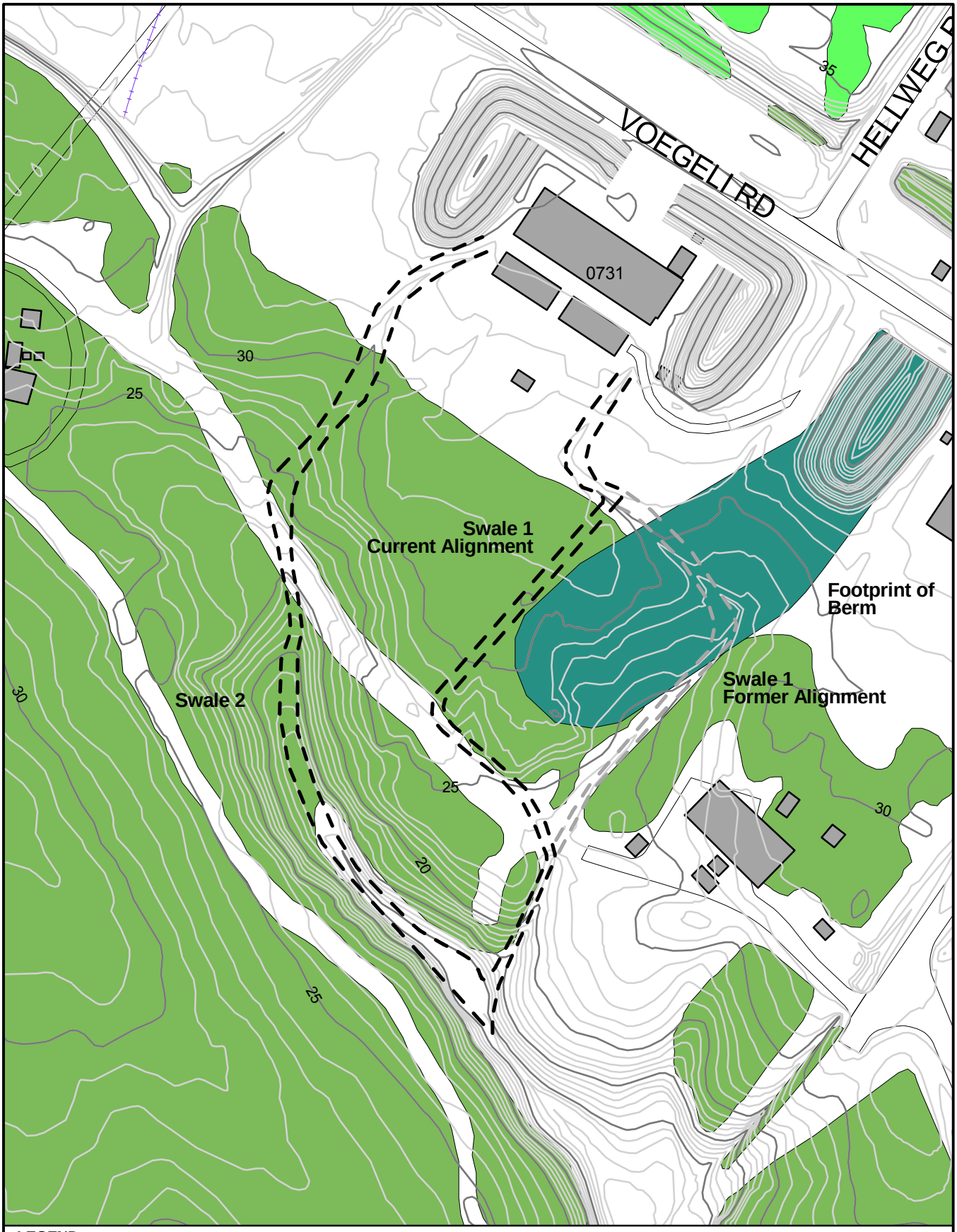


LEGEND

- Buildings
- Roads
- Vegetation
- Vegetation
- Railroads
- Swale
- Index Contours (5 feet Intervals)
- Contours (1 foot Intervals)

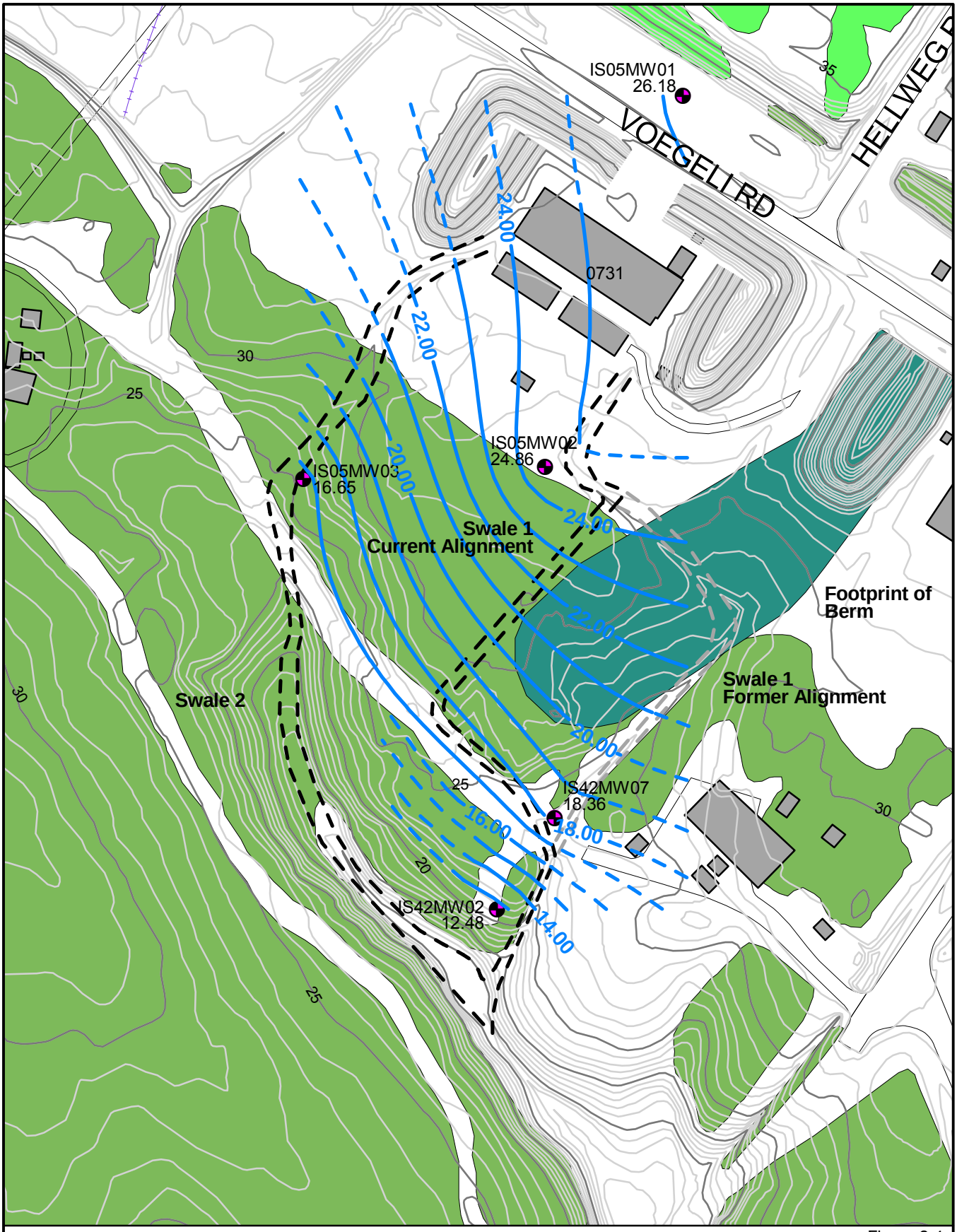
N

50 0 50 100 Feet

Figure 2-3
Topographic Map
Site 5 SSA
IHDIV-NSWC
Indian Head, Maryland

CH2MHILL

File Path: v:\18gis\indianhead\figures\site5.apr



LEGEND

- Monitoring Well Locations
- Buildings
- Roads
- Vegetation
- Vegetation
- Potentiometric Surface Contour
- Inferred Potentiometric Surface Contour
- Railroads
- Swale
- Index Contours (5 feet Intervals)
- Contours (1 foot Intervals)

N

50 0 50 100 Feet

Figure 2-4
Groundwater Surface Map
August 21, 2001
Site 5 SSA
IHDIV-NSWC
Indian Head, Maryland

CH2MHILL

SECTION 3

Field Activities

The field investigation was performed in two rounds. The first phase occurred during summer 2001. Because some data collected during the first round were rejected, a second round of sampling was undertaken in January and February 2002.

This section describes the scope and rationale for the field activities that were conducted during the SSA at Site 5. The field activities, performed between August 6 and 8, 2001, included monitoring well installation and development. The field activities performed August 20 and 21, 2001, and February 21, 2002, included groundwater, surface water, and sediment sampling.

3.1 Monitoring Well Installation

Three shallow groundwater monitoring wells (IS05MW01, IS05MW02, and IS05MW03) were installed at the locations shown in Figure 3-1. Monitoring well IS05MW01 was installed in an area hydraulically upgradient of Site 5. The remaining two wells were installed within the boundaries of Site 5.

Drilling was performed using a truck mounted drill-rig employing 4.25-inch inside-diameter (ID) hollow-stem augers. During drilling, split-spoon samples were collected at 5-foot intervals. Monitoring wells were constructed of flush-threaded, 2-inch ID, Schedule 40, polyvinyl chloride (PVC) riser and 2-inch ID, Schedule 40 PVC, machine-slotted screen, 10 feet in length. The annular space was back-filled with filter sand to a depth approximately 2 feet above the top of the screen. A 2-foot bentonite seal was installed on top of the sand. The remainder of the annular space was back-filled with a cement/bentonite slurry using a tremie pipe. The wells were completed with concrete pads and steel, stick-up protective casings. Monitoring well construction details are presented in Table 3-1. Boring logs and well construction diagrams are presented in Appendix A

Each monitoring well was developed using a combination of pumping and surging with a variable flow rate submersible pump and surge block. The development water was monitored for water quality parameters including pH, specific conductivity, temperature, turbidity, and dissolved oxygen (DO). The well was considered developed when water quality parameters were stabilized over three successive readings spaced approximately five minutes apart. The final stabilized water quality parameters for monitoring wells IS05MW01 through IS05MW03 are presented in Table 3-2.

Investigation-derived waste (IDW) generated during the monitoring well installation activity consisted of soil cuttings, decontamination rinsate, and groundwater generated during monitoring well development and sampling activities. IDW was placed into 55-gallon drums, labeled, and staged on-site.

The newly installed monitoring wells were vertically surveyed for ground surface and top of casing (riser) elevations. The wells were also located horizontally with a global position

system (GPS) unit. A summary of well elevations and horizontal coordinates are presented in Table 3-3. The survey report is provided in Appendix B.

3.2 Monitoring Well Sampling and Water Level Survey

Five groundwater samples were collected from three wells at Site 5(IS05MW01 through IS05MW03) and two wells at Site 42 (IS42MW02 and IS42MW07) on August 21, 2001 (Figure 3-1). Additionally, one duplicate sample (IS05MW060801) was collected from well IS05MW02. It should be noted that the Site 42 monitoring wells have a slightly different naming convention than that used above; however, for consistency, they are referred to in a similar fashion as those installed during the Site 5 SSA.

During follow-up sampling, two additional groundwater samples were collected from the Site 42 wells (IS42MW02 and IS42MW07) on January 23, 2002, and three additional groundwater samples were collected from the Site 5 wells (IS05MW01 through IS05MW03) on February 21, 2002. Additionally, one duplicate sample (IS05MW020202P) was collected from well IS05MW02. Note that Tetra Tech NUS performed the sampling of the Site 42 wells on January 23, 2002; CH2M HILL performed the sampling of the Site 5 wells on February 21, 2002. Prior to any groundwater sampling, depth to groundwater was recorded at each well (Table 3-3); data for wells on site 42 (IS42MW02 and IS42MW07) were provided by Tetra Tech NUS. The monitoring wells were purged and samples collected using a submersible pump and a low-flow sampling procedure. Water quality parameters (pH, specific conductivity, temperature, turbidity, and dissolved oxygen) were collected during the purging process. Purging continued until the water quality parameters stabilized. The final stabilized water quality parameters for each well are presented in Table 3-4. It should be noted that the pH values are outside of the typical range of natural waters; however, these low levels of pH were seen during both rounds of groundwater sampling. Groundwater samples were analyzed for total and dissolved Target Analyte List (TAL) inorganics, Target Compound List (TCL) volatile organic compounds (VOCs), TCL semivolatile organic compounds (SVOCs), dissolved total organic carbon (TOC), pH, and hardness (Table 3-5). TAL dissolved metals and dissolved TOC samples were filtered in the field using an in-line filter.

Groundwater samples were placed in clean glass and high-density polyethylene (HDPE) containers provided by the laboratory and preserved according to Navy protocol. Samples were then submitted to the contracted laboratory and analyzed within proper holding times.

Field quality assurance (QA)/quality control (QC) samples, including a field blank, equipment blank, trip blank, and duplicate, were analyzed in addition to laboratory QA/QC samples, including a matrix spike/matrix spike duplicate (MS/MSD) sample in accordance with the Navy guidance.

The submersible pump was decontaminated between well locations using a phosphate-free detergent wash, followed by a 10-percent methanol wash, followed by a tap-water rinse, and a final rinse with deionized (DI) water. An equipment blank was collected to verify decontamination procedures were effective in preventing cross contamination between well locations.

It should be noted that many of the field parameters varied greatly between to the two sampling events, as seen in Tables 3-2 and 3-4. The differences in groundwater parameters are likely due to changes in field conditions, as over 6 months time had elapsed between groundwater well development and sampling. Additionally, active surging during well development could have greatly increased the DO, which then apparently did not return to ambient conditions during the time of development but did before sampling.

With regard to the turbidity, a bad meter likely explains the >999 NTU readings. This conclusion is supported by the fact that the higher-turbidity samples (from IS05MW02 and IS05MW03) do not have particularly higher metals concentrations than those from IS05MW01 (with the exception of iron). The other high turbidity reading (700 NTU) was measured by Tetra Tech from an existing well (IS42MW07).

3.3 Surface Water Sampling

Three surface water samples were collected from locations IS05SW01 through IS05SW03 in Swale 2 on August 20, 2001 (Figure 3-1). On February 21, 2002, three surface water samples were collected from locations IS05SW03 through IS05SW05 in Swale 2. Only one sampling location (IS05SW03/IS05SD03) was common to the two sampling events as shown in Figure 3-1.

Samples collected in 2001 were analyzed for total and dissolved silver, total organic carbon, pH, and hardness (Table 3-5). Additionally, field measurements of DO, pH, and specific conductivity were made. These field parameters are summarized in Table 3-6. Similar to the groundwater field parameters, the pH values measured in surface water are outside of the typical range of natural waters. During the 2001 and 2002 sampling rounds the pH varied greatly (e.g. IS05SW03 2001 pH 8.77, 2002 pH 5.77). During both events rinse water was inadvertently being released into the swale due to a blocked manhole. Variability in the characteristics of this process water may account for the pH variations. Samples collected in 2002 were analyzed for total and dissolved TAL metals, TOC, and hardness. Additionally, field measurements of DO, pH, and specific conductivity were made. These field parameters are summarized in Table 3-6.

All surface water samples were placed in clean HDPE containers provided by the laboratory and preserved according to Navy protocol. Surface water samples were then submitted to the contracted laboratory and analyzed within proper holding times.

The appropriate number of field QA/QC samples, including a field blank, equipment blank, and duplicate, were analyzed in addition to laboratory QA/QC samples, including a MS/MSD sample in accordance with the Navy guidance.

3.4 Sediment Sampling

Three sediment samples were collected from locations IS05SD01 through IS05SD03 in Swale 2 on August 20, 2001 (Figure 3-1). On February 21, 2002, three sediment samples were collected from locations IS05SD03 through IS05SD05 in Swale 2. Each sediment sample was taken after collection of the surface water sample with which it was co-located.

Each sample was collected from the top 6 inches at each location using a stainless steel trowel. Samples collected in 2001 were analyzed for total silver, total organic carbon, pH, and grain size (Table 3-5). Samples collected in 2002 were analyzed for total TAL metals and TOC. Grain size analysis was conducted only on the two sediment samples collected in new locations during the 2002 sampling effort since the third location at the confluence of the two swales was analyzed for grain size in 2001.

All sediment samples were placed in clean glass containers provided by the laboratory and preserved according to Navy protocol. Sediment samples were then submitted to the contracted laboratory and analyzed within proper holding times.

The appropriate number of field QA/QC samples, including a field blank, equipment blank, and duplicate, were analyzed in addition to laboratory QA/QC samples, including a MS/MSD sample in accordance with the Navy guidance.

Table 3-1
Monitoring Well Construction Details
Site 5 SSA
IHDIV-NSWC
Indian Head, Maryland

Monitoring Well	Elevation at Top of Casing (feet above MSL)	Elevation at Ground Surface (feet above MSL)	Bottom of Screen (feet bgs)		Top of Screen (feet bgs)	
			Depth	Elevation	Depth	Elevation
IS05MW01	37.53	34.5	15	19.5	5	29.5
IS05MW02	34.46	31.6	16	15.6	6	25.6
IS05MW03	28.46	26.6	17	9.6	7	19.6
IS42MW02	23.56	21.5	26	-4.5	16	5.5
IS42MW07	27.38	25.6	18	7.6	8	17.6

MSL = mean sea level
bgs = below ground surface

Table 3-2
Stabilized Field Parameters During Monitoring Well Development
Site 5 SSA
IHDIV-NSWC
Indian Head, Maryland

Well	pH	Specific Conductance (µS/cm)	Turbidity (NTU)	Dissolved Oxygen (mg/L)	Temperature (^{o}C)
IS05MW01	4.55	45.8	76	12.17	18.7
IS05MW02	5.08	14.3	103	14.09	17.1
IS05MW03	5.26	9.3	74	13.21	15.2

µS/cm = microsiemens per centimeter
NTU = nephelometric turbidity units
mg/l = milligrams per liter
^{o}C = degrees celsius

Table 3-3
Site 5 Monitoring Well Elevations, Coordinates, and Water Level Measurements
2001 & 2002 Sampling Events
Site 5 SSA
IHDIV-NSWC
Indian Head, Maryland

Well	Coordinate		TPVC Elevation	2001 Sampling Event [1]		2002 Sampling Event [2]	
	Longitude	Latitude		Depth to Groundwater (feet)	Groundwater Elevation (feet above MSL)	Depth to Groundwater (feet)	Groundwater Elevation (feet above MSL)
IS05MW01	-77.20107269	38.57113065	37.53	11.35	26.18	12.30	25.23
IS05MW02	-77.20154341	38.57012989	34.46	9.60	24.86	10.91	23.55
IS05MW03	-77.20237374	38.57009628	28.46	11.81	16.65	12.85	15.61
IS42MW02	-77.20170511	38.5689352	23.56	11.08	12.48	11.62	11.94
IS42MW07	-77.20150724	38.56918303	27.38	9.02	18.36	12.32	15.06

[1] Depth to groundwater was measured by CH2M HILL on August 21, 2001.
[2] Depth to groundwater in wells IS42MW02 and IS42MW07 was measured by Tetra Tech NUS on January 23, 2002. Depth to groundwater in wells IS05MW01 through IS05MW03 was measured by CH2M HILL on February 21, 2002.

TPVC = Top of PVC Riser
MSL = mean sea level

Table 3-4
Stabilized Field Parameters for Groundwater Sampling
2002 Sampling Event
Site 5 SSA
IHDIV-NSWC
Indian Head, Maryland

Well	Sample ID	pH	Specific Conductance (µS/cm)	Turbidity (NTU)	Dissolved Oxygen (mg/L)	Temperature (^oC)	Oxidation Reduction Potential (mV)
IS05MW01[1]	IS05MW010202	4.19	320	215	4.77	15.08	198
IS05MW02 [1]	IS05MW020202	4.03	101	>999	4.23	14.16	227
IS05MW03 [1]	IS05MW030202	3.97	660	>999	0.00	11.72	243
IS42MW02 [2]	IS42MW002002	5.63	341	5	1.06	14.1	48
IS42MW07 [2]	IS42MW007002	5.70	147	700	3.11	13.1	221

[1] Field parameters in groundwater were measured in wells IS05MW01 through IS05MW03 on February 21, 2002 by CH2M HILL.
[2] Field parameters in groundwater were measured in wells IS42MW02 and IS42MW07 on January 23, 2002 by TetraTech.

µS/cm = microsiemens per centimeter
NTU = nephelometric turbidity units
mg/l = milligrams per liter
^oC = degrees celsius
mV = millivolts

Table 3-5
Samples Collected and Parameters Analyzed
2001 & 2002 Sampling Events
Site 5 SSA
IHDIV-NSWC
Indian Head, Maryland

Station ID	Sample ID	pH (SW 846 9045C)	Hardness (130.2)	Silver (SW 846 6010B)	Dissolved Silver (SW 846 6010B)	TOC (415.1)	Dissolved TOC (415.1)	Grainsize (ASTM D422)	TCL VOCs (OLM03)	TCL SVOCs OLM03)	TAL metals (ILM03/ILM04)	TAL Filterd Metals (ILM04)
2001 Sampling Event												
Groundwater Sampling												
IS05MW01	IS05MW010801	X	X			X	X		X	X	X	X
IS05MW02	IS05MW020801	X	X			X	X		X	X	X	X
IS05MW03	IS05MW030801	X	X			X	X		X	X	X	X
IS42MW02	IS05MW040801	X	X			X	X		X	X	X	X
IS42MW07	IS05MW050801	X	X			X	X		X	X	X	X
Sediment Sampling												
IS05SD01	IS05SD01	X		X		X		X				
IS05SD02	IS05SD02	X		X		X		X				
IS05SD03	IS05SD03	X		X		X		X				
Surface Water Sampling												
IS05SW01	IS05SW01	X	X	X	X	X						
IS05SW02	IS05SW02	X	X	X	X	X						
IS05SW03	IS05SW03	X	X	X	X	X						
2002 Sampling Event												
Groundwater Sampling												
IS05MW01	IS05MW010202										X	X
IS05MW02	IS05MW020202										X	X
IS05MW03	IS05MW030202										X	X
Sediment Sampling												
IS05SD03	IS05SD030202					X					X	
IS05SD04	IS05SD010202					X		X			X	
IS05SD05	IS05SD020202					X		X			X	
Surface Water Sampling												
IS05SW03	IS05SW030202		X			X					X	X
IS05SW04	IS05SW010202		X			X					X	X
IS05SW05	IS05SW020202		X			X					X	X

Table 3-6
Field Parameters for Surface Water
2001 & 2002 Sampling Events
Site 5 SSA
IHDIV-NSWC
Indian Head, Maryland

Surface Water Sampling Location	Sample Identification	pH	Specific Conductance (µS/cm)	Dissolved Oxygen (mg/L)
2001 Sampling Event				
IS05SW01	IS05SW01	8.71	516	0.26
IS05SW02	IS05SW02	9.31	662	0.25
IS05SW03	IS05SW03	8.77	412	8.60
2002 Sampling Event				
IS05SW03	IS05SW030202	5.77	265	0.00 [2]
IS05SW04	IS05SW040202	5.38	229	0.00 [2]
IS05SW05	IS05SW050202	5.32	103	9.76

[1] Locations IS05SW01 and IS05SW02 changed in 2002, but IS05SW03 remained the same.
[2] DO readings of zero likely due to meter errors. The instrument was recalibrated repeatedly. These readings were taken on the last day of sampling, so another meter could not be brought to the site in time. DO data is used to provide insight into conditions in the groundwater or surface water at the site. These measurements are generally qualitative, and lacking this data does not affect the results of the SSA.

µS/cm = microsiemens per centimeter
mg/l = milligrams per liter

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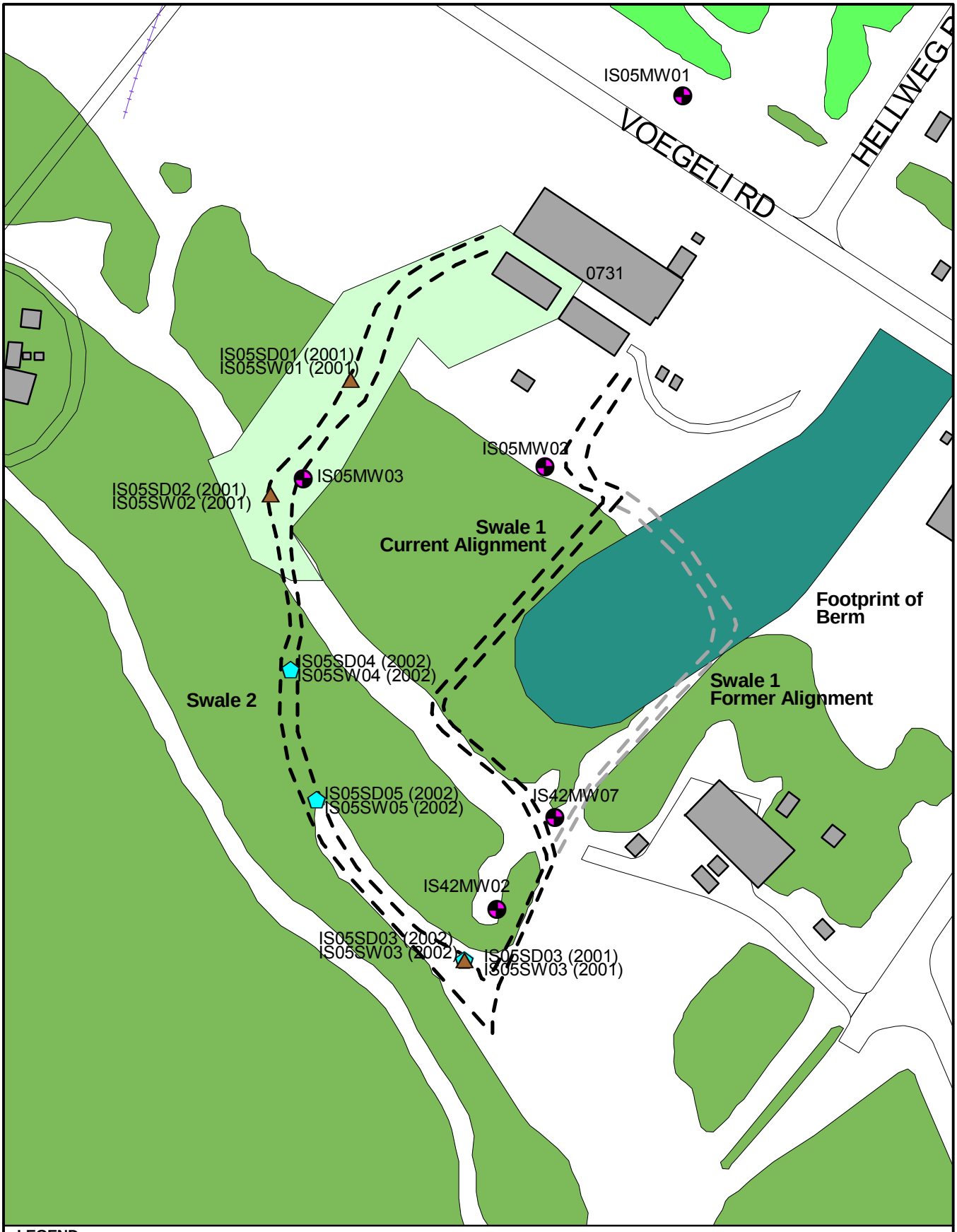

LEGEND

- Monitoring Well Locations
- Sediment and Surface Water Sample Locations (2002)
- Sediment and Surface Water Sample Locations (2001)
- Vegetation
- Vegetation
- Approximate Limit of Excavated Area (1994)
- Buildings
- Roads
- Railroads
- Swale

N

50 0 50 100 Feet

Figure 3-1
Monitoring Well, Sediment, and Surface Water Sample Locations
Site 5 SSA
IHDIV-NSWC
Indian Head, Maryland

CH2MHILL

SECTION 4

Analytical Results

This section discusses the analytical results of samples collected from groundwater, surface water, and sediment at Site 5. It should be noted that where specific concentrations are reported in the discussion below, if a sample has a duplicate, the higher of the two detections is reported.

4.1 Groundwater

Analytical results from the 2001 and the 2002 groundwater sampling activities are presented in the attached tables. A third party data validator rejected some analytical results from the 2001 groundwater sampling. Inorganic data (dissolved iron, manganese, sodium, and zinc) for some samples were rejected due to comparable or high detects in the associated filtered equipment blank. The unfiltered blank had no contamination, so the problem was most likely caused by contamination in the disposable filter, or misuse of the filter. The results for 2-butanone were also rejected in some samples due to low response in the initial calibration. This is a common occurrence when extracting 2-butanone from groundwater by purging with an inert gas (typically helium) as 2-butanone is semi-soluble in water and therefore not readily extracted from groundwater.

4.1.1 August 2001 Groundwater Data

Organic analytical results for the 5 groundwater samples taken in August of 2001, IS05MW01, IS05MW02, IS05MW03, IS42MW02, and IS42MW07, are provided in Table 4-1 and Appendix C.

Three VOCs, 1,1,1-trichloroethane, 1,1-dichloroethane, and tetrachloroethylene, were detected in IS42MW07 at concentrations of 2.1 μg/L, 4.3 μg/L, and 1 μg/L, respectively. No other VOCs were detected in groundwater (Figure 4-6).

4.1.2 February 2002 Groundwater Data

Analytical results (Table 4-2 and Appendix C) for the five groundwater samples taken in February of 2002, IS05MW010202, IS05MW020202, IS05MW030202, IS42MW0202, and IS42MW0702, (Table 4-2 and Appendix C) indicated the presence of several metals in one or more of the unfiltered samples. Although no clear pattern was discernible for all metals, a general trend was observed for some analytes, such as calcium, cobalt, magnesium, sodium, and zinc. These metals have the highest concentration in well IS05MW01 (the upgradient well), the second highest concentration in well IS05MW02, and the third highest concentration in well IS05MW03, while the concentrations of these metals were at least an order of magnitude less in the downgradient wells at Site 42 (IS42MW02 and IS42MW07). The results for arsenic, chromium, lead, and silver are shown in Figure 4-1 because of their frequency of detection, potential source at the site (silver), and/or their general contribution to risk. As illustrated on Figure 4-1, arsenic was only detected in the downgradient well, IS42MW07, at a concentration of 2 micrograms per liter (μg/L). Chromium and lead were

detected in the following wells, in order from highest to lowest concentrations: IS05MW02, IS05MW03, IS05MW01, and IS42MW07. None of these metals was detected in well IS42MW02 (Figure 4-1). Silver was not detected in any of the unfiltered groundwater samples.

Analytical results (Table 4-2 and Appendix C) of the five groundwater samples indicated the presence of several dissolved metals in one or more of the filtered groundwater samples. Although no clear pattern was discernible for all dissolved metals, a general trend was observed for some of the analytes, such as barium, calcium, cobalt, lead, magnesium, manganese, nickel, potassium, sodium, and zinc. These dissolved metals have the highest concentration in well IS05MW01 (the upgradient well), the second highest concentration in well IS05MW02, and the third highest concentration in well IS05MW03, while the concentrations of these metals were at least an order of magnitude less (or not detected) in the downgradient wells at Site 42 (IS42MW02 and IS42MW07). The distributions of selected metals are shown on Figure 4-1. These include chromium, iron, and nickel. Silver also is included because it is the metal of most interest at the site. As illustrated in Figure 4-1, chromium was only detected in wells IS05MW01 (the upgradient well) and IS42MW07 (a downgradient well), at concentrations of 60.1 μg/L and 0.5 μg/L, respectively. Iron and nickel show a spatial trend in concentration with elevated concentrations in well IS05MW01 (upgradient well) and low concentrations in well IS42MW07. Note that equivalent concentrations of iron (12 μg/L) and equivalent concentrations of nickel (0.4 μg/L) were detected in the downgradient wells, IS42MW02 and IS42MW07. Silver was not detected in any of the filtered groundwater samples.

Analytical results (Table 4-2 and Appendix C) of the five groundwater samples, indicate that no VOCs were detected in the Site 5 wells (IS05MW01 through IS05MW03). Trace amounts of chlorobenzene, ethyl ether, and cis-1,2-dichloroethene were detected in the downgradient well IS42MW02. Additionally, trace amounts of 1,1,1-trichloroethane, 1,1-dichloroethane, 1,1-dichloroethene, methylene chloride, and tetrachloroethylene were detected in downgradient well IS42MW07.

Analytical results (Table 4-2 and Appendix C) of the five groundwater samples, indicate that no SVOCs were detected in the Site 5 wells (IS05MW01 through IS05MW03). Trace amounts of bis(2-ethylhexyl)phthalate were detected in down gradient well IS42MW002.

4.2 Surface Water

Analytical results of the three surface water samples IS05SW040202, IS05SW050202, and IS05SW030202, collected on February 21, 2002 (Table 4-3 and Appendix C), indicate the presence of several metals in one or more of the samples. The analytical results of the 2002 surface water samples also indicate the presence of several dissolved metals in one or more of the filtered samples. These include barium, cadmium, calcium, cobalt, iron, magnesium, manganese, mercury, potassium, and sodium.

In general, the greatest number of maximum detected analyte concentrations were found in sample IS05SW030202. Sample IS05SW040202 had the second highest number of maximum detected analyte concentrations. Figure 4-3 shows the distribution of total and dissolved iron and manganese because of their frequency of detection and their general contributions

to risk. Silver is included as the metal of interest at the site; it was only detected in the unfiltered samples collected from IS05SW04, which has the closest proximity to the sampling location IS05SW02, from which an elevated concentration of silver was detected in surface water. In general, total silver concentrations decreased from upstream to downstream.

Some or all of the silver concentration detected in the surface water may be attributed to runoff from the manhole behind Building 731. The sanitary sewer line that the washwater effluent from the x-ray facility at Building 731 normally goes to was plugged with concrete in 1999. Silver-contaminated washwater backed up in the sanitary sewer and discharged from the manhole behind Building 0731. This effluent was analyzed and found to contain 2.1 ppm silver. This discharge almost certainly contributed to the silver found in the surface water. The manhole has been unplugged so washwater will no longer overflow into the ditch behind Building 731.

4.3 Sediment

Figure 4-4 shows the distribution of silver in sediment samples collected in 2001. Analytical results of the three sediment samples, IS05SD01, IS05SD02, and IS05SD03, (Table 4-4 and Appendix C) collected in 2001 indicate the presence of silver at concentrations of 0.73 mg/kg, 14.8 mg/kg (in the duplicate sample), and 0.51 mg/kg, respectively. Analytical results of the three sediment samples collected on February 21, 2002, IS05SD040202, IS05SD050202, and IS05SD030202, (Table 4-5 and Appendix C) indicate the presence of several metals in one or more of the samples. Figure 4-5 shows the distribution of silver in sediment samples collected in 2002. The overall spatial trend shows an increase in silver concentration from location IS05SD04 (3.2 mg/kg) to location IS05SD03 (15.8 mg/kg) at the confluence of Swales 1 and 2.

Table 4-1
Constituents Detected in Groundwater
2001 Sampling Event
Site 5 SSA
IHDIV-NSWC
Indian Head, Maryland

Station ID	IS05MW01		IS05MW02		IS05MW02		IS05MW03		IS42MW02		IS42MW07	
Sample ID	IS05MW010801		IS05MW020801		IS05MW060801		IS05MW030801		IS05MW040801		IS05MW050801	
Sample Date	08/21/01		08/21/01		08/21/01		08/21/01		08/21/01		08/21/01	
Chemical Name												
Volatile Organic Compounds (UG/L)												
1,1,1-Trichloroethane	10	U	10	U	10	R	10	U	10	U	2.1	J
1,1-Dichloroethane	10	U	10	U	10	R	10	U	10	U	4.3	J
Tetrachloroethene	10	U	10	U	10	R	10	U	10	U	1	J
Wet Chemistry (MG/L)												
Hardness	28		20		18		12		32		80	
Total organic carbon (TOC)	3.1		2.1		1.9		3.5		1.9		3.9	
pH	4.33		5.26		5.24		4.98		5.95		5.87	

J - Reported value is estimated
K - Reported value is biased high
L - Reported value is biased low

Table 4-2
Constituents Detected in Groundwater
2002 Sampling Event
Site 5 SSA
IHDIV-NSWC
Indian Head, Maryland

Station ID	IS05MW01	IS05MW02		IS05MW03	IS42MW02		IS42MW07	
Sample ID	IS05MW010202	IS05MW020202	IS05MW020202P	IS05MW030202	IS42MW002F002	IS42MW002U002	IS42MW007F002	IS42MW007U002
Sample Date	02/21/02	02/21/02	02/21/02	02/21/02	01/23/02	01/23/02	01/23/02	01/23/02
Chemical Name								
Volatile Organic Compounds (UG/L)								
1,1,1-Trichloroethane	NA	NA	NA	NA	NA	1 U	NA	1
1,1-Dichloroethane	NA	NA	NA	NA	NA	1 U	NA	1
1,1-Dichloroethene	NA	NA	NA	NA	NA	1 U	NA	1 J
Chlorobenzene	NA	NA	NA	NA	NA	1	NA	1 U
Ethyl ether	NA	NA	NA	NA	NA	1	NA	1 U
Methylene chloride	NA	NA	NA	NA	NA	2 U	NA	2
Tetrachloroethene	NA	NA	NA	NA	NA	1 U	NA	1 J
cis-1,2-Dichloroethene	NA	NA	NA	NA	NA	1	NA	1 U
Semi-volatile Organic Compounds (UG/L)								
bis(2-Ethylhexyl)phthalate	NA	NA	NA	NA	NA	5 J	NA	5 U
Total Metals (UG/L)								
Aluminum	893 B	9,210	9,800	5,720	NA	7 U	NA	7
Arsenic	5 U	5 U	5 U	5 U	NA	2 U	NA	2 K
Barium	211	99.9 J	104 J	107 J	NA	0.3	NA	0.3
Beryllium	1.7 J	1.1 J	1.1 J	0.72 J	NA	0.2 U	NA	0.2
Cadmium	0.41 J	0.49 B	0.51 B	0.54 B	NA	0.2 K	NA	0.2 K
Calcium	4,610 J	1,960 J	1,800 J	770 B	NA	67	NA	67
Chromium	27.7	34.6	102	54.5	NA	0.5 U	NA	0.5
Cobalt	58.3	23.9 J	24.9 J	16.2 B	NA	0.5	NA	0.5 K
Copper	8.7 U	11.9 B	13.3 B	9 J	NA	1 U	NA	1 K
Iron	1,430	12,200	12,600	13,200	NA	12	NA	12
Lead	8.6	10.9	15.7	9.2	NA	0.4 U	NA	0.4
Magnesium	4,640 J	2,360 J	2,540 J	2,480 J	NA	1	NA	1
Manganese	335	85.2	95.1	111	NA	1	NA	1
Mercury	0.09 U	0.12 J	0.15 J	0.16 J	NA	0.067 U	NA	0.068 U
Nickel	66.5	34.9 B	79.7	48 B	NA	0.4 J	NA	0.4 J
Potassium	1,140 J	2,040 J	2,140 J	1,470 J	NA	66 B	NA	66 K
Sodium	65,300	22,000	21,600	13,200	NA	116	NA	116
Thallium	2.4 U	2.4 U	2.4 U	2.4 U	NA	3 U	NA	3 K

Table 4-2
Constituents Detected in Groundwater
2002 Sampling Event
Site 5 SSA
IHDIV-NSWC
Indian Head, Maryland

Station ID	IS05MW01	IS05MW02		IS05MW03	IS42MW02		IS42MW07	
Sample ID	IS05MW010202	IS05MW020202	IS05MW020202P	IS05MW030202	IS42MW002F002	IS42MW002U002	IS42MW007F002	IS42MW007U002
Sample Date	02/21/02	02/21/02	02/21/02	02/21/02	01/23/02	01/23/02	01/23/02	01/23/02
Chemical Name								
Vanadium	4.5 U	21.2 J	22 J	11.2 J	NA	0.6 B	NA	0.6 K
Zinc	66.8	46.4	50.7	21.4	NA	2 B	NA	2
Dissolved Metals (UG/L)								
Aluminum	461 B	79.7 B	62 U	201	7 B	NA	7 B	NA
Antimony	2.4 J	1.8 U	1.8 U	1.8 U	2 U	NA	2 B	NA
Barium	235	211	24.9 B	39.4 B	0.3	NA	0.3 B	NA
Beryllium	1.8 J	1.8 J	0.48 U	0.48 U	0.2 U	NA	0.2 U	NA
Cadmium	0.38 B	0.35 U	0.35 U	0.35 U	0.2 K	NA	0.2 U	NA
Calcium	5,100	4,310 J	1,190 J	712 B	67	NA	67 B	NA
Chromium	60.1	6.4 U	6.4 U	6.4 U	0.5 U	NA	0.5 B	NA
Cobalt	62.9	57.9	13.8 J	11.4 J	0.5	NA	0.5 U	NA
Copper	15.2 J	8.7 U	8.7 U	8.7 U	1 U	NA	1 B	NA
Iron	1,310	469	69.4 B	182 B	12	NA	12 B	NA
Lead	10.6	7.8	1.8 U	1.8 U	0.4 U	NA	0.4 B	NA
Magnesium	5,120	4,710 J	1,080 J	1,670 J	1	NA	7.5 B	NA
Manganese	386	306	42.3	73.3	1 K	NA	1 B	NA
Mercury	0.09 U	0.09 U	0.09 U	0.11 J	0.067 U	NA	0.067 B	NA
Nickel	93.8	52.3	11.5 J	11.7 J	0.4 J	NA	0.4 B	NA
Potassium	1,200 J	1,050 J	301 J	273 J	66 B	NA	66 B	NA
Sodium	69,000	68,600	20,600	13,700	116	NA	116	NA
Zinc	79.5	61.7	7.1 U	7.1 U	2 B	NA	2 B	NA

NA - Not analyzed
B - Analyte not detected above associated blank
J - Reported value is estimated
K - Reported value may be biased high
U - Analyte not detected
shaded cells designate detections

Table 4-3
Constituents Detected in Surface Water
2002 Sampling Event
Site 5 SSA
IHDIV-NSWC
Indian Head, Maryland

Station ID	IS05SW03	IS05SW04	IS05SW05	
Sample ID	IS05SW030202	IS05SW040202	IS05SW050202	IS05SW050202P
Sample Date	02/21/02	02/21/02	02/21/02	02/21/02
Chemical Name				
Total Metals (UG/L)				
Aluminum	12,200	7,430	259 B	1,800
Barium	277	73.5 J	12.8 B	28.6 B
Beryllium	0.67 J	0.59 J	0.48 U	0.48 U
Cadmium	9.3	0.69 J	0.35 U	0.35 U
Calcium	17,500	5,860	8,830	9,550
Chromium	23.3	10.7	6.4 U	6.4 U
Cobalt	10.4 J	12.2 J	3.3 U	4.6 J
Copper	64.1	10.4 J	9.6 J	18.5 J
Iron	224,000	10,500	762	4,270
Lead	2.2 J	5.4	1.8 U	3.5
Magnesium	5,880	1,880 J	1,980 J	2,370 J
Manganese	1,160	755	164	587
Mercury	0.17 J	0.14 J	0.09 U	0.08 U
Nickel	20.3 J	11.5 J	7.3 U	7.3 U
Potassium	4,800 J	4,320 J	1,370 J	1,670 J
Silver	6.1 U	11.6	6.1 U	6.1 U
Sodium	44,300	64,700	16,100	16,800
Vanadium	34.7 J	18.1 J	4.5 U	4.8 J
Zinc	192	49.3	7.1 U	30.3
Dissolved Metals (UG/L)				
Barium	55.7 B	20.1 J	12.4 B	12 B
Cadmium	0.79 J	0.35 U	0.35 U	0.35 U
Calcium	15,400	5,280	9,320	8,950
Cobalt	3.3 U	5.2 J	3.3 U	3.3 U
Iron	25,700	1,350	303	432
Magnesium	4,250 J	1,340 J	2,110 J	1,940 J
Manganese	638	678	160	159
Mercury	0.09 U	0.09 J	0.08 U	0.11 J
Potassium	3,470 J	3,650 J	1,500 J	1,370 J
Sodium	36,600	63,900	17,000	16,300
Wet Chemistry (MG/L)				
Hardness	67.9	22.4	30.2	33.6
Total organic carbon (TOC)	7	17	9	5 U

B - Analyte not detected above associated blank
J - Reported value is estimated
U - Analyte not detected
shaded cells designate detections

Table 4-4
Constituents Detected in Sediment
2001 Sampling Event
Site 5 SSA
IHDIV-NSWC
Indian Head, Maryland

Station ID	IS05SD01	IS05SD02		IS05SD03
Sample ID	IS05SD01	IS05SD02	IS05SD04	IS05SD03
Sample Date	08/20/01	08/20/01	08/20/01	08/20/01
Chemical Name				
Total Metals (MG/KG)				
Silver	0.73 J	7.8	14.8	0.51 J
Wet Chemistry (MG/KG)				
Total organic carbon (TOC)	15,000	12,000	22,000	16,000
pH	6.95	6.77	7.11	6.88

J - Reported value is estimated
shaded cells designate detections

Table 4-5
Constituents Detected in Sediment
2002 Sampling Event
Site 5 SSA
IHDIV-NSWC
Indian Head, Maryland

Station ID	IS05SD03	IS05SD04	IS05SD05	
Sample ID	IS05SD030202	IS05SD040202	IS05SD050202	IS05SD050202P
Sample Date	02/21/02	02/21/02	02/21/02	02/21/02
Chemical Name				
Total Metals (MG/KG)				
Aluminum	11,200	2,710	2,120	2,410
Arsenic	4.8	2.1	2.7	3.6
Barium	94.3	17.7 J	12.9 J	16 J
Beryllium	0.77 J	0.42 J	0.36 J	0.47 J
Cadmium	3	0.5 J	0.47 B	0.54 B
Calcium	1,520 J	113 J	265 J	631 J
Chromium	21.1	12.5	12.7	14.8
Cobalt	14.8 J	6.8 J	4.1 J	5 J
Copper	43.7 J	3.2 J	5 J	6.4 J
Iron	30,000 J	7,090 J	8,960 J	10,600 J
Lead	23 K	4.1 K	3.9 K	5.7 K
Magnesium	1,270 J	1,060	949	1,520
Manganese	191 K	74.1 K	70.6 K	112 K
Mercury	0.23	0.04 J	0.05 J	0.12
Nickel	19.6 K	14.6 K	19.1 K	13.1 K
Potassium	834 J	198 J	171 J	186 J
Silver	15.8	3.2	4	2.5
Sodium	185 J	44.4 U	43.1 U	42.4 U
Vanadium	35.1	12.7	12.7	16
Zinc	150	15.7	13.8	20.1
Wet Chemistry (MG/KG)				
Total organic carbon (TOC)	12,200	2,000	1,600	1,600

B - Analyte not detected above associated blank
J - Reported value is estimated
K - Reported value may be biased high
U - Analyte not detected
shaded cells designate detections

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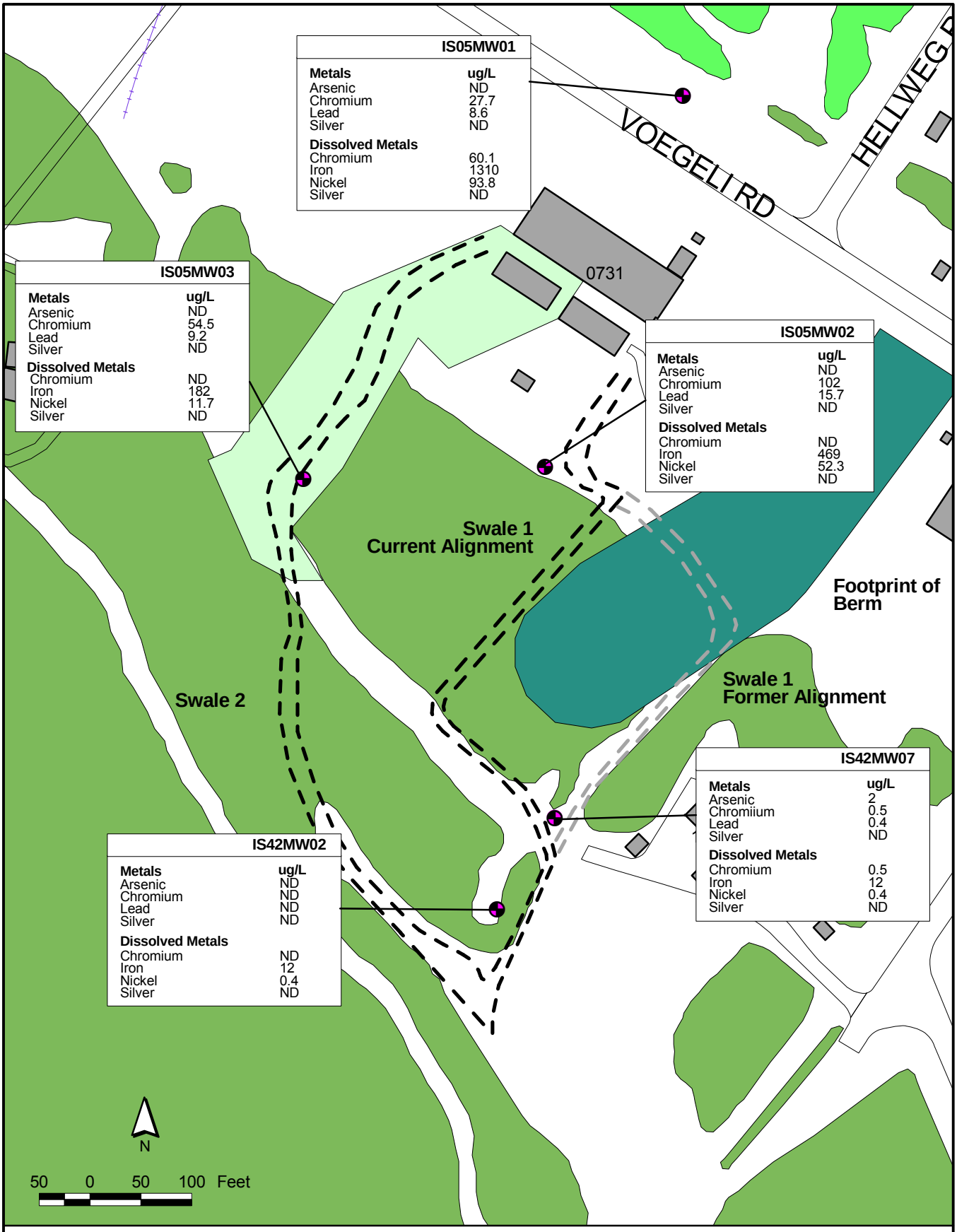


LEGEND

- Monitoring Well Locations
- Vegetation
- Vegetation
- Approximate Limit of Excavated Area (1994)
- Buildings
- Roads
- Railroads
- Swale

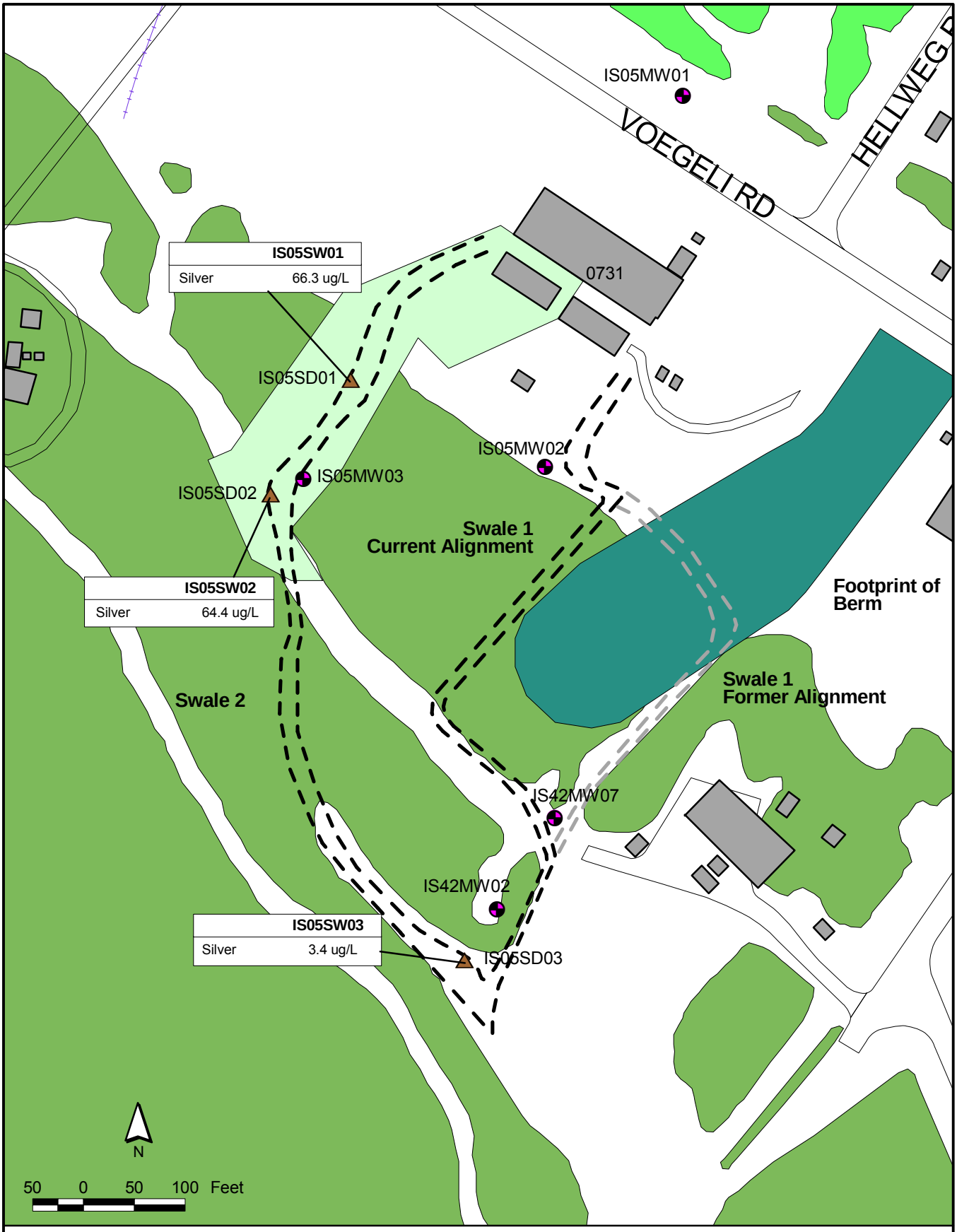
ug/L = Micrograms per Liter

ND = Not Detected

Figure 4-1
Selected Total Metals in Groundwater
2002 Sampling Event
Site 5 SSA
IHDIV-NSWC
Indian Head, Maryland

CH2MHILL

File Path: v:\18gis\indianhead\figures\site5.apr



LEGEND

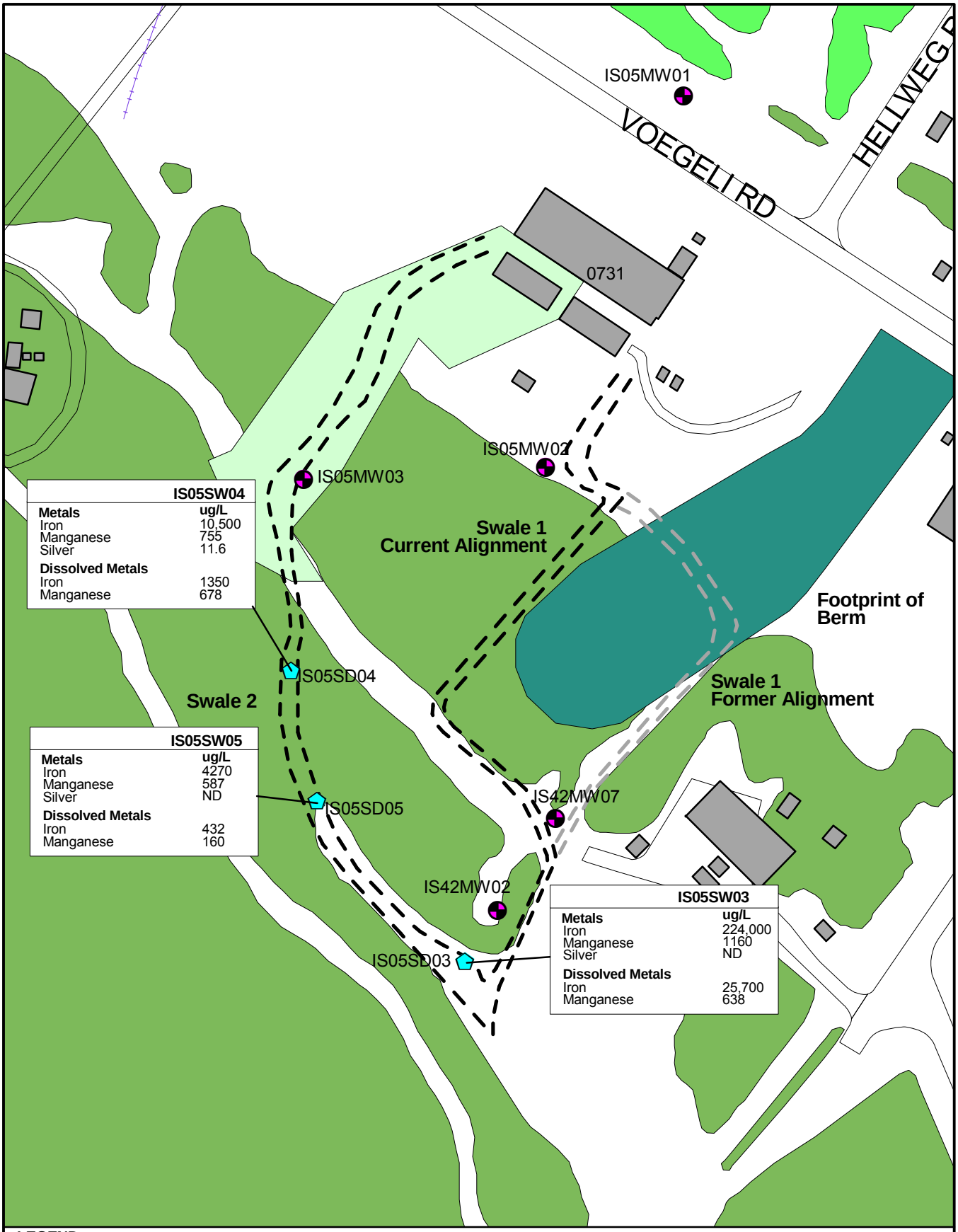
- Monitoring Well Locations
- Sediment and Surface Water Sample Locations
- Vegetation
- Vegetation
- Approximate Limit of Excavated Area (1994)
- Buildings
- Roads
- Railroads
- Swale

ug/L = Micrograms per Liter

Figure 4-2
Total Silver in Surface Water
2001 Sampling Event
Site 5 SSA
IHDIV-NSWC
Indian Head, Maryland

CH2MHILL

File Path: v:\18gis\indianhead\figures\site5.apr



LEGEND

- Monitoring Well Locations
- Sediment and Surface Water Sample Locations
- Vegetation
- Vegetation
- Approximate Limit of Excavated Area (1994)
- Buildings
- Roads
- Railroads
- Swale

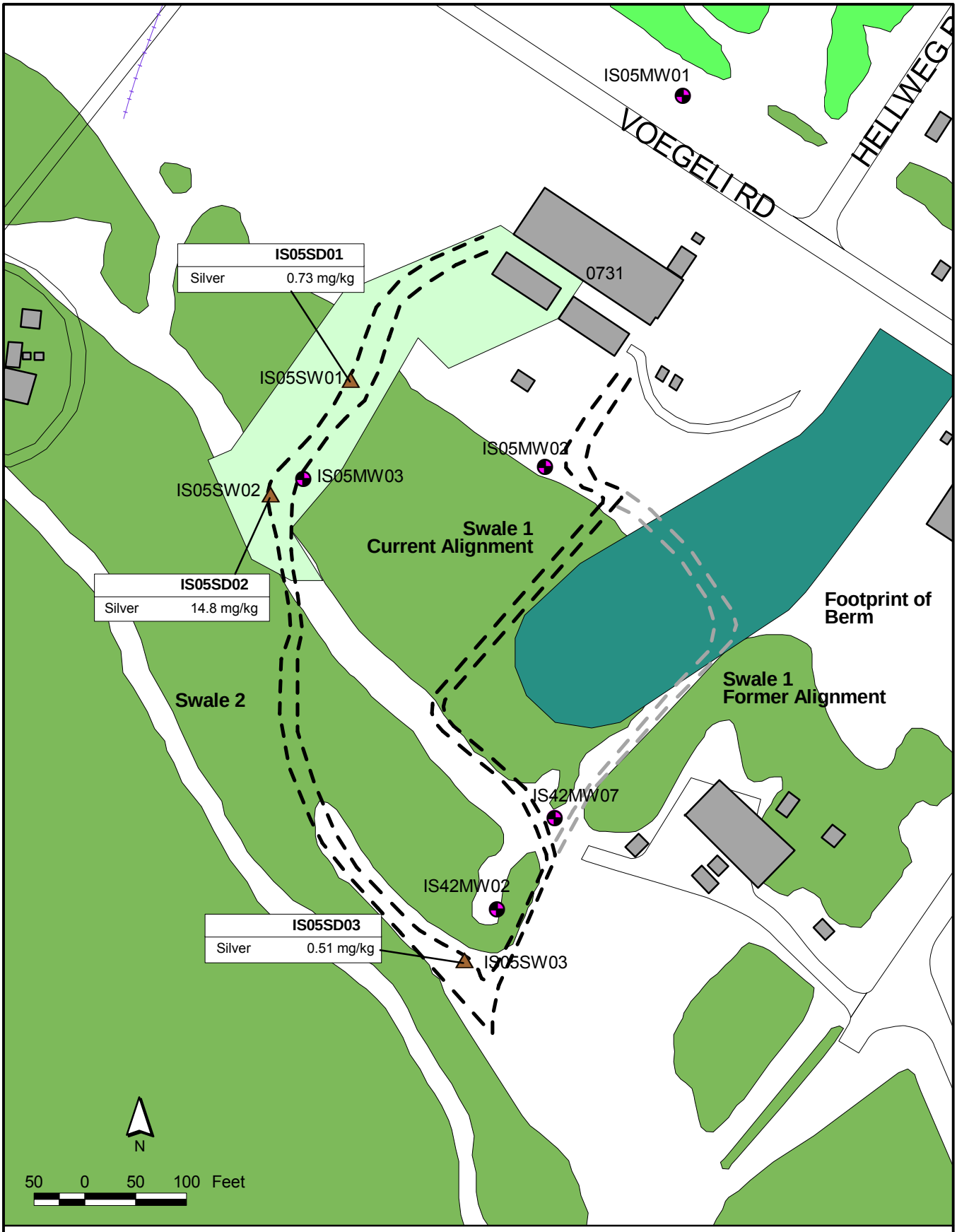
N

50 0 50 100 Feet

Figure 4-3
Selected Metals in Surface Water
2002 Sampling Event
Site 5 SSA
IHDIV-NSWC
Indian Head, Maryland

CH2MHILL

File Path: v:\18gis\indianhead\figures\site5.apr



LEGEND

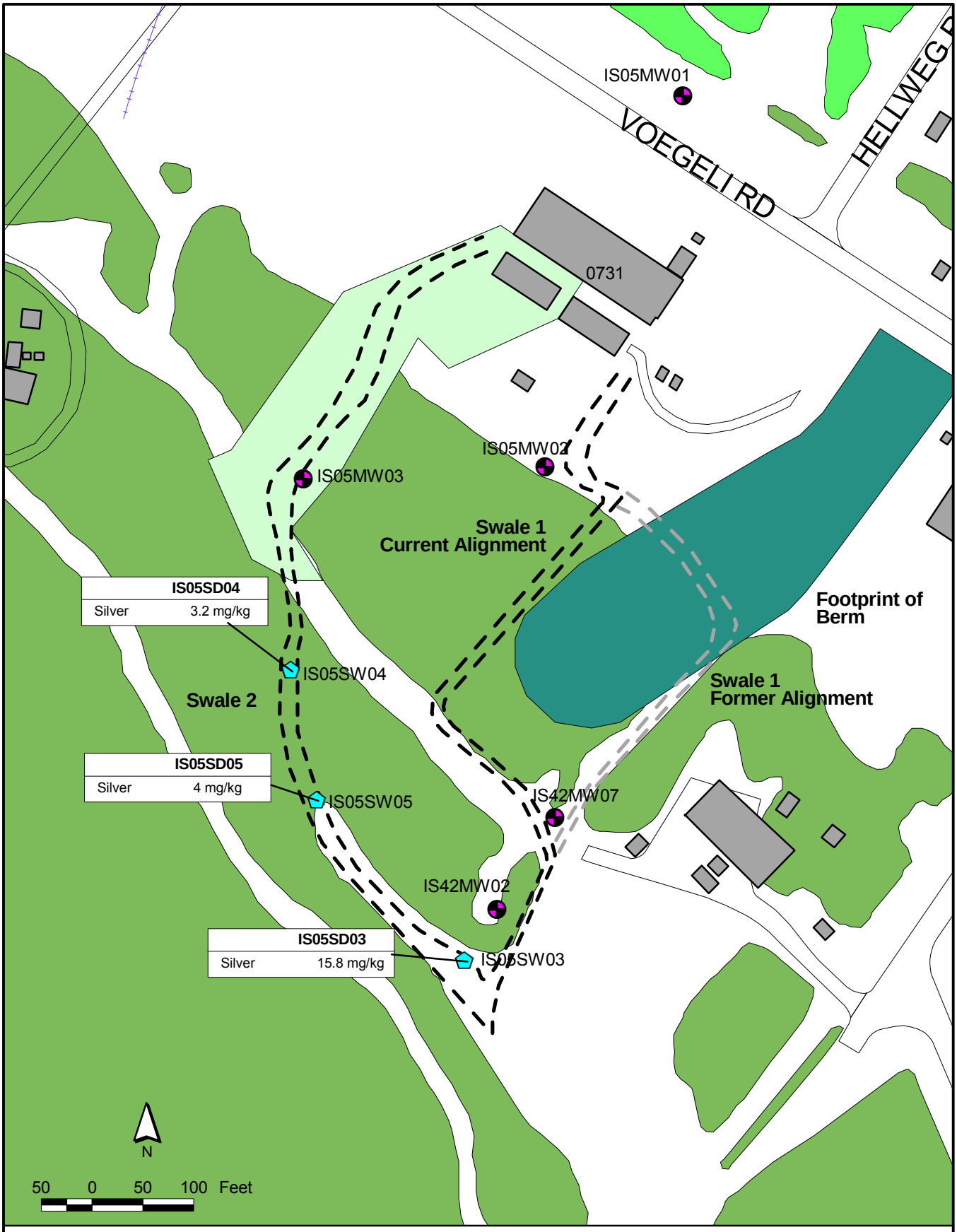
- Monitoring Well Locations
- Sediment and Surface Water Sample Locations
- Vegetation
- Vegetation
- Approximate Limit of Excavated Area (1994)
- Buildings
- Roads
- Railroads
- Swale

mg/kg = Milligrams per Kilogram

Figure 4-4
Silver in Sediment
2001 Sampling Event
Site 5 SSA
IHDIV-NSWC
Indian Head, Maryland

CH2MHILL

File Path: v:\18gis\indianhead\figures\site5.apr



LEGEND

- Monitoring Well Locations
- Sediment and Surface Water Sample Locations
- Vegetation
- Vegetation
- Approximate Limit of Excavated Area (1994)
- Buildings
- Roads
- Railroads
- Swale

mg/kg = Milligrams per Kilogram

Figure 4-5
Total Silver in Sediment
2002 Sampling Event
Site 5 SSA
IHDIV-NSWC
Indian Head, Maryland

CH2MHILL

SECTION 5

Risk Characterization

This section presents the methods and results of the human-health and ecological risk screenings.

5.1 Human Health Risk Screening

The analytical data generated during the SSA in August 2001 and during the supplemental SSA sampling in February 2002 were compared to conservative human-health risk-based criteria. The evaluation consists of the August 2001 groundwater data, February 2002 groundwater data, and the January 2002 groundwater data (provided by Tetra Tech NUS). Groundwater and surface water samples were analyzed for filtered and unfiltered metals. Only unfiltered surface water data were evaluated in the risk assessment since it is assumed that receptors would come in direct contact with the surface water at the source. Both filtered and unfiltered groundwater samples were evaluated in the risk assessment. This screening was used to help determine if the site requires further action based on detected concentrations above human-health risk-based criteria.

5.1.1 Methods

The human health risk screening was conducted using a combined risk screening and risk ratio technique. The approach is detailed as follows:

5.1.1.1 Groundwater

- The groundwater data were screened against the Safe Drinking Water Act (SDWA) Maximum Contaminant Levels (MCLs). The SDWA Action Level was used as the screening level for lead. If the maximum detected concentration exceeded the MCL, the constituent was retained as a chemical of potential concern (COPC) for further evaluation (Table 5-1).
- The groundwater concentrations were also compared to human-health risk-based criteria for potable water (the tap water Risk-Based Concentrations (RBCs)) obtained from the April 2002 USEPA Region III RBC table, the most current at the time the risk screening was performed. Per EPA protocol (EPA, 1992) for RBCs based on noncarcinogenic effects (indicated by an "N" next to the value in the RBC table), the value presented in the RBC table was divided by 10 to account for exposure to multiple constituents or a hazard quotient (HQ) of 0.1. RBCs based on carcinogenic effects (indicated by a "C" next to the value in the RBC Table) were used as presented in the RBC table, which is based on a carcinogenic risk of $1x10^{-6}$. If the maximum detected concentration exceeded the RBC, the constituent was retained as a COPC for further evaluation.

5.1.1.2 Surface Water

The maximum detected concentrations were compared to 10 times the tap water RBCs (following USEPA Region III standard practices). For RBCs based on noncarcinogenic effects, the value presented in the RBC table was divided by 10 to account for exposure to multiple constituents or a HQ of 0.1. This value was then multiplied by 10 to derive the surface water screening risk-based concentration. Tap water RBCs based on carcinogenic effects were multiplied by 10 to derive the surface water screening concentration. If the maximum detected concentration exceeded the RBC, the constituent was retained as a COPC for further evaluation.

5.1.1.3 Sediment

The maximum detected concentrations were compared to 10 times the residential soil RBCs (following USEPA Region III standard practices). For RBCs based on noncarcinogenic effects, the value presented in the RBC table was divided by 10 to account for exposure to multiple constituents or an HQ of 0.1. This value was then multiplied by 10 to derive the sediment screening risk-based concentration. Residential soil RBCs based on carcinogenic effects were multiplied by 10 to derive the sediment screening concentration. If the maximum detected concentration exceeded the RBC, the constituent was retained as a COPC for further evaluation.

5.1.1.4 Groundwater, Surface Water, and Sediment

- If the maximum detected concentration of a compound or analyte exceeded the applicable RBC, the site concentrations were compared to background values. Background data was available for groundwater only, therefore, this step was not performed for the surface water or sediment. This step includes comparing the maximum detected concentration to the facility background average concentration (as reported in TTNUS, 2002). If the maximum detected concentration was below the facility average concentration, the constituent was eliminated from further consideration as a COPC. This is done per Navy guidance and was confirmed as being appropriate for a site screening assessment by EPA's toxicologist Alvaro Alvarado in an email to CH2M HILL's risk assessor Roni Warren, dated 1/14/03. The Indian Head Installation Restoration Team (IHIRT) concurred that background groundwater data can be used to screen out COPCs for SSAs only, but that if a full HHRA is required, the COPCs would have to be reconsidered.

- If the maximum detected concentration of a compound or analyte exceeded the applicable RBC and the background average, the contaminant was retained as COPC and the risk was estimated by calculating a corresponding risk level (CRL) as follows:

$$CRL = \frac{(MC)(ARL)}{RBC}$$

where:

MC maximum concentration.

ARL acceptable risk level (based on an apparent hazard index (AHI) of 1 or an apparent cancer risk (ACR) of $1x10^{-6}$).

RBC corresponding USEPA Region III risk-based concentration.

- The CRLs for each constituent were then added together to obtain the Cumulative Apparent Hazard Index (CAHI) and Cumulative Apparent Cancer Risk (CACR). If the hazard index (HI) by target organ (sum of the HQs for each constituent with the same noncarcinogenic target) was greater than 0.5 or the CACR was greater than $5x10^{-5}$, the constituents which contributed to these values were carried through to the final phase of screening analysis.
- For constituents identified as COPCs during the preceding step, a CRL was calculated as discussed above, however, the 95 percent upper confidence limit (UCL) was used in place of the maximum detected concentration to obtain a more site-specific risk ratio. If the 95 percent UCL was greater than the maximum detected concentration, the maximum detected concentration was used in the calculation. If the hazard index (HI) by target organ was greater than 0.5, or the CACR was greater than $5 x10^{-5}$, then additional evaluation may be required (per fax from Dawn Iovan USEPA Region III toxicologist to Holly Rosnick, CH2M HILL, suggestions for pre-remedial screening, June 3, 1998). The constituents which contribute to these values are considered COPCs.

5.1.2 Results

5.1.2.1 Groundwater

In the filtered groundwater, two inorganic constituents (antimony and nickel) were detected at maximum concentrations above their respective MCLs and/or RBCs. Antimony was not detected in the facility-wide background samples, and nickel was detected at the site at concentrations above the average facility-wide background concentrations. Therefore, antimony and nickel were retained as COPCs for the risk ratio evaluation. As shown in Table 5-1A, each constituent was evaluated by target organ. The CAHI by target organ resulted in a value of 0.3 therefore, antimony and nickel were dropped as COPCs and filtered groundwater is assumed not to pose a threat to human health.

In the unfiltered groundwater samples, two volatile organic compounds (1,1-dichloroethene and tetrachloroethylene), one semivolatile organic compound (bis(2-ethylhexyl)phthalate), and four inorganic constituents (arsenic, chromium, nickel, and thallium) were detected at maximum concentrations above their respective MCLs and/or RBCs, and background levels and were retained as COPCs for the risk ratio evaluation. The CAHI for unfiltered groundwater is 1.2; therefore, a target organ evaluation was conducted. The target organ evaluation identified a CAHI of 0.9 from chromium (the target is no observed adverse effect level (NOAEL)). The CACR is $7x10^{-5}$, which is above the $5x10^{-5}$ cutoff level. This CACR is associated with 1,1-dichloroethene, tetrachloroethylene, bis(2-ethylhexyl)phthalate, and arsenic. Therefore chromium, 1,1-dichloroethene, tetrachloroethylene, bis(2-ethylhexyl)phthalate, and arsenic were carried through to the final screening, calculation of the risk ratio using the 95 percent UCL (Table 5-1B). The maximum detected concentration of the four constituents contributing to the CACR was used in place of the 95 percent UCL due to the limited number of groundwater samples available. Therefore, using the April 2002 USEPA RBCs, these four constituents were retained as COPCs: 1,1-dichloroethene, tetrachloroethylene, bis(2-ethylhexyl)phthalate, and arsenic for the groundwater. Chromium was also retained as a COPC since the calculated CAHI is 0.7.

It should be noted that total chromium data was screened against hexavalent chromium screening criteria. Most of the total chromium is usually in the more stable form of trivalent chromium, rather than the unstable hexavalent chromium. Additionally, the highest detect level was 102 µg/L, which is below the RBC of hexavalent chromium (110 µg/L), it is only above the RBC (0.1) screening value (11 µg/L). This result was a field duplicate, and the concentration in the corresponding parent sample was 54.5 µg/L (IS05MW030202), so the 102 mg/L result may be biased high. If the maximum concentration of 102 µg/L was assumed to be one sixth hexavalent chromium, or 17 µg/L of hexavalent chromium, (an assumption made for Region IX risk assessments), the screening criteria would have been only slightly exceeded.

Bis(2-ethylhexyl)phthalate (BEHP) was not detected in the associated field or laboratory blanks, but it should be noted that BEHP is a common field and laboratory contaminant. Phthalates are used as plasticizers, the most common of which is BEHP, and are often introduced into samples during handling. If the field samplers wore latex gloves during the field sampling process, this also could have been the source. Latex gloves are coated with plasticizers such as BEHP and di-n-butylphthalate to facilitate release of the gloves from the skin. Laboratory personnel also wear latex gloves during sample extraction and handling.

These compounds were reevaluated against the April 2003 RBC values and site geochemical data (for chromium) and were determined not to be COCs in groundwater (Appendix E).

5.1.2.2 Surface Water

The results of the surface water screening analysis are shown in Tables 5-2, 5-2A, and 5-2B. Based on the first phase of screening (comparison to RBCs, Table 5-2), iron and manganese were retained as COPCs. Phase 2 screening (risk ratio using maximum detected concentration, Table 5-2A) eliminated manganese, keeping iron as the only COPC for Phase 3 evaluation. Iron was also retained as a COPC from the Phase 3 screening (Table 5-2B). The maximum detected concentration of iron was used as the exposure concentration in the Phase 3 screening because there were only 3 surface water samples collected.

The results of the iron reevaluation in 2003 indicated that it should not be retained as a COC (Appendix E).

5.1.2.3 Sediment

Tables 5-3 and 5-3A present the results of the screening of the sediment at Site 5. Phase 1 screening (Table 5-3) resulted in the retention of arsenic and iron as COPCs. Phase 2 screening (Table 5-3A) eliminated both COPCs from sediment. Therefore, exposure to Site 5 sediment is not expected to be a concern for human health.

5.1.3 Summary

No COPCs were retained for sediment. Iron was originally the only COPC retained for the surface water. Chromium, 1,1-dichloroethene, tetrachloroethylene, bis(2-ethylhexyl)phthalate, and arsenic were originally retained as COPCs for groundwater. However, following reevaluation of these compounds, they are no longer retained as COCs (Appendix E). Therefore, based on human health concerns, there are no COPCs for sediment, surface water, or groundwater at Site 5.

5.2 Ecological Risk Screening

As noted in Section 1.2 the southern section of Swale 2 (approximately 400 feet) was not adequately characterized in previous investigations and is, therefore, the subject of this ecological risk screening. Surface water and sediment samples were collected during the field investigation to support this ecological risk screening.

5.2.1 Ecological Setting

The area surrounding the northern portion of Swale 2 is a wet meadow/wetland approximately 100 feet wide, surrounded by woods on both sides. The swale is densely vegetated with emergent vegetation. The wetland is likely supported by process water released from upgradient buildings.

The southern portion of the swale (defined as the area south of surface water and sediment sampling locations IS05SW/SD01) is forested. The drainage appears to have formed its own path through the mixed hardwood forest that extends east to Swale 1. Swale 2 is approximately 3 to 6 feet wide along the southern portion, and contained approximately 5 to 8 inches of water during an August 2001 site reconnaissance. The stream is partially impounded at the junction of Swale 1 and 2 due to a tree fall. Aquatic insects, frogs, deer tracks and many birds were observed in and around the swale. South of the confluence of Swale 1 and 2 is a well-defined creek approximately 12 feet wide.

Waste water discharged to Swale 2 may have introduced contaminants directly to the surface water and sediment in the swale. Additionally, waste water may have infiltrated into the ground as well, introducing contaminants to groundwater.

Potential receptors may include aquatic/wetland species present in the surface water and/or sediment (e.g., aquatic plants, benthic and aquatic invertebrates, frogs), and semiaquatic species that forage in wetland areas (e.g., raccoon and green heron).

5.2.2 Summary of Analytical Data Used in the Screening

In February 2002, three surface water samples, IS05SW040202, IS05SW050202, and IS05SW030202, were collected and analyzed for total and dissolved TAL inorganics, hardness, and dissolved TOC. Three sediment samples, IS05SD040202, IS05SD050202, and IS05SD030202, were collocated with the surface water samples, as shown in Figure 3-1. These samples were collected from 0 to 6 inches beneath the sediment surface and analyzed for TAL inorganics and TOC. Grain size analysis was conducted only on the samples collected from the two new locations, since the sample from the third location at the confluence of the swales was analyzed for grain size in August 2001.

5.2.3 Methods

To screen for potential risk to aquatic receptors and benthic invertebrates, the maximum and average detected concentrations of metals in each medium were compared to conservative ecological screening values. The maximum and average detected dissolved metals concentrations in surface water were compared to freshwater screening values for aquatic receptors. The maximum and average detected metals concentrations in sediment were compared to freshwater sediment screening values for benthic invertebrates. Screening

values used in the assessment that are not part of the Region III Biological Technical Assistance Group's (BTAG's) set of screening values (USEPA, 1995) are included in Appendix D.

To screen for potential risk to upper trophic level receptors, maximum and average exposure estimates were developed. Raccoon and green heron were selected to represent the semiaquatic omnivores and carnivores that may use the swale for feeding. Dietary intakes for each receptor species were calculated using the following formula (modified from USEPA, 1993):

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

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)

Exposure estimates for the raccoon and green heron were compared to reference toxicity values (lowest observed adverse effect level (LOAEL)). Toxicity reference values and parameters used to develop exposure estimates are provided in Tables 5-4 through 5-11.

5.2.4 Results

5.2.4.1 Aquatic Receptors

Iron and manganese were the only dissolved metals detected in surface water samples that had average concentrations in excess of the freshwater screening values for aquatic receptors (Table 5-12). The dissolved iron concentrations in the three surface water samples collected in 2002 were 1,350 µg/L for IS5SW01, 432 µg/L for IS5SW02, and 25,700 for IS5SW03. Dissolved manganese concentrations in the same three samples were 678, 160, and 638 µg/L, respectively. It is unlikely that iron and manganese are site-related. A likely explanation relates to the character of the stream. With the exception of the southernmost stretch that was sampled, the stream is very shallow. Flow in the stream is slow and throughout the length sampled, the channel is very incised. The field technician observed what was thought to be iron precipitate in the vicinity of IS5SW03, and also rusted metal in

the stream bank. It is likely that the high iron and manganese levels are a result of soil erosion during precipitation events and the relatively stagnant condition of the system. The rusted metal could also contribute to the iron levels in surface water. In addition, background groundwater concentrations of dissolved iron in the vicinity of Site 5 are similarly high. The closest monitoring well (BGDMW004F001) sampled in the Background Investigation by Brown and Root Engineering (B&RE, 1997) contained 5,230 ug/L dissolved iron and the average for the study was 3,137 ug/L. These data suggest that the soils in the vicinity are naturally high in iron, which are likely contributing to the high iron concentrations found in the stream.

Dissolved silver, the primary site contaminant, was not detected in any of the three surface water samples (Appendix C).

5.2.4.2 Benthic Invertebrates

Metals detected in the sediment samples that had average concentrations in excess of the freshwater sediment screening values included cadmium and silver (Table 5-13). Only one of the samples contained cadmium at a concentration exceeding the screening value and the average concentration of cadmium only slightly exceeded the screening value (HQ=1.05). It should be noted that these screening values are quite conservative. Therefore, although cadmium may pose an isolated risk at one location, it is unlikely to pose significant risk to the benthic invertebrate population in the stream.

The potential for risk to benthic invertebrates from silver was further evaluated by looking at bulk sediment toxicity tests conducted as part of the Site 42 RI (Tetra Tech NUS, 1999) and subsequent Toxicity Identification Evaluation (TIE) study (SAIC, 2001). Site 42 is located adjacent to Site 5. Silver was measured at concentrations above ecological screening levels in Site 42 sediments, and was identified as a COPC for benthic invertebrates. Toxicity was observed in 28-day sediment toxicity tests (*Hyalella azteca*) conducted as part of the Site 42 RI (Tetra Tech NUS, 1999). An additional five 10-day bulk sediment toxicity tests on *H. azteca* were conducted as a precursor to TIE testing (SAIC, 2001). Toxicity was also observed in these tests. A subsequent TIE study was conducted on four of the five Site 42 samples. Silver was not identified as a causative agent for the toxicity observed in the TIE study.

Silver concentrations in the 4 sediment samples analyzed in the TIE study ranged from 1.1 mg/kg to 25.3 mg/kg (SAIC, 2001). Silver concentrations in the three Site 5 samples ranged from 2.50 to 15.8 mg/kg. Since the Site 5 silver concentrations are within the range of or less than the Site 42 concentrations in the TIE study, it is expected that silver in Site 5 sediment poses minimal risk to benthic invertebrates.

5.2.4.3 Upper Trophic Level Receptors

The ratio of exposure doses to reference toxicity values are presented in Tables 5-14 and 5-15. Although the estimated mean exposure level for the green heron exceeded the LOAEL-based reference toxicity value for mercury, the maximum site concentration of mercury, 0.23 mg/kg, is within background levels at Indian Head (0.01–0.25 mg/kg) (TetraTech NUS, 2002).

Based on this ecological risk screening, the following conclusions can be made regarding the potential for risk to ecological receptors at the site:

- Iron and manganese, while present at elevated levels, are likely the result of natural processes. Other inorganics pose minimal risk to surface water receptors.
- Inorganics in sediment pose minimal risks to benthic invertebrates.
- The comparison of food chain exposure estimates to reference toxicity values indicates that the levels of metals in surface water and sediment, accounting for background, pose minimal risks to upper trophic level receptors.

Table 5-1
Selection of Chemicals of Potential Concern in Groundwater
Site 5 SSA
IHDIV - NSWC
Indian Head, Maryland

Analyte	Detection Frequency	Maximum Detected Concentration	Sample Location of Maximum Detected Concentration	MCL-Groundwater[1]	Adjusted Tap Water RBC[2]	Exceeds RBC?	Background Average	Exceeds Background Concentration?
2001 Sampling Volatile Organic Compounds (UG/L)								
1,1,1-Trichloroethane	1 - 5	2.1	IS05MW050801	200	320	No		
1,1-Dichloroethane	1 - 5	4.3	IS05MW050801	NA	80	No		
Tetrachloroethene	1 - 5	1	IS05MW050801	5	1.1	No		
2002 Sampling Volatile Organic Compounds (UG/L)								
1,1,1-Trichloroethane	1 / 2	1	IS42MW007U002	200	317	No		
1,1-Dichloroethane	1 / 2	1	IS42MW007U002	NA	79.8	No		
1,1-Dichloroethene	**1 / 2**	**1**	**IS42MW007U002**	**7**	**0.043602**	**Yes**	**Yes [4]**	
Chlorobenzene	1 / 2	1	IS42MW002U002	100	10.6	No		
Ethyl ether	1 / 2	1	IS42MW002U002	NA	122	No		
Methylene chloride	1 / 2	2	IS42MW007U002	5	4.10	No		
Tetrachloroethene	**1 / 2**	**1**	**IS42MW007U002**	**5**	**0.63**	**Yes**	**Yes [4]**	
cis-1,2-Dichloroethene	1 / 2	1	IS42MW002U002	70	6.08	No		
Semivolatile Organic Compounds (UG/L)								
bis(2-Ethylhexyl)phthalate	**1 / 2**	**5**	**IS42MW002U002**	**6**	**4.78**	**Yes**	**3.7**	**Yes**
Total Metals (UG/L)								
Aluminum	1 / 5	9800	IS05MW020202	NA	3650	Yes	42250	No
Arsenic	**5 / 5**	**2**	**IS42MW007U002**	**10**	**0.0446**	**Yes**	**4.8**	**No**
Barium	4 / 5	211	IS05MW020202	2000	256	No		
Beryllium	3 / 5	1.7	IS05MW010202	4	7.3	No		
Cadmium	4 / 5	0.41	IS05MW010202	5	1.83	No		
Calcium	4 / 5	4610	IS05MW010202	NA	NA	No		
Chromium	**4 / 5**	**102**	**IS05MW020202**	**100**	**11.0**	**Yes**	**61.3**	**Yes**
Cobalt	2 / 5	58.3	IS05MW010202	NA	73	No		
Copper	5 / 5	9	IS05MW030202	1300	146	No		
Iron	4 / 5	13200	IS05MW030202	NA	1100	Yes	23650	No
Lead[3]	5 / 5	15.7	IS05MW020202	15	15	Yes	23	No
Magnesium	5 / 5	4640	IS05MW010202	NA	NA	No		
Manganese	2 / 5	335	IS05MW010202	NA	73	Yes	1309	No
Mercury	4 / 5	0.16	IS05MW030202	2	1.10	No		
Nickel	**4 / 5**	**79.7**	**IS05MW020202**	**NA**	**73**	**Yes**	**57**	**Yes**
Potassium	5 / 5	2140	IS05MW020202	NA	NA	No		
Sodium	1 / 5	65300	IS05MW010202	NA	NA	No		
Thallium	**3 / 5**	**3**	**IS42MW007U002**	**2**	**0.256**	**Yes**	**2.9**	**Yes**
Vanadium	4 / 5	22	IS05MW020202P	NA	25.6	No	88	No
Zinc	1 / 5	66.8	IS05MW010202	NA	1095	No		
Dissolved Metals (UG/L)								
Aluminum	1 / 5	201	IS05MW030202	NA	3650	No		
Antimony	**1 / 5**	**2.4**	**IS05MW010202**	**6**	**1.46**	**Yes**	**Yes [4]**	
Barium	3 / 5	235	IS05MW010202 IS05MW010202	2000	256	No		
Beryllium	2 / 5	1.8	IS05MW020202	4	7.3	No		
Cadmium	1 / 5	0.2	IS42MW002F002	5	1.83	No		
Calcium	3 / 5	5100	IS05MW010202	NA	NA	No		
Chromium	1 / 5	60.1	IS05MW010202	100	11.0	Yes	61.3	No
Cobalt	4 / 5	62.9	IS05MW010202	NA	73	No		
Copper	1 / 5	15.2	IS05MW010202	1300	146	No		
Iron	3 / 5	1310	IS05MW010202	NA	1100	Yes	23650	No
Lead[3]	2 / 5	10.6	IS05MW010202	15	15	No		
Magnesium	4 / 5	5120	IS05MW010202	NA	NA	No		
Manganese	4 / 5	386	IS05MW010202	NA	73	Yes	1309	No
Mercury	1 / 5	0.11	IS05MW030202	2	1.10	No		
Nickel	**4 / 5**	**93.8**	**IS05MW010202**	**NA**	**73**	**Yes**	**57**	**Yes**
Potassium	3 / 5	1200	IS05MW010202	NA	NA	No		
Sodium	5 / 5	69000	IS05MW010202	NA	NA	No		
Zinc	2 / 5	79.5	IS05MW010202	NA	1095	No		

[1] Drinking Water Standards and Health Advisories, U.S. EPA Region III, Summer 2000.
[2] Risk-Based Concentration Table, April 2, 2002, U.S. EPA Region III, Jennifer Hubbard.
[3] Action level for lead from Drinking Water Standards and Health Advisories.
[4] Constituent not detected in the background samples, however, maxiumum detected concentration exceeds RBC value, therefore, constituent retained as a COPC.

Table 5-1A
Site 5
Phase 2 - Selection of Chemicals of Potential Concern from Groundwater
IHDIV - NSWC
Indian Head, Maryland

Analyte	Detection Frequency	Maximum Detected Concentration*	Tap Water RBC	Acceptable Risk Level	Apparent Hazard Index[a]	Corresponding Risk Level[b]	Target Organ
VOLATILE ORGANIC COMPOUNDS (µg/L)							
1,1-Dichloroethene	1 - 2	1	0.0436	1.0E-06		2E-05	
Tetrachloroethene	1 - 2	1	0.63	1.0E-06		2E-06	
SEMIVOLATILE ORGANIC COMPOUNDS (µg/L)							
bis(2-Ethylhexyl)phthalate	1 - 2	5	4.8	1.0E-06		1E-06	
TOTAL INORGANIC COMPOUNDS (µg/L)							
Arsenic	5 - 5	2	0.045	1.0E-06		4E-05	
Chromium	4 - 5	102	110	1	0.9		NOAEL
Nickel	4 - 5	79.7	730	1	0.1		Whole Body
Thallium	3 - 5	3	25.55	1	0.1		Skin/Vascular
Cumulative Apparent Hazard Index[c]					1.2		
Cumulative Apparent Cancer Risk[d]						7E-05	
						Cumulative NOAEL HI =	0.9
						Cumulative Whole Body HI =	0.1
						Cumulative Skin HI =	0.1
						Cumulative Vascular HI =	0.1
DISSOLVED INORGANIC COMPOUNDS (µg/L)							
Antimony	1 / 5	2.4	14.6	1	0.2		Blood
Nickel	4 / 5	93.8	730	1	0.1		Whole Body
Cumulative Apparent Hazard Index[c]					0.3		
Cumulative Apparent Cancer Risk[d]							
						Cumulative Blood HI =	0.2
						Cumulative Whole Body HI =	0.1

Constituents selected as COPCs are indicated by shading.

Trivalent chromium used as a surrogate for total chromium.

All units are ug/L.

[a] Apparent Hazard Index equals maximum detected concentration divided by the RBC divided by the acceptable risk level.

[b] Corresponding Risk Level equals maximum detected concentration divided by the RBC divided by the acceptable risk level.

[c] Cumulative Apparent Hazard Index equals sum of Apparent Hazard Indices for each constituent.

[d] Cumulative Apparent Cancer Risk equals sum of Corresponding Risks Levels for each constituent.

Constituent selected as COPC if it contributes to an overall Apparent Hazard Index by target organ greater than 0.5 or Cumulative Apparent Cancer Risk greater than 5E-05, otherwise, constituent not selected as COPC.

Table 5-1B
Site 5
Phase 3 - Selection of Chemicals of Potential Concern for Groundwater
IHDIV - NSWC
Indian Head, Maryland

Analyte	Detection Frequency	95% UCL		95% UCL Rationale	Tap Water RBC	Acceptable Risk Level	Apparent Hazard Index[a]	Corresponding Risk Level[b]	Target Organ
VOLATILE ORGANIC COMPOUNDS (µg/L)									
1,1-Dichloroethene	1 - 2	1	M	(5)	0.0436	1.0E-06		2E-05	
Tetrachloroethene	1 - 2	1	M	(5)	0.63	1.0E-06		2E-06	
SEMIVOLATILE ORGANIC COMPOUNDS (µg/L)									
bis(2-Ethylhexyl)phthalate	1 - 2	5	M	(5)	4.8	1.0E-06		1E-06	
TOTAL INORGANIC COMPOUNDS (µg/L)									
Arsenic	1 - 5	2	M	(2)	0.04	1.0E-06		4E-05	
Chromium	4 - 5	78	N	(4)	110	1	0.7		NOAEL
Cumulative Apparent Hazard Index[c]							0.7		
Cumulative Apparent Cancer Risk[d]								7E-05	
							Total NOAEL HI =		0.7

Constituents selected as COPCs are indicated by shading.
All units are µg/L.
[a] Apparent Hazard Index equals maximum detected concentration divided by the RBC divided by the acceptable risk level.
[b] Corresponding Risk Level equals maximum detected concentration divided by the RBC divided by the acceptable risk level.
[c] Cumulative Apparent Hazard Index equals sum of Apparent Hazard Indices for each constituent.
[d] Cumulative Apparent Cancer Risk equals sum of Corresponding Risks Levels for each constituent.
Constituent selected as COPC if it contributes to an overall Apparent Hazard Index by target organ greater than 0.5 or Cumulative Apparent Cancer Risk greater than 5E-05, otherwise, constituent not selected as COPC.
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 (M); 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 exceeds maximum detected concentration. Therefore, maximum concentration used.
(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.
(5) Maximum detected concentration used because sample size is less than 5.

Table 5-2
Selection of Chemicals of Potential Concern in Surface Water
Site 5 SSA
IHDIV - NSWC
Indian Head, Maryland

Analyte	Detection Frequency	Maximum Detected Concentration	Sample Location of Maximum Detected Concentration	Adjusted Tap Water RBC[1]	Selected as COPC?
Total Metals (ug/L)					
Aluminum	3 / 3	12200	IS05SW030202	36500	No
Barium	2 / 3	277	IS05SW030202	2555	No
Beryllium	2 / 3	0.67	IS05SW030202	73	No
Cadmium	2 / 3	9.3	IS05SW030202	18.25	No
Calcium	3 / 3	17500	IS05SW030202	NA	No
Chromium	2 / 3	23.3	IS05SW030202	109.5	No
Cobalt	3 / 3	12.2	IS05SW010202	730	No
Copper	3 / 3	64.1	IS05SW030202	1460	No
Iron	**3 / 3**	**224000**	**IS05SW030202**	**11000**	**Yes**
Lead	3 / 3	5.4	IS05SW010202	15	No
Magnesium	3 / 3	5880	IS05SW030202	NA	No
Manganese	**3 / 3**	**1160**	**IS05SW030202**	**730**	**Yes**
Mercury	2 / 3	0.17	IS05SW030202	10.95	No
Nickel	2 / 3	20.3	IS05SW030202	730	No
Potassium	3 / 3	4800	IS05SW030202	NA	No
Silver	4 / 6	66.3	IS05SW01	182.5	No
Sodium	3 / 3	64700	IS05SW010202	NA	No
Vanadium	3 / 3	34.7	IS05SW030202	255.5	No
Zinc	3 / 3	192	IS05SW030202	10950	No

[1]U.S. EPA Region III, April 2, 2002 for tap water (10 times the cancer benchmark value = 1e-06; 10 times the HQ = 0.1).

Table 5-2A
Site 5
Phase 2 - Selection of Chemicals of Potential Concern from Surface Water
IHDIV - NSWC
Indian Head, Maryland

Analyte	Detection Frequency	Maximum Detected Concentration	Tap Water RBC x10	Acceptable Risk Level	Apparent Hazard Index[a]	Corresponding Risk Level[b]	Target Organ
INORGANIC COMPOUNDS (µg/L)							
Iron	3 - 3	224,000	110,000	1	2.0		Gastrointestinal
Manganese	3 - 3	1,160	7,300	1	0.2		CNS
Cumulative Apparent Hazard Index[c]					2.2		
Cumulative Apparent Cancer Risk[d]							
						Total Gastrointestinal HI =	0.2
						Total CNS HI =	2.2

All units are ug/L.
[a] Apparent Hazard Index equals maximum detected concentration divided by the RBC divided by the acceptable risk level.
[b] Corresponding Risk Level equals maximum detected concentration divided by the RBC divided by the acceptable risk level.
[c] Cumulative Apparent Hazard Index equals sum of Apparent Hazard Indices for each constituent.
[d] Cumulative Apparent Cancer Risk equals sum of Corresponding Risks Levels for each constituent.
Constituent selected as COPC if it contributes to an overall Apparent Hazard Index by target organ greater than 0.5 or Cumulative Apparent Cancer Risk greater than 5E-05, otherwise, constituent not selected as COPC.

Table 5-2B
Site 5
Phase 3 - Selection of Chemicals of Potential Concern for Surface Water
IHDIV - NSWC
Indian Head, Maryland

Analyte	Detection Frequency	95% UCL		95% UCL Rationale	Tap Water RBC x10	Acceptable Risk Level	Apparent Hazard Index[a]	Corresponding Risk Level[b]	Target Organ
INORGANIC COMPOUNDS (µg/L)									
Iron	3 - 3	224,000	M	(5)	110,000	1	2.0		Gastrointestinal
Cumulative Apparent Hazard Index[c]							2.0		
Cumulative Apparent Cancer Risk[d]									
							Total Gastrointestinal HI =		2.0

Constituents selected as COPCs are indicated by shading.
All units are µg/L.
[a] Apparent Hazard Index equals maximum detected concentration divided by the RBC divided by the acceptable risk level.
[b] Corresponding Risk Level equals maximum detected concentration divided by the RBC divided by the acceptable risk level.
[c] Cumulative Apparent Hazard Index equals sum of Apparent Hazard Indices for each constituent.
[d] Cumulative Apparent Cancer Risk equals sum of Corresponding Risks Levels for each constituent.
Constituent selected as COPC if it contributes to an overall Apparent Hazard Index by target organ greater than 0.5 or Cumulative Apparent Cancer Risk greater than 5E-05, otherwise, constituent not selected as COPC.
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 (M); 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 exceeds maximum detected concentration. Therefore, maximum concentration used.
(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.
(5) Maximum detected concentration used because sample size is less than 5.

Table 5-3
Selection of Chemicals of Potential Concern in Sediment
Site 5 SSA
IHDIV - NSWC
Indian Head, Maryland

Analyte	Detection Frequency	Maximum Detected Concentration	Sample Location of Maximum Detected Concentration	Adjusted Soil RBC[1]	Selected as COPC?
Total Metals (MG/KG)					
Aluminum	3 / 3	11,200	IS05SD030202	78,214	No
Arsenic	**3 / 3**	**4.8**	**IS05SD030202**	**4.26**	**Yes**
Barium	3 / 3	94.3	IS05SD030202	5,475	No
Beryllium	3 / 3	0.77	IS05SD030202	156	No
Cadmium	3 / 3	3	IS05SD030202	78.0	No
Calcium	3 / 3	1,520	IS05SD030202	NA	No
Chromium	3 / 3	21.1	IS05SD030202	235	No
Cobalt	3 / 3	14.8	IS05SD030202	1,600	No
Copper	3 / 3	43.7	IS05SD030202	3,129	No
Iron	**3 / 3**	**30,000**	**IS05SD030202**	**23,000**	**Yes**
Lead	3 / 3	23	IS05SD030202	400	No
Magnesium	3 / 3	1,520	IS05SD020202P	NA	No
Manganese	3 / 3	191	IS05SD030202	1,564	No
Mercury	3 / 3	0.23	IS05SD030202	23.5	No
Nickel	3 / 3	19.6	IS05SD030202	1,564	No
Potassium	3 / 3	834	IS05SD030202	NA	No
Silver	6 / 6	15.8	IS05SD030202	391	No
Sodium	1 / 3	185	IS05SD030202	NA	No
Vanadium	3 / 3	35.1	IS05SD030202	548	No
Zinc	3 / 3	150	IS05SD030202	23,464	No

[1]U.S. EPA Region III, April 2, 2002 for residential soil (10 times the cancer benchmark value = 1e-06; 10 times the HQ = 0.1).

Table 5-3A
Site 5
Phase 2 - Selection of Chemicals of Potential Concern from Sediment
IHDIV - NSWC
Indian Head, Maryland

Analyte	Detection Frequency	Maximum Detected Concentration*	Residential Soil RBC x10	Acceptable Risk Level	Apparent Hazard Index[a]	Corresponding Risk Level[b]	Target Organ
INORGANIC COMPOUNDS (mg/kg)							
Arsenic	3 - 3	4.8	4.26	1.0E-06		1E-06	
Iron	3 - 3	30,000	230,000	1	0.1		Gastrointestinal
Cumulative Apparent Hazard Index[c]					0.1		
Cumulative Apparent Cancer Risk[d]						1E-06	
						Total Gastrointestinal HI =	0.1

Constituents selected as COPCs are indicated by shading.
All units are mg/kg.
[a] Apparent Hazard Index equals maximum detected concentration divided by the RBC divided by the acceptable risk level.
[b] Corresponding Risk Level equals maximum detected concentration divided by the RBC divided by the acceptable risk level.
[c] Cumulative Apparent Hazard Index equals sum of Apparent Hazard Indices for each constituent.
[d] Cumulative Apparent Cancer Risk equals sum of Corresponding Risks Levels for each constituent.
Constituent selected as COPC if it contributes to an overall Apparent Hazard Index by target organ greater than 0.5 or Cumulative Apparent Cancer Risk greater than 5E-05, otherwise, constituent not selected as COPC.

Table 5-4
Ingestion Screening Values for Mammals
Site 5
IHDIV-NSWC
Indian Head, Maryland

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	0.126	Sample et al. 1996
Cadmium	rat	0.303	6 weeks	oral (gavage)	reproduction	10	1	Sample et al. 1996
Cadmium	dog	10	3 months	oral	reproduction	7.5	0.75	ATSDR 1993
Chromium	rat	0.35	3 months	oral in water	mortality	131.4	13.14	Sample et al. 1996
Copper	mink	1	357 days	oral in diet	reproduction	15.14	11.7	Sample et al. 1996
Lead	rat	0.35	3 generations	oral in diet	reproduction	80	8	Sample et al. 1996
Mercury	rat	0.35	3 generations	oral in diet	reproduction	0.16	0.032	Sample et al. 1996
Mercury	mink	1	93 days	oral in diet	mortality/weight loss	0.25	0.15	Sample et al. 1996
Nickel	rat	0.35	3 generations	oral in diet	reproduction	80	40	Sample et al. 1996
Selenium	rat	0.35	1 year	oral in water	reproduction	0.33	0.2	Sample et al. 1996
Silver	rat	0.35	2 weeks	oral in water	mortality	181	18.1	ATSDR 1990
Zinc	rat	0.35	GD 1-16	oral in diet	reproduction	320	160	Sample et al. 1996
Zinc	mink	1	25 weeks	oral	reproduction	208	20.8	ATSDR 1992

Table 5-5
Ingestion Screening Values for Birds
Site 5
IHDIV-NSWC
Indian Head, Maryland

Chemical	Test Organism	Body Weight (kg)	Duration	Exposure Route	Effect/Endpoint	LOAEL (mg/kg/d)	NOAEL (mg/kg/d)	Reference
Inorganics								
Arsenic	brown-headed cowbird	0.049	7 months	oral in diet	mortality	7.38	2.46	Sample et al. 1996
Arsenic	mallard	1	128 days	oral in diet	mortality	12.84	5.14	Sample et al. 1996
Cadmium	mallard	1.153	90 days	oral in diet	reproduction	20	1.45	Sample et al. 1996
Chromium	American black duck	1.25	10 months	oral in diet	reproduction	5	1	Sample et al. 1996
Copper	chicks	0.534	10 weeks	oral in diet	growth/mortality	61.7	47	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	Japanese quail	0.15	1 year	oral in diet	reproduction	0.9	0.45	Sample et al. 1996
Mercury	mallard	1	3 generations	oral in diet	reproduction	0.064	0.0064	Sample et al. 1996
Nickel	mallard	0.782	90 days	oral in diet	growth/mortality	107	77.4	Sample et al. 1996
Selenium	mallard	1	100 days	oral in diet	reproduction	0.8	0.4	Sample et al. 1996
Selenium	screech owl	0.2	13.7 weeks	oral in diet	reproduction	1.5	0.44	Sample et al. 1996
Silver	mallard	?	14 days	oral	?	1780	178	USEPA 1999
Zinc	chicken	1.935	44 weeks	oral in diet	reproduction	131	14.5	Sample et al. 1996

Table 5-6
Maximum Sediment Bioaccumulation Factors Used For Aquatic Plants and Frogs
Site 5
IHDIV-NSWC
Indian Head, Maryland

Chemical	Sediment-Plant BCF (dry weight)		Sediment-Frog BAF (dry weight)	
	Value	Reference	Value	Reference
Inorganics				
Arsenic	1.103	Bechtel Jacobs 1998a	0.126	Pascoe et al. 1996
Cadmium	3.25	Bechtel Jacobs 1998a	0.164	Pascoe et al. 1996
Chromium	0.0075	Baes et al. 1984	0.038	Krantzberg and Boyd 1992
Copper	0.625	Bechtel Jacobs 1998a	0.1	Krantzberg and Boyd 1992
Lead	0.468	Bechtel Jacobs 1998a	0.07	Krantzberg and Boyd 1992
Mercury	5	Bechtel Jacobs 1998a	4.58	Cope et al. 1990
Nickel	1.411	Bechtel Jacobs 1998a	1	--
Selenium	3.012	Bechtel Jacobs 1998a	1	--
Silver	0.4	Baes et al. 1984	1	--
Zinc	1.82	Bechtel Jacobs 1998a	0.147	Pascoe et al. 1996

Table 5-7
Maximum Sediment Bioaccumulation Factors Used For Aquatic Invertebrates and Fish
Site 5
IHDIV-NSWC
Indian Head, Maryland

Chemical	Sediment-Invertebrate BAF (dry weight)		Sediment-Fish BAF (dry weight)	
	Value	Reference	Value	Reference
Inorganics				
Arsenic	0.675	Bechtel Jacobs 1998b	0.126	Pascoe et al. 1996
Cadmium	3.073	Bechtel Jacobs 1998b	0.164	Pascoe et al. 1996
Chromium	0.186	Bechtel Jacobs 1998b	0.038	Krantzberg and Boyd 1992
Copper	7.957	Bechtel Jacobs 1998b	0.1	Krantzberg and Boyd 1992
Lead	0.326	Bechtel Jacobs 1998b	0.07	Krantzberg and Boyd 1992
Mercury	1.735	Bechtel Jacobs 1998b	4.58	Cope et al. 1990
Nickel	0.214	Bechtel Jacobs 1998b	1	--
Selenium	1	--	1	--
Silver	0.18	Hirsch 1998	1	--
Zinc	4.759	Bechtel Jacobs 1998b	0.147	Pascoe et al. 1996

Table 5-8
Exposure Parameters for Upper Trophic Level Ecological Receptors; Maximum Values
Site 5
IHDIV-NSWC
Indian Head, Maryland

Receptor	Body Weight (kg)		Water Ingestion Rate (L/day)		Food Ingestion Rate (kg/day - dry)	
	Value	Reference	Value	Reference	Value	Reference
Birds						
Green heron	0.158	Sample et al. 1997	0.02274	allometric equation	0.04582	allometric equation
Mammals						
Raccoon	4.23	Silva and Downing 1995	0.60919	allometric equation	0.12681	Conover 1989

Table 5-8
Exposure Parameters for Upper Trophic Level Ecological Receptors; Maximum Values
Site 5
IHDIV-NSWC
Indian Head, Maryland

Receptor	Dietary Composition (percent)							Soil/ Sediment Ingestion (percent)	
	Terr. Plants	Soil Invert.	Small Mammals	Fish/ Frogs	Aquatic Plants	Aquatic Invert.	Reference	Value	Reference
Birds									
Green heron	0	0	0	71	0	29	Sample et al. 1997	0	Sample et al. 1997
Mammals									
Raccoon	0	0	0	7	40	43.6	USEPA 1993	9.4	Beyer et al. 1994

Table 5-9
Average Sediment Bioaccumulation Factors Used For Aquatic Invertebrates and Fish
Site 5
IHDIV-NSWC
Indian Head, Maryland

Chemical	Sediment-Invertebrate BAF (dry weight)		Sediment-Fish BAF (dry weight)	
	Value	Reference	Value	Reference
Inorganics				
Arsenic	0.437	Bechtel Jacobs 1998b	0.126	Pascoe et al. 1996
Cadmium	0.679	Bechtel Jacobs 1998b	0.164	Pascoe et al. 1996
Chromium	0.09	Bechtel Jacobs 1998b	0.038	Krantzberg and Boyd 1992
Copper	0.919	Bechtel Jacobs 1998b	0.1	Krantzberg and Boyd 1992
Lead	0.338	Bechtel Jacobs 1998b	0.07	Krantzberg and Boyd 1992
Mercury	1.022	Bechtel Jacobs 1998b	3.25	Cope et al. 1990
Nickel	0.129	Bechtel Jacobs 1998b	1	--
Selenium	1	--	1	--
Silver	0.18	Hirsch 1998	1	--
Zinc	0.954	Bechtel Jacobs 1998b	0.147	Pascoe et al. 1996

Table 5-10
Average Sediment Bioaccumulation Factors Used For Aquatic Plants and Frogs
Site 5
IHDIV-NSWC
Indian Head, Maryland

Chemical	Sediment-Plant BCF (dry weight)		Sediment-Frog BAF (dry weight)	
	Value	Reference	Value	Reference
Inorganics				
Arsenic	0.0371	Bechtel Jacobs 1998a	0.126	Pascoe et al. 1996
Cadmium	0.514	Bechtel Jacobs 1998a	0.164	Pascoe et al. 1996
Chromium	0.0075	Baes et al. 1984	0.038	Krantzberg and Boyd 1992
Copper	0.123	Bechtel Jacobs 1998a	0.1	Krantzberg and Boyd 1992
Lead	0.0377	Bechtel Jacobs 1998a	0.07	Krantzberg and Boyd 1992
Mercury	0.344	Bechtel Jacobs 1998a	3.25	Cope et al. 1990
Nickel	0.034	Bechtel Jacobs 1998a	1	--
Selenium	0.567	Bechtel Jacobs 1998a	1	--
Silver	0.4	Baes et al. 1984	1	--
Zinc	0.358	Bechtel Jacobs 1998a	0.147	Pascoe et al. 1996

Table 5-11
Exposure Parameters for Upper Trophic Level Ecological Receptors; Average Values
Site 5
IHDIV-NSWC
Indian Head, Maryland

Receptor	Body Weight (kg)		Water Ingestion Rate (L/day)		Food Ingestion Rate (kg/day - dry)	
	Value	Reference	Value	Reference	Value	Reference
Birds						
Green heron	0.212	Dunning 1993	0.02087	allometric equation	0.04048	allometric equation
Mammals						
Raccoon	5.94	Silva and Downing 1995	0.49209	allometric equation	0.10003	Conover 1989

Table 5-11
Exposure Parameters for Upper Trophic Level Ecological Receptors; Average Values
Site 5
IHDIV-NSWC
Indian Head, Maryland

Receptor	Dietary Composition (percent)							Soil/ Sediment Ingestion (percent)	
	Terr. Plants	Soil Invert.	Small Mammals	Fish/ Frogs	Aquatic Plants	Aquatic Invert.	Reference	Value	Reference
Birds									
Green heron	0	0	0	71	0	29	Sample et al. 1997	0	Sample et al. 1997
Mammals									
Raccoon	0	0	0	7	40	43.6	USEPA 1993	9.4	Beyer et al. 1994

Table 5-12
Surface Water Screening Statistics
Site 5
IHDIV-NSWC
Indian Head, Maryland

Chemical	Reporting Limit Range	Frequency of Detection	Maximum Concentration Detected	Sample ID of Maximum Concentration	Arithmetic Mean	Screening Value
Dissolved Metals (UG/L)						
Aluminum	200 - 200	0 / 3	--	--	52.8	87.0
Antimony	60.0 - 60.0	0 / 3	--	--	0.90	30.0
Copper	25.0 - 25.0	0 / 3	--	--	4.35	2.74
Iron	100 - 100	3 / 3	25,700	IS05SW030202	9,161	320
Lead	3.00 - 3.00	0 / 3	--	--	0.90	0.54
Manganese	15.0 - 15.0	3 / 3	678	IS05SW010202	492	120
Nickel	40.0 - 40.0	0 / 3	--	--	3.65	16.1
Selenium	5.00 - 5.00	0 / 3	--	--	1.85	4.60
Silver	10.0 - 10.0	0 / 3	--	--	3.05	0.36

NSV - No Screening Value
1 - Shaded cells indicate hazard quotient based on reporting limits

Table 5-13
Sediment Screening Statistics
Site 5
IHDIV-NSWC
Indian Head, Maryland

Chemical	Reporting Limit Range	Frequency of Detection	Maximum Concentration Detected	Sample ID of Maximum Concentration	Arithmetic Mean	Screening Value
Inorganics (MG/KG)						
Beryllium	0.90 - 2.00	3 / 3	0.77	IS05SD030202	0.55	NSV
Cadmium	0.90 - 2.00	2 / 3	3.00	IS05SD030202	1.26	1.20
Copper	4.50 - 9.80	3 / 3	43.7	IS05SD030202	17.8	34.0
Mercury	0.10 - 0.20	3 / 3	0.23	IS05SD030202	0.13	0.15
Selenium	0.90 - 2.00	0 / 3	--	--	0.47	1.00
Silver	1.80 - 3.90	3 / 3	15.8	IS05SD030202	7.67	1.00
Zinc	3.60 - 7.90	3 / 3	150	IS05SD030202	61.9	150

NSV - No Screening Value
1 - Shaded cells indicate hazard quotient based on reporting limits

Table 5-14
Summary of Hazard Quotients for Food Web Exposures - Maximum Exposure Case
Site 5
IHDIV-NSWC
Indian Head, Maryland

Chemical	Raccoon LOAEL	Green Heron LOAEL
Inorganics		
Arsenic	0.10	0.03
Cadmium	0.03	0.04
Chromium	<0.01	0.10
Copper	0.33	0.49
Lead	<0.01	0.03
Mercury	0.09	3.91
Nickel	<0.01	0.04
Selenium	0.33	0.73
Silver	<0.01	<0.01
Zinc	0.06	0.49

Table 5-15
Summary of Hazard Quotients for Food Web Exposures - Average Exposure Case
Site 5
IHDIV-NSWC
Indian Head, Maryland

Chemical	Raccoon LOAEL	Green Heron LOAEL
Inorganics		
Arsenic	0.01	0.01
Cadmium	<0.01	<0.01
Chromium	<0.01	0.03
Copper	0.01	0.02
Lead	<0.01	<0.01
Mercury	<0.01	1.01
Nickel	<0.01	0.02
Selenium	0.02	0.11
Silver	<0.01	<0.01
Zinc	<0.01	0.03

SECTION 6

Conclusions and Recommendations

Based on a review of the analytical data, the results of the human health risk screening (HHRS), and the reevaluation of the COCs identified during the human health risk screening the following conclusions can be made about Site 5:

- No constituents were retained as COPCs in groundwater, surface water, or sediment.

Based on a review of the analytical data and the results of the ecological risk screening (ERS), the following conclusions can be made about Site 5:

- Iron and manganese, while present at elevated levels, are likely the result of natural processes. Other inorganics pose minimal risk to surface water receptors. Inorganics in sediment pose minimal risks to benthic invertebrates.
- The comparison of food chain exposure estimates to reference toxicity values indicates that the levels of metals in surface water and sediment, accounting for background, pose minimal risks to upper trophic level receptors.

Based upon the risk screening conclusions, further investigation is not warranted for this site. Therefore, Site 5 is recommended for no further action.

SECTION 7

References

ABB Environmental Services (ABB). 1991. *Draft Site Characterization and Remediation Evaluation Report.* Naval Ordnance Station, Site 5, Indian Head, Maryland. September.

ABB.1993. *Removal Action Findings Report*, Naval Surface Warfare Center, Site 5, Indian Head, Maryland. December.

Agency for Toxic Substances and Disease Registry (ATSDR). 1995. *Toxicological profile for polycyclic aromatic hydrocarbons (PAHs)*. US Department of Health and Human Services, Public Health Service, ATSDR, Atlanta, GA. August.

ATSDR. 1994. *Toxicological profile for DDE, DDE and DDT*. US Department of Health and Human Services, Public Health Service, ATSDR, Atlanta, GA. May.

ATSDR. 1993. *Toxicological profile for cadmium*. US Department of Health and Human Services, Public Health Service, ATSDR, Atlanta, GA. TP-92/06.

ATSDR. 1992. *Toxicological profile for cobalt.* US Department of Health and Human Services, Public Health Service, ATSDR, Atlanta, GA. July.

ATSDR. 1990. *Toxicological Profile for Aluminum. Draft*.

Beliles, R.P., J.H. Butala, and C.R. Stack. 1985. Chronic toxicity and three-generation reproduction study of styrene monomer in the drinking water of rats. *Fundamental and Applied Toxicology*. 5:855–868.

Beyer, W.N. 1996. Accumulation of chlorinated benzenes in earthworms. *Bulletin of Environmental Contamination and Toxicology*. 57:729–736.

Beyer, W.N., E.E. Connor, and S. Gerould. 1994. Estimates of soil ingestion by wildlife. *Journal of Wildlife Management*. 58:375–382.

Brown and Root Environmental (B&RE). 1997. *Background Investigation Report for Indian Head and Stump Neck Annex Naval Surface Warfare Center, Indian Head, Maryland*. Prepared for Engineering Field Activity Chesapeake, U.S. Navy. December.

Brumbaugh, W.G., C.G. Ingersoll, N.E. Kemble, T.W. May, and J.L. Zajicek. 1994. Chemical characterization of sediments and pore water from the Upper Clark Fork River and Milltown Reservoir, Montana. *Environmental Toxicology and Chemistry*. 13:1971–1983.

Buchman, M.F. 1999. *NOAA screening quick reference tables.* NOAA HAZMAT Report 99-1, Seattle, WA. 12 pp.

CH2M HILL. 1985. *Naval Assessment and Control of Installation Pollutants Confirmation Study.*

CH2M HILL. 2001. *Draft Remedial Investigation Report Sites 11, 13, 17, 21, and 25, Indian Head Division-NSWC, Indian Head Maryland*. July.

CH2M HILL. 2001. *Final Site Screening Work Plan for Site 5, Naval Surface Warfare Center, Indian Head Division, Indian Head Maryland*. September.

Chief of Naval Operations (CNO). 1999. *Navy Policy for Conducting Ecological Risk Assessments*. Memorandum from Chief of Naval Operations to Commander, Naval Facilities Engineering Command. Ser N453E/9U595355. April.

Conover, M.R. 1989. Potential compounds for establishing conditioned food aversions in raccoons. *Wildlife Society Bulletin.* 17:430–435.

Conover, M.R. 1989. Potential compounds for establishing conditioned food Dunning, J.B., Jr. (editor). 1993. *CRC handbook of avian body masses.* CRC Press, Boca Raton, FL. 371 pp.

Cope, W.G., J.G. Wiener, and R.G. Rada. 1990. Mercury accumulation in yellow perch in Wisconsin seepage lakes: relation to lake characteristics. *Environmental Toxicology and Chemistry.* 9:931–940.

Coulston, F. and A.C. Kolbye, Jr. (eds). 1994. Interpretive review of the potential adverse effects of chlorinated organic chemicals on human health and the environment. *Regulatory Toxicology and Pharmacology.* 20:S1–S1056.

Diaz, G.W., R.J. Julian and R.J. Squires. 1994. Lesions in broiler chickens following experimental intoxication with cobalt. Avian Diseases, 38:308_316.

Domenico, P.A., and F.W. Schwartz. 1998. *Physical and Chemical Hydrogeology.* John Wiley & Sons, Inc. New York. 506 pp.

Eisler, R. 1989. *Pentachlorophenol hazards to fish, wildlife, and invertebrates: a synoptic review.* U.S. Fish and Wildlife Service Biological Report 85(1.17), Contaminant Hazard Reviews Report No. 17. 72 pp.

Ensafe/Allen & Hoshall (E/A&H). 1994. *Final Site Inspection Report, Phase II Indian Head Division, Naval Surface Warfare Center*.

Grimes, J. and M. Jaber. 1989. *Para-dichlorobenzene: An acute oral toxicity study with the bobwhite, Final Report.* Prepared by Wildlife International Ltd., Easton, MD under project No. 264-101 and submitted to Chemical Manufacturers Association, Washington, DC. July.

Haliburton NUS Corporation (HNUS). 1994a. *Environmental Permits Report and Field Sampling Report for Site 5 – Swale 2, Indian Head Division, Naval Surface Warfare Center*, Indian Head, Maryland. May.

HNUS. 1994b. *Engineering/Cost Analysis (EE/CA) Report for Installation Restoration Site 5 – Swale 2, Indian Head Division, Naval Surface Warfare Center.* Draft. April.

HNUS. 1995. *Post-Removal Action Report for Site 5 – Swale 2 at Indian Head Division, Naval Surface Warfare Center.* July 1995.

Hart, Fred C. Associates, Inc. (FCHA). 1983. *Initial Assessment Study of Naval Ordnance Station*, Indian Head, Maryland. May.

Hill, E.F. and M.B. Camardese. 1986. *Lethal dietary toxicities of environmental contaminants and pesticides to* Coturnix. U.S. Fish and Wildlife Service Technical Report 2.

Hill, E.F., R.G. Heath, J.W. Spann, and J.D. Williams. 1975. *Lethal dietary toxicities of environmental pollutants to birds.* U.S. Fish and Wildlife Service Special Scientific Report—Wildlife No. 191, Washington D.C.

Hiortdahl, S.N, 1990. *Changes in Ground-Water Quality Caused by River-Water Intrusion in the Potomac Group Aquifer System of Northwestern Charles County, Maryland* in *Proceedings of the FOCUS Conference on Eastern Regional Ground Water Issues*. Springfield, Massachusetts. October 17–19, 1990.

Hiortdahl, S.N, 1997. *Geologic Framework, Hydrogeology, and Ground-Water Quality of the Potomac Group Aquifer System, Northwestern Charles County, Maryland.* U.S. Geological Survey Water-Resources Investigation Report 91-4059.

Ingersoll, C.G., W.G. Brumbaugh, F.J. Dwyer, and N.E. Kemble. 1994. Bioaccumulation of metals by *Hyalella azteca* exposed to contaminated sediments from the Upper Clark Fork River, Montana. *Environmental Toxicology and Chemistry.* 13:2013–2020.

Integrated Risk Information System (IRIS). 1998. U.S. Environmental Protection Agency, Washington DC.

International Programme on Chemical Safety (IPCS). 1994. *Environmental Health Criteria 156 – Hexachlorobutadiene.* World Health Organization, Geneva.

Kearney, A.T., Inc. 1988. *Phase II RCRA Facility Assessment of the Naval Ordnance Station*, Indian Head, Maryland. August.

Krantzberg, G. and D. Boyd. 1992. The biological significance of contaminants in sediment from Hamilton Harbour, Lake Ontario. *Environmental Toxicology and Chemistry.* 11:1527–1540.

Maruya, K.A., R.W. Risebrough, and A.J. Horne. 1997. The bioaccumulation of polynuclear aromatic hydrocarbons by benthic invertebrates in an intertidal marsh. *Environmental Toxicology and Chemistry.* 16:1087–1097.

Maryland Department of Natural Resources (MDNR) Natural Heritage Program. 1992. *Rare, Threatened and Endangered Species and Natural Area Survey for the Naval Surface Warfare Center, Indian Head Division 1991–1992.*

McCollister, D.D., P.T. Lockwood, and V.K. Rowe. 1961. Toxicologic information on 2,4,5-trichlorophenol. *Toxicology and Applied Pharmacology.* 3:63–70.

McLane, M.A.R. and L.C. Hall. 1972. DDE thins Screech Owl eggshells. Bulletin Environmental Contamination and Toxicology. 8:65–68.

National Academy of Sciences (NAS). 1980. Mineral Tolerance of Domestic Animals. National Academy Press, Washington, DC.

National Toxicology Program (NTP). 1997. *Effect of dietary restriction on toxicology and carcinogenesis studies of butyl benzyl phthalate (CAS No. 85-68-7) in F344/N rats and B6C3F1 mice (feed studies).* Technical Report Series No. 458, NTP TR458. Prepared by U.S. Department of Health and Human Services.

NTP. 1989. *Toxicology and carcinogenesis studies of 2,4-dichlorophenol in F344/N rats and B6C3F1 mice (feed studies).* Technical Report Series No. 353. Research Triangle Park, NC: U.S. Department of Health and Human Services, Public Health Service, National Institutes of Health.

Naval Facilities Engineering Command (NAVFAC). 2001. *Navy Guidance for Conducting Ecological Risk Assessments.* http://web.ead.anl.gov/ecorisk/. February

Oliver, B.G. and A.J. Niimi. 1988. Trophodynamic analysis of polychlorinated biphenyl congeners and other chlorinated hydrocarbons in the Lake Ontario ecosystem. *Environmental Science and Technology.* 22:388–397.

Oliver, B.G. 1987. Biouptake of chlorinated hydrocarbons from laboratory-spiked and field sediments by oligochaete worms. *Environmental Science and Technology.* 21:785–790.

Opresko, D.M., B.E. Sample, and G.W. Suter II. 1993. *Toxicological benchmarks for wildlife.* Environmental Restoration Division, ORNL Environmental Restoration Program. ES/ER/TM-86.

Parsons Engineering Science, Inc. (Parsons). 2000. *Draft Integrated Natural Resources Management Plan (DINRMP), Naval Surface Warfare Center Indian Head Division*. Draft. February.

Pascoe, G.A., R.J. Blanchet, and G. Linder. 1996. Food chain analysis of exposures and risks to wildlife at a metals-contaminated wetland. *Archives of Environmental Contamination and Toxicology.* 30:306–318.

Patton, J.F. and M.P. Dieter. 1980. Effects of petroleum hydrocarbons on hepatic function in the duck. *Comp. Biochem. Physiol.* 65C:33–36.

Rungby, J. and G. Danscher. 1984. Hyperactivity in Silver Exposed Mice. *Acta Pharmacol et Toxicol.* 55: 398–401.

Science Applications International Corporation (SAIC). 2001. *Draft Site Report for: Sediment Toxicity Identification Evaluation Demonstration: Indian Head Naval Surface Warfare Center*. Submitted to: Department of the Navy. February.

Rigdon, R.H. and J. Neal. 1963. *Absorption and excretion of benzpyrene observation in the duck, chicken, mouse, and dog.* Texas Reports on Biology and Medicine. 21(2):247–261.

Sample, B.E., M.S. Aplin, R.A. Efroymson, G.W. Suter II, and C.J.E. Welsh. 1997. *Methods and tools for estimation of the exposure of terrestrial wildlife to contaminants.* Environmental Sciences Division, Oak Ridge National Laboratory. ORNL/TM-13391.

Sample, B.E., D.M. Opresko, and G.W. Suter II. 1996. *Toxicological benchmarks for wildlife: 1996 revision.* Environmental Restoration Division, ORNL Environmental Restoration Program. ES/ER/TM-86/R3.

Science Applications International Corporation (SAIC), 2001. Site report for sediment toxicity identification evaluation demonstration: Indian Head Naval Surface Warfare Center. February 13, 2001.

Stickel, L.F. 1973. Pesticide residues in birds and mammals. Pages 254–312 IN C.A. Edwards (ed). *Environmental pollution by pesticides.* Plenum Press, New York.

Suter, G.W. II and C.L. Tsao. 1996. *Toxicological benchmarks for screening potential contaminants of concern for effects on aquatic biota: 1996 revision.* Environmental Restoration Division, ORNL Environmental Restoration Program, ES/ER/TM-96/R2. 54 pp.

Terrestrial Toxicity Database (TERRETOX). 1998. Environmental Research Laboratory, U.S. Environmental Protection Agency, Duluth, MN.

Tetra Tech NUS (TTNUS). 2002. Background Soil Investigation Report for Indian Head and Stump Neck Annex, Naval Surface Warfare Center, Indian Head, Maryland. February, 2002. Report prepared for the Naval Surface Warfare Center, Indian Head, Maryland.

TTNUS. 1999. Results of a 28 day sediment toxicity test with *Hyalella azteca* for Naval Surface Warfare Center, Indian Head, Maryland. December 1, 1999. Report prepared for the Naval Surface Warfare Center, Indian Head, Maryland.

TTNUS. 1999. *Remedial Investigation Report Site 12 Towngut Landfill, Site 39/41 Organic Plant/Scrapyard, Site 42 Olsen Road Landfill, Site 44 Soakout Area, Indian Head Division, Naval Surface Warfare Center, Indian Head, Maryland*. July.

TTNUS. 2001. *Feasability Study Report Site 12 Towngut Landfill and Site 41 Scrapyard, Indian Head Division, Naval Surface Warfare Center, Indian Head, Maryland*. January.

Tucker, R.K. and D.G. Crabtree. 1970. *Handbook of toxicity of pesticides to wildlife.* U.S. Fish and Wildlife Service Research Publication 84. 131 pp.

United States Department of Agriculture, Soil Conservation Service (USDA SCS). 1974. *Soil Survey of Charles County, Maryland*.

United States Environmental Protection Agency (USEPA). 1984. *Health Assessment Document for Hexachlorocyclopentadiene.* EPA/600/8-84/001F.

USEPA. 1990. Assessment of risks from exposure of humans, terrestrial and avian wildlife, and aquatic life to dioxins and furans from disposal and use of sludge from bleached kraft and sulfite pulp and paper mills. EPA/560/5-90/013.

USEPA. 1992. Selecting Exposure Routes and Contaminants of concern by Risk–Based Screening. EPA/903/R-93-001. January

USEPA. 1993. Wildlife Exposure Factors Handbook. Volume I of II. USEPA Office of Research and Development. EPA/600/R-93/187a. December.

USEPA. 1995. Region III BTAG Screening Values.

USEPA Region III. 1995a. *Revised Region III BTAG screening levels.* Memorandum from R.S. Davis to Users. August.

USEPA. 1997. *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments*. Interim Final. EPA/540/R-97/006.

USEPA Region IV. 1999a. *Supplemental guidance to RAGS: Region 4 Ecological Risk Assessment Bulletins.* August.

USEPA. 1999b. *National Recommended Water Quality Criteria – Correction.* EPA/822/Z-99/001.

USEPA Region III. 2001. *Risk-Based Concentration Table*. Memorandum from Jennifer Hubbard to Users. September

Vroblesky, D. A. and W. B. Fleck. 1991. *Hydrogeologic framework of the coastal plain of Maryland, Delaware, and the District of Columbia*. United States Geological Survey Professional Paper 1404-E.

Wolf, M. A., V. K. Rowe, D. D. McCollister, R. L. Hollinsworth, and F. Oyen. 1956. Toxicological Studies of Certain Alkylated Benzenes and Benzene. Arch. Ind. Health. 14:387–398.

Appendix A
Boring Logs and Well Completion Diagrams

PROJECT NUMBER	BORING NUMBER	
145185.FI.MW	IS05MW01	SHEET 1 OF 1

SOIL BORING LOG

PROJECT : NSWC Indian Head LOCATION : Site 5

TOC ELEVATION 37.53 DRILLING CONTRACTOR : Groundwater Systems, Herndon, VA

DRILLING METHOD AND EQUIPMENT USED : 4-1/4-inch Hollow-stem Augers, CME 75 drill rig

WATER LEVELS : START :8/07/01 END : 8/07/01 LOGGER : E. Corack

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. OVM (ppm):
	2.0	24/24	1-S	11-11-12-10 (23)	Full Recovery 3" top soil, 21" stiff clay 0.0 PID no odor	Breathing Zone = 0.0 ppm
5	7.0	20/24	2-S	9-18-20-22 (38)	20" Recovery brown fine sand 0.0 PID no odor	Breathing Zone = 0.0 ppm Driller noted water table 6.5 ft bgs
10						
15					- End of Boring	Monitoring well set to 15 ft below grade

PROJECT NUMBER	WELL NUMBER		
145185.FI.MW	IS05MW01	SHEET 1	OF 1

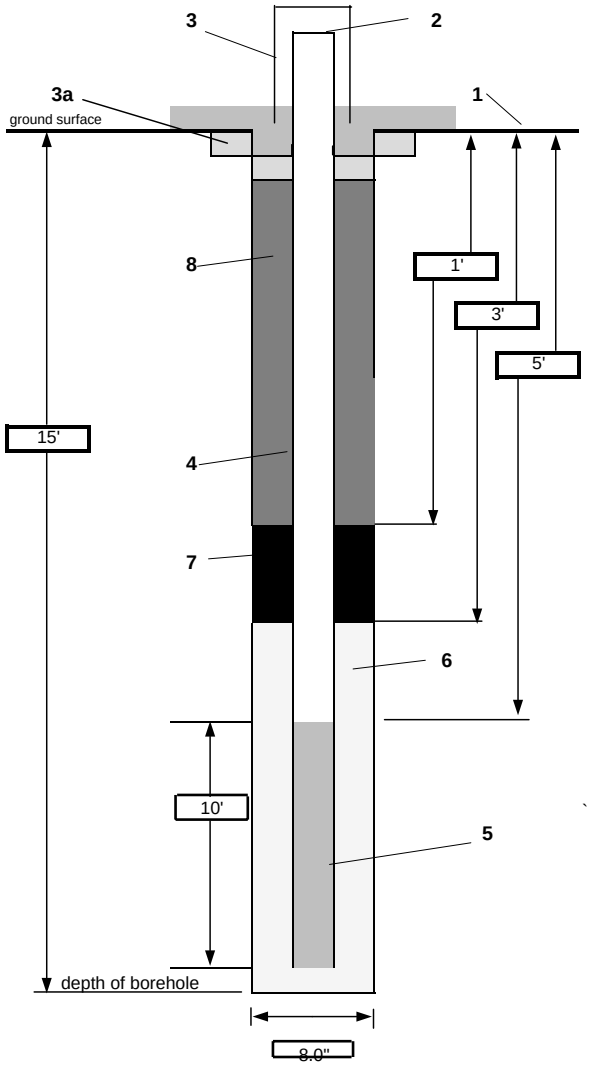
WELL COMPLETION DIAGRAM

PROJECT : NSWC Indian Head LOCATION : Site 5

DRILLING CONTRACTOR : Groundwater Systems, Herndon, VA

DRILLING METHOD AND EQUIPMENT USED : 4-1/4-inch Hollow-stem Augers

WATER LEVELS : START : 8/07/01 END : 8/07/01 LOGGER : E. Corack



1- Ground elevation at well	34.5
2- Top of casing elevation	37.53
3- Wellhead protection cover type	Riser casing with ballards
a) drain tube	sand drain
b) concrete pad dimensions	4 ft x 4 ft pad
4- Dia./type of well casing	9'11" length, 2" PVC Schedule 40
5- Type/slot size of screen	10' length, 2" PVC Schedule 40 10 slot
6- Type screen filter	DSI #1 filter sand
a) quantity used	
7- Type of seal	3/8" Bentonite Chips
a) quantity used	
8- Grout	
a) Grout mix used	(concrete pad down to bentonite)
b) Method of placement	
c) Vol. Of well casing grout	
Development method	surge/submersible pump
Development time	
Estimated purge volume	33 gallons

Comments Survey Datum: North American Vertical Datum 1988 (NAVD 8

C 1 5715 — SEQUENCE NO. (MDE USE ONLY)

1 2 3 6 (THIS NUMBER IS TO BE PUNCHED IN COLS. 3-6 ON ALL CARDS)

STATE OF MARYLAND
WELL COMPLETION REPORT
FILL IN THIS FORM COMPLETELY
PLEASE TYPE

THIS REPORT MUST BE SUBMITTED WITHIN 45 DAYS AFTER WELL IS COMPLETED.

COUNTY NUMBER 01-14161-W(T)

ST/CO USE ONLY DATE Received MM DD YY (8–13)

DATE WELL COMPLETED MM 08 DD 07 YY 01 (15–20)

Depth of Well 22 15 25 (TO NEAREST FOOT)

PERMIT NO. FROM "PERMIT TO DRILL WELL" 0 - 94 - 4157 (28–37)

OWNER US Navy Lantnavfac Eng Com (last name) (first name) ISO5MW01

STREET OR RFD 1510 Gilbert TOWN Norfork Va 23511

SUBDIVISION ____ SECTION ____ LOT ____

WELL LOG
Not required for driven wells

STATE THE KIND OF FORMATIONS PENETRATED, THEIR COLOR, DEPTH, THICKNESS AND IF WATER BEARING

DESCRIPTION (Use additional sheets if needed)	FEET FROM	FEET TO	check if water bearing
Top Soil	0	1'	
Clay	1'	6'	
Sandy Silty Clay	6	15	✓

NUMBER OF UNSUCCESSFUL WELLS: ____

WELL HYDROFRACTURED yes Y no N

CIRCLE APPROPRIATE LETTER
- A A WELL WAS ABANDONED AND SEALED WHEN THIS WELL WAS COMPLETED
- E ELECTRIC LOG OBTAINED
- P TEST WELL CONVERTED TO PRODUCTION WELL

I HEREBY CERTIFY THAT THIS WELL HAS BEEN CONSTRUCTED IN ACCORDANCE WITH COMAR 26.04.04 "WELL CONSTRUCTION" AND IN CONFORMANCE WITH ALL CONDITIONS STATED IN THE ABOVE CAPTIONED PERMIT, AND THAT THE INFORMATION PRESENTED HEREIN IS ACCURATE AND COMPLETE TO THE BEST OF MY KNOWLEDGE.

DRILLERS LIC. NO.: M __ D __ __ __

DRILLERS SIGNATURE (MUST MATCH SIGNATURE ON APPLICATION)

LIC. NO.: M __ D __ __ __

SITE SUPERVISOR (sign. of driller or journeyman responsible for sitework if different from permittee)

GROUTING RECORD
WELL HAS BEEN GROUTED (Circle Appropriate Box) yes Y 44 no N 44

TYPE OF GROUTING MATERIAL (Circle one)

CEMENT CM 43–46 BENTONITE CLAY BC 45–48

NO. OF BAGS 1 NO. OF POUNDS 94

GALLONS OF WATER 7

DEPTH OF GROUT SEAL (to nearest foot)

from 0 (48 TOP 52) ft. to 2 (54 BOTTOM 58) ft. (enter 0 if from surface)

CASING RECORD
casing types insert appropriate code below

ST STEEL, CO CONCRETE, PL PLASTIC, OT OTHER

MAIN CASING TYPE	Nominal diameter top (main) casing (nearest inch)!	Total depth of main casing (nearest foot)
PL (60 61)	2 (63 64)	5 (66 70)

OTHER CASING (if used) — EACH CASING

diameter inch	depth (feet) from	to

SCREEN RECORD
screen type or open hole insert appropriate code below

ST STEEL, BR BRASS BRONZE, HO OPEN HOLE, PL PLASTIC, OT OTHER

C 2 — DEPTH (nearest ft.)

EACH SCREEN	TYPE	from	to
1	PL (8 9)	5 (11 15)	15 (17 21)
2	(23 24)	(28 30)	(32 36)
3	(38 39)	(41 45)	(47 51)

SLOT SIZE 1 .010 2 ____ 3 ____

DIAMETER OF SCREEN 2" (56 60) (NEAREST INCH)

GRAVEL PACK IF WELL DRILLED WAS FLOWING WELL INSERT F IN BOX 68: from 3 to 15

MDE USE ONLY (NOT TO BE FILLED IN BY DRILLER)

T (E.R.O.S.) W Q

70 TELESCOPE CASING ____ 72 LOG INDICATOR ____ 74 75 76 OTHER DATA ____

C 3 (1 2)

PUMPING TEST
HOURS PUMPED (nearest hour) N/A (8 9)

PUMPING RATE (gal. per min.) ____ (11 15)

METHOD USED TO MEASURE PUMPING RATE ____

WATER LEVEL (distance from land surface)

BEFORE PUMPING ____ (17 20) ft.

WHEN PUMPING ____ (22 25) ft.

TYPE OF PUMP USED (for test)

A air (27), P piston (27), T turbine (27), C centrifugal (27), R rotary (27), O other (describe below) (27), J jet (27), S submersible (27)

PUMP INSTALLED
DRILLER INSTALLED PUMP (CIRCLE) (YES or NO) YES NO

IF DRILLER INSTALLS PUMP, THIS SECTION MUST BE COMPLETED FOR ALL WELLS.

TYPE OF PUMP INSTALLED PLACE (A,C,J,P,R,S,T,O) IN BOX 29. ____ (29)

CAPACITY: GALLONS PER MINUTE (to nearest gallon) ____ (31 35)

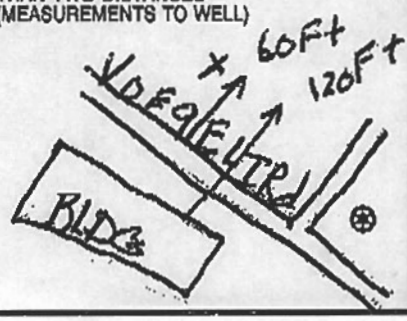
PUMP HORSE POWER ____ (37 41)

PUMP COLUMN LENGTH (nearest ft.) ____ (43 47)

CASING HEIGHT (circle appropriate box and enter casing height)

+ (48) above / – (49) below — LAND SURFACE 2 (50 51) (nearest foot)

LOCATION OF WELL ON LOT
SHOW PERMANENT STRUCTURE SUCH AS BUILDING, SEPTIC TANKS, AND /OR LANDMARKS AND INDICATE NOT LESS THAN TWO DISTANCES (MEASUREMENTS TO WELL)



PROJECT NUMBER	BORING NUMBER	
145185.FI.MW	IS05MW02	SHEET 1 OF 1

SOIL BORING LOG

PROJECT : NSWC Indian Head LOCATION : Site 5

TOC ELEVATION 34.46 DRILLING CONTRACTOR : Parratt-Wolff, Hillsborough, NC

DRILLING METHOD AND EQUIPMENT USED : 4-1/4-inch Hollow-stem Augers, CME 75 drill rig

WATER LEVELS : START :8/07/01 END : 8/07/01 LOGGER : E. Corack

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. OVM (ppm):
	2.0	14/24	1-S	2-4-6-7 (10)	4" top soil 10" tan stiff silty clay 0.0 PID no odor	Breathing Zone = 0.0 ppm
5						
	7.0	16/24	2-S	7-12-12-20 (24)	moist at 6' bgs 16" light brown fine sand no odor	Breathing Zone = 0.0 ppm
						Drillers note water table ~ 8'
10	12.0	24/24	3-S	3-3-4-2 (7)	wet, fat, plastic clay light brown and grey no odor	Breathing Zone = 0.0 ppm
15					- End of Boring	Monitoring well set to 16 ft below grade

PROJECT NUMBER	WELL NUMBER		
145185.FI.MW	IS05MW02	SHEET 1	OF 1

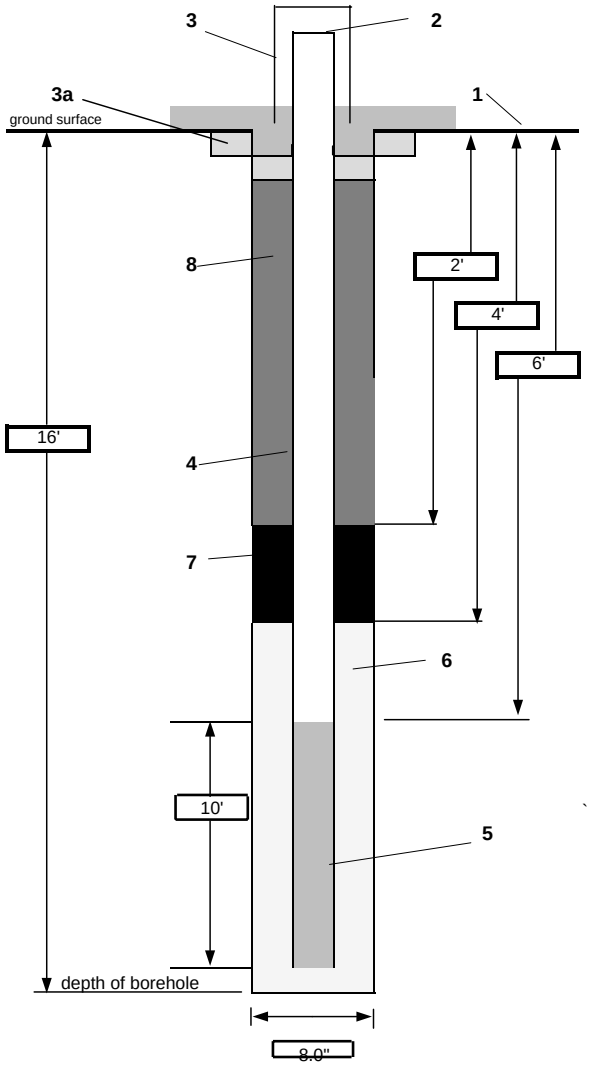
WELL COMPLETION DIAGRAM

PROJECT : NSWC Indian Head LOCATION : Site 5

DRILLING CONTRACTOR : Groundwater Systems, Herndon, VA

DRILLING METHOD AND EQUIPMENT USED : 4-1/4-inch Hollow-stem Augers

WATER LEVELS : START : 8/07/01 END : 8/07/01 LOGGER : E. Corack



1- Ground elevation at well	31.6
2- Top of casing elevation	34.46
3- Wellhead protection cover type	Riser casing with ballards
a) drain tube	sand drain
b) concrete pad dimensions	4 ft x 4 ft pad
4- Dia./type of well casing	9'3.5" length, 2" PVC Schedule 40
5- Type/slot size of screen	10' length, 2" PVC Schedule 40 10 slot
6- Type screen filter	DSI #1 filter sand
a) quantity used	
7- Type of seal	3/8" Bentonite Chips
a) quantity used	
8- Grout	
a) Grout mix used	(concrete pad down to bentonite)
b) Method of placement	
c) Vol. Of well casing grout	
Development method	surge/submersible pump
Development time	
Estimated purge volume	54 gallons

Comments Survey Datum: North American Vertical Datum 1988 (NAVD 8

C1 5716 SEQUENCE NO. (MDE USE ONLY)
1 2 3 6 (THIS NUMBER IS TO BE PUNCHED IN COLS. 3-6 ON ALL CARDS)

STATE OF MARYLAND
WELL COMPLETION REPORT
FILL IN THIS FORM COMPLETELY
PLEASE TYPE

THIS REPORT MUST BE SUBMITTED WITHIN 45 DAYS AFTER WELL IS COMPLETED.

COUNTY NUMBER 01-14162-W(CT)

ST/CO USE ONLY DATE Received MM DD YY 8 13

DATE WELL COMPLETED MM DD YY 08 07 01 (15 20)

Depth of Well 22 16 26 (TO NEAREST FOOT)

PERMIT NO. FROM "PERMIT TO DRILL WELL" CK - 94 - 4158 (28 29 30 31 32 33 34 35 36 37)

OWNER US Navy Lant Nav Fac Eng Com (last name) (first name) ESDS MAY-02
STREET OR RFD 1510 Gilbert TOWN Norfolk VA 23511
SUBDIVISION ____ SECTION ____ LOT ____

WELL LOG
Not required for driven wells

STATE THE KIND OF FORMATIONS PENETRATED, THEIR COLOR, DEPTH, THICKNESS AND IF WATER BEARING

DESCRIPTION (Use additional sheets if needed)	FEET FROM	FEET TO	check if water bearing
Top Soil	0	1'	
Clay	1'	8'	
Silty Sandy Clay	8	16	✓

NUMBER OF UNSUCCESSFUL WELLS: ____

WELL HYDROFRACTURED yes Y no (N)

CIRCLE APPROPRIATE LETTER
- A A WELL WAS ABANDONED AND SEALED WHEN THIS WELL WAS COMPLETED
- E ELECTRIC LOG OBTAINED
- P TEST WELL CONVERTED TO PRODUCTION WELL

I HEREBY CERTIFY THAT THIS WELL HAS BEEN CONSTRUCTED IN ACCORDANCE WITH COMAR 26.04.04 "WELL CONSTRUCTION" AND IN CONFORMANCE WITH ALL CONDITIONS STATED IN THE ABOVE CAPTIONED PERMIT, AND THAT THE INFORMATION PRESENTED HEREIN IS ACCURATE AND COMPLETE TO THE BEST OF MY KNOWLEDGE.

DRILLERS LIC. NO.: M D 4 8 4 1
[signature]
DRILLERS SIGNATURE (MUST MATCH SIGNATURE ON APPLICATION)

LIC. NO.: M D

SITE SUPERVISOR (sign. of driller or journeyman responsible for sitework if different from permittee)

GROUTING RECORD
WELL HAS BEEN GROUTED (Circle Appropriate Box) yes (Y) 44 no N 44

TYPE OF GROUTING MATERIAL (Circle one)
CEMENT (CM) 45 46 BENTONITE CLAY BC 45 46

NO. OF BAGS 1 NO. OF POUNDS 94
GALLONS OF WATER 7
DEPTH OF GROUT SEAL (to nearest foot)
from 0 (48 TOP 52) ft. to 4' (54 BOTTOM 58) ft.
(enter 0 if from surface)

CASING RECORD
casing types insert appropriate code below
- ST STEEL
- CO CONCRETE
- PL PLASTIC
- OT OTHER

MAIN CASING TYPE	Nominal diameter top (main) casing (nearest inch)	Total depth of main casing (nearest foot)
PL (50 51)	2 (63 64)	6 (66 70)

OTHER CASING (if used)

EACH CASING	diameter inch	depth (feet) from	to

SCREEN RECORD
screen type or open hole insert appropriate code below
- ST STEEL
- BR BRASS BRONZE
- HO OPEN HOLE
- PL PLASTIC
- OT OTHER

C2 DEPTH (nearest ft.)

EACH SCREEN			
1	PL (6 8)	6 (11 15)	16 (17 21)
2	(23 24)	(26 30)	(32 36)
3	(38 39)	(41 45)	(47 51)

SLOT SIZE 1 010 2 ____ 3 ____

DIAMETER OF SCREEN 2" (56 60) (NEAREST INCH)

GRAVEL PACK IF WELL DRILLED WAS FLOWING WELL INSERT F IN BOX 66 — from 4 to 16

MDE USE ONLY (NOT TO BE FILLED IN BY DRILLER)
T (E.R.O.S.) W Q
70 TELESCOPE CASING; 72 LOG INDICATOR; 74 75 76 OTHER DATA

C3 1 2

PUMPING TEST
N/A

HOURS PUMPED (nearest hour) ____ (8 9)

PUMPING RATE (gal. per min.) ____ (11 15)

METHOD USED TO MEASURE PUMPING RATE ____

WATER LEVEL (distance from land surface)

BEFORE PUMPING ____ (17 20) ft.

WHEN PUMPING ____ (22 25) ft.

TYPE OF PUMP USED (for test)
- A (27) air
- P (27) piston
- T (27) turbine
- C (27) centrifugal
- R (27) rotary
- O (27) other (describe below)
- J (27) jet
- S (27) submersible

PUMP INSTALLED
DRILLER INSTALLED PUMP (CIRCLE) (YES or NO) YES (NO)

IF DRILLER INSTALLS PUMP, THIS SECTION MUST BE COMPLETED FOR ALL WELLS.

TYPE OF PUMP INSTALLED PLACE (A,C,J,P,R,S,T,O) IN BOX 29. ____ (29)

CAPACITY: GALLONS PER MINUTE (to nearest gallon) ____ (31 35)

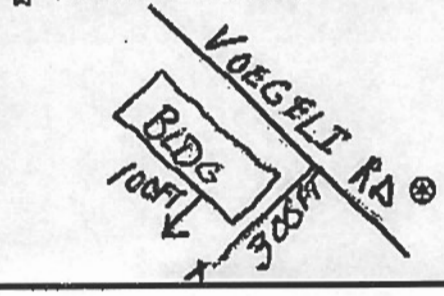
PUMP HORSE POWER ____ (37 41)

PUMP COLUMN LENGTH (nearest ft.) ____ (43 47)

CASING HEIGHT (circle appropriate box and enter casing height)
- (+) (49) above
- (–) (49) below

LAND SURFACE 2 (50 51) (nearest foot)

LOCATION OF WELL ON LOT
SHOW PERMANENT STRUCTURE SUCH AS BUILDING, SEPTIC TANKS, AND /OR LANDMARKS AND INDICATE NOT LESS THAN TWO DISTANCES (MEASUREMENTS TO WELL)



PROJECT NUMBER	BORING NUMBER	
145185.FI.MW	IS05MW03	SHEET 1 OF 1

SOIL BORING LOG

PROJECT : NSWC Indian Head LOCATION : Site 5

TOC ELEVATION 28.46 DRILLING CONTRACTOR : Parratt-Wolff, Hillsborough, NC

DRILLING METHOD AND EQUIPMENT USED : 4-1/4-inch Hollow-stem Augers, CME 75 drill rig

WATER LEVELS : START :8/06/01 END : 8/06/01 LOGGER : E. Corack

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. OVM (ppm):
	2.0	12/24	1-S	1-2-4-5 (6)	top soil light brown silty clay; no odor 0.0 PID	Breathing Zone = 0.0 ppm
5						
	7.0	16/24	2-S	5-8-11-12 (19)	grey brittle clay; no odor 0.0 PID	Breathing Zone = 0.0 ppm
10						Driller notes water table ~ 9 ft bgs
	12.0	13/24	3-S	4-5-6-7 (11)	light brown and grey stiff clay; no odor vein of grey sand at 11' and spoon is moist 0.0 PID	Breathing Zone = 0.0 ppm
15						
					- End of Boring	Monitoring well set to 17 ft below grade

PROJECT NUMBER	WELL NUMBER		
145185.FI.MW	IS05MW03	SHEET 1	OF 1

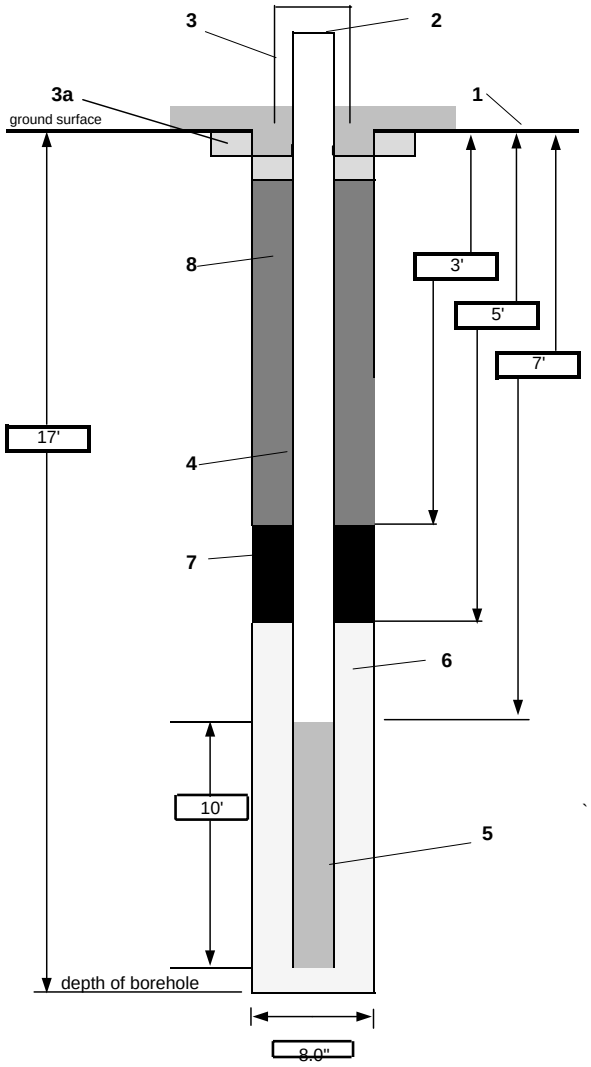
WELL COMPLETION DIAGRAM

PROJECT : NSWC Indian Head LOCATION : Site 5

DRILLING CONTRACTOR : Groundwater Systems, Herndon, VA

DRILLING METHOD AND EQUIPMENT USED : 4-1/4-inch Hollow-stem Augers

WATER LEVELS : START : 8/06/01 END : 8/06/01 LOGGER : E. Corack



1- Ground elevation at well	26.6
2- Top of casing elevation	28.46
3- Wellhead protection cover type	Riser casing with ballards
a) drain tube	sand drain
b) concrete pad dimensions	4 ft x 4 ft pad
4- Dia./type of well casing	9'1.5" length, 2" PVC Schedule 40
5- Type/slot size of screen	10' length, 2" PVC Schedule 40 10 slot
6- Type screen filter	DSI #1 filter sand
a) quantity used	
7- Type of seal	3/8" Bentonite Chips
a) quantity used	
8- Grout	
a) Grout mix used	(concrete pad down to bentonite)
b) Method of placement	
c) Vol. Of well casing grout	
Development method	surge/submersible pump
Development time	
Estimated purge volume	40 gallons

Comments Survey Datum: North American Vertical Datum 1988 (NAVD 8

C 1 [illegible] SEQUENCE NO. (MDE USE ONLY)

1 2 3 6 (THIS NUMBER IS TO BE PUNCHED IN COLS. 3-6 ON ALL CARDS)

STATE OF MARYLAND
WELL COMPLETION REPORT
FILL IN THIS FORM COMPLETELY
PLEASE TYPE

THIS REPORT MUST BE SUBMITTED WITHIN 45 DAYS AFTER WELL IS COMPLETED.

COUNTY NUMBER 01-14-160.W(T)

ST/CO USE ONLY DATE Received MM DD YY 8 13

DATE WELL COMPLETED MM DD YY 08 06 01 15 20

Depth of Well 22 17 26 (TO NEAREST FOOT)

PERMIT NO. FROM "PERMIT TO DRILL WELL" [illegible] 28 29 30 31 32 33 34 35 36 37

OWNER US Navy Lant Nav Fac (TEL) 2505MW-03

STREET OR RFD 1510 Gilbert (last name) (first name) TOWN Norfolk VA 23511

SUBDIVISION ____ SECTION ____ LOT ____

WELL LOG
Not required for driven wells

STATE THE KIND OF FORMATIONS PENETRATED, THEIR COLOR, DEPTH, THICKNESS AND IF WATER BEARING

DESCRIPTION (Use additional sheets if needed)	FEET FROM	FEET TO	check if water bearing
Top Soils	0	1'	
Clay	1'	6'	
Sand	6	8	
Silty Sandy Clay	8	17	✓

NUMBER OF UNSUCCESSFUL WELLS: ____

WELL HYDROFRACTURED yes Y no N

CIRCLE APPROPRIATE LETTER
- A A WELL WAS ABANDONED AND SEALED WHEN THIS WELL WAS COMPLETED
- E ELECTRIC LOG OBTAINED
- P TEST WELL CONVERTED TO PRODUCTION WELL

I HEREBY CERTIFY THAT THIS WELL HAS BEEN CONSTRUCTED IN ACCORDANCE WITH COMAR 26.04.04 "WELL CONSTRUCTION" AND IN CONFORMANCE WITH ALL CONDITIONS STATED IN THE ABOVE CAPTIONED PERMIT, AND THAT THE INFORMATION PRESENTED HEREIN IS ACCURATE AND COMPLETE TO THE BEST OF MY KNOWLEDGE.

DRILLERS LIC. NO.: M W D [illegible]

DRILLERS SIGNATURE (MUST MATCH SIGNATURE ON APPLICATION)

LIC. NO.: M ___ D ___

SITE SUPERVISOR (sign. of driller or journeyman responsible for sitework if different from permittee)

GROUTING RECORD
WELL HAS BEEN GROUTED (Circle Appropriate Box) yes Y 44 no N 44

TYPE OF GROUTING MATERIAL (Circle one)

CEMENT CM 45 46 BENTONITE CLAY BC 45 46

NO. OF BAGS 2 NO. OF POUNDS 94

GALLONS OF WATER 16

DEPTH OF GROUT SEAL (to nearest foot)

from 0 ft. to 5 ft.
48 TOP 52 54 BOTTOM 58
(enter 0 if from surface)

CASING RECORD
casing types insert appropriate code below

ST STEEL, CO CONCRETE, PL PLASTIC, OT OTHER

MAIN CASING TYPE PL 60 61

Nominal diameter top (main) casing (nearest inch)! 2" 63 64

Total depth of main casing (nearest foot) 7 66 70

OTHER CASING (If used) EACH CASING

diameter inch	depth (feet) from	to

SCREEN RECORD
screen type or open hole insert appropriate code below

ST STEEL, BR BRASS BRONZE, HO OPEN HOLE, PL PLASTIC, OT OTHER

C 2 1 2

DEPTH (nearest ft.) EACH SCREEN

1 PL 7 17
8 9 11 15 17 21

2 ____
23 24 26 30 32 36

3 ____
38 39 41 45 47 51

SLOT SIZE 1 .010 2 ____ 3 ____

DIAMETER OF SCREEN 2" (NEAREST INCH) 56 60

GRAVEL PACK IF WELL DRILLED WAS FLOWING WELL INSERT F IN BOX 68

from	to
5	17

68

MDE USE ONLY (NOT TO BE FILLED IN BY DRILLER)

T (E.R.O.S.) W Q

70 TELESCOPE CASING ____ 72 LOG INDICATOR ____ 74 75 76 OTHER DATA ____

C 3 1 2

PUMPING TEST
HOURS PUMPED (nearest hour) N/A 8 9

PUMPING RATE (gal. per min.) ____ 11 15

METHOD USED TO MEASURE PUMPING RATE ____

WATER LEVEL (distance from land surface)

BEFORE PUMPING ____ ft. 17 20

WHEN PUMPING ____ ft. 22 25

TYPE OF PUMP USED (for test)

A air, P piston, T turbine, C centrifugal, R rotary, O other (describe below), J jet, S submersible (27)

PUMP INSTALLED
DRILLER INSTALLED PUMP (CIRCLE) (YES or NO) YES NO

IF DRILLER INSTALLS PUMP, THIS SECTION MUST BE COMPLETED FOR ALL WELLS.

TYPE OF PUMP INSTALLED PLACE (A,C,J,P,R,S,T,O) IN BOX 29. ____ 29

CAPACITY: GALLONS PER MINUTE (to nearest gallon) ____ 31 35

PUMP HORSE POWER ____ 37 41

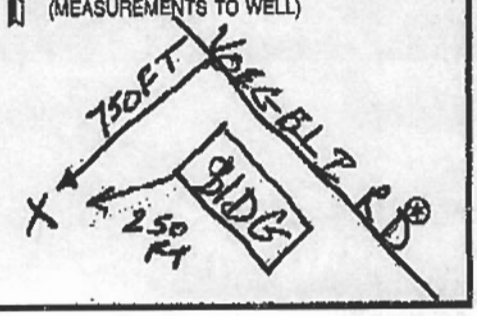
PUMP COLUMN LENGTH (nearest ft.) ____ 43 47

CASING HEIGHT (circle appropriate box and enter casing height)

+ above, − below (49) LAND SURFACE 2 (nearest foot) 50 51

LOCATION OF WELL ON LOT

SHOW PERMANENT STRUCTURE SUCH AS BUILDING, SEPTIC TANKS, AND /OR LANDMARKS AND INDICATE NOT LESS THAN TWO DISTANCES (MEASUREMENTS TO WELL)



Appendix B
Survey Report

PROJECT NUMBER	BORING NUMBER	
145185.FI.MW	IS05MW01	SHEET 1 OF 1

SOIL BORING LOG

PROJECT : NSWC Indian Head LOCATION : Site 5

TOC ELEVATION 37.53 DRILLING CONTRACTOR : Groundwater Systems, Herndon, VA

DRILLING METHOD AND EQUIPMENT USED : 4-1/4-inch Hollow-stem Augers, CME 75 drill rig

WATER LEVELS : START :8/07/01 END : 8/07/01 LOGGER : E. Corack

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. OVM (ppm):
	2.0	24/24	1-S	11-11-12-10 (23)	Full Recovery 3" top soil, 21" stiff clay 0.0 PID no odor	Breathing Zone = 0.0 ppm
5	7.0	20/24	2-S	9-18-20-22 (38)	20" Recovery brown fine sand 0.0 PID no odor	Breathing Zone = 0.0 ppm Driller noted water table 6.5 ft bgs
10						
15					- End of Boring	Monitoring well set to 15 ft below grade

PROJECT NUMBER	BORING NUMBER	
145185.FI.MW	IS05MW02	SHEET 1 OF 1

SOIL BORING LOG

PROJECT : NSWC Indian Head LOCATION : Site 5

TOC ELEVATION 34.46 DRILLING CONTRACTOR : Parratt-Wolff, Hillsborough, NC

DRILLING METHOD AND EQUIPMENT USED : 4-1/4-inch Hollow-stem Augers, CME 75 drill rig

WATER LEVELS : START :8/07/01 END : 8/07/01 LOGGER : E. Corack

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. OVM (ppm):
	2.0	14/24	1-S	2-4-6-7 (10)	4" top soil 10" tan stiff silty clay 0.0 PID no odor	Breathing Zone = 0.0 ppm
5	7.0	16/24	2-S	7-12-12-20 (24)	moist at 6' bgs 16" light brown fine sand no odor	Breathing Zone = 0.0 ppm Drillers note water table ~ 8'
10	12.0	24/24	3-S	3-3-4-2 (7)	wet, fat, plastic clay light brown and grey no odor	Breathing Zone = 0.0 ppm
15					- End of Boring	Monitoring well set to 16 ft below grade

PROJECT NUMBER	BORING NUMBER	
145185.FI.MW	IS05MW03	SHEET 1 OF 1

SOIL BORING LOG

PROJECT : NSWC Indian Head LOCATION : Site 5

TOC ELEVATION 28.46 DRILLING CONTRACTOR : Parratt-Wolff, Hillsborough, NC

DRILLING METHOD AND EQUIPMENT USED : 4-1/4-inch Hollow-stem Augers, CME 75 drill rig

WATER LEVELS : START :8/06/01 END : 8/06/01 LOGGER : E. Corack

DEPTH BELOW SURFACE (FT)	INTERVAL (FT)	RECOVERY (IN)	#/TYPE	STANDARD PENETRATION TEST RESULTS 6"-6"-6"-6" (N)	SOIL DESCRIPTION: SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY, OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY.	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS, AND INSTRUMENTATION. OVM (ppm):
	2.0	12/24	1-S	1-2-4-5 (6)	top soil light brown silty clay; no odor 0.0 PID	Breathing Zone = 0.0 ppm
5						
	7.0	16/24	2-S	5-8-11-12 (19)	grey brittle clay; no odor 0.0 PID	Breathing Zone = 0.0 ppm
10						Driller notes water table ~ 9 ft bgs
	12.0	13/24	3-S	4-5-6-7 (11)	light brown and grey stiff clay; no odor vein of grey sand at 11' and spoon is moist 0.0 PID	Breathing Zone = 0.0 ppm
15						
					- End of Boring	Monitoring well set to 17 ft below grade

PROJECT NUMBER	WELL NUMBER		
145185.FI.MW	IS05MW01	SHEET 1	OF 1

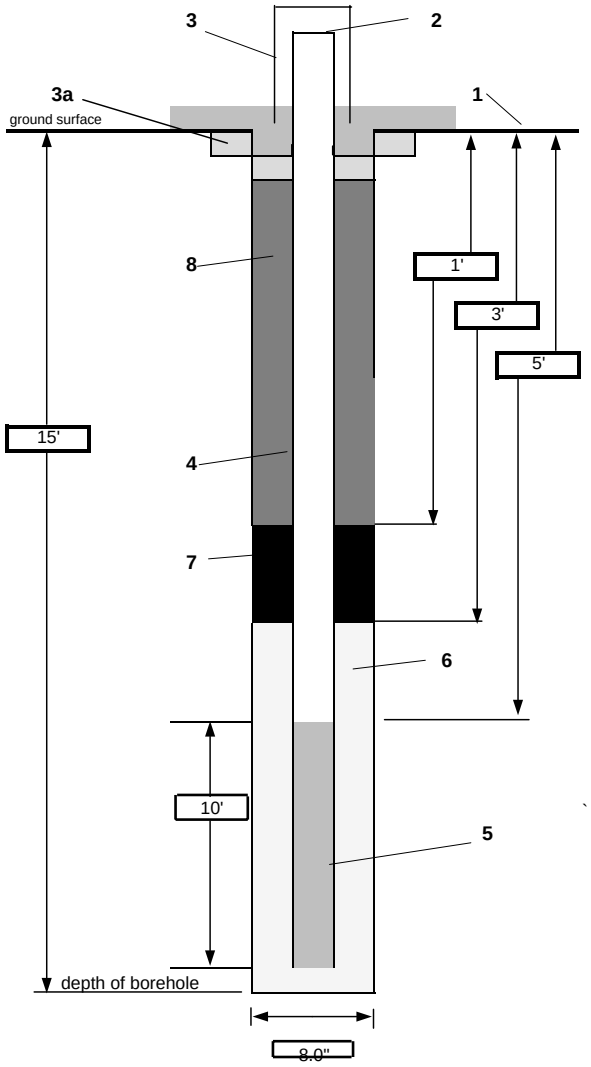
WELL COMPLETION DIAGRAM

PROJECT : NSWC Indian Head LOCATION : Site 5

DRILLING CONTRACTOR : Groundwater Systems, Herndon, VA

DRILLING METHOD AND EQUIPMENT USED : 4-1/4-inch Hollow-stem Augers

WATER LEVELS : START : 8/07/01 END : 8/07/01 LOGGER : E. Corack



1- Ground elevation at well	34.5
2- Top of casing elevation	37.53
3- Wellhead protection cover type	Riser casing with ballards
a) drain tube	sand drain
b) concrete pad dimensions	4 ft x 4 ft pad
4- Dia./type of well casing	9'11" length, 2" PVC Schedule 40
5- Type/slot size of screen	10' length, 2" PVC Schedule 40 10 slot
6- Type screen filter	DSI #1 filter sand
a) quantity used	
7- Type of seal	3/8" Bentonite Chips
a) quantity used	
8- Grout	
a) Grout mix used	(concrete pad down to bentonite)
b) Method of placement	
c) Vol. Of well casing grout	
Development method	surge/submersible pump
Development time	
Estimated purge volume	33 gallons

Comments Survey Datum: North American Vertical Datum 1988 (NAVD 8

PROJECT NUMBER	WELL NUMBER		
145185.FI.MW	IS05MW02	SHEET 1	OF 1

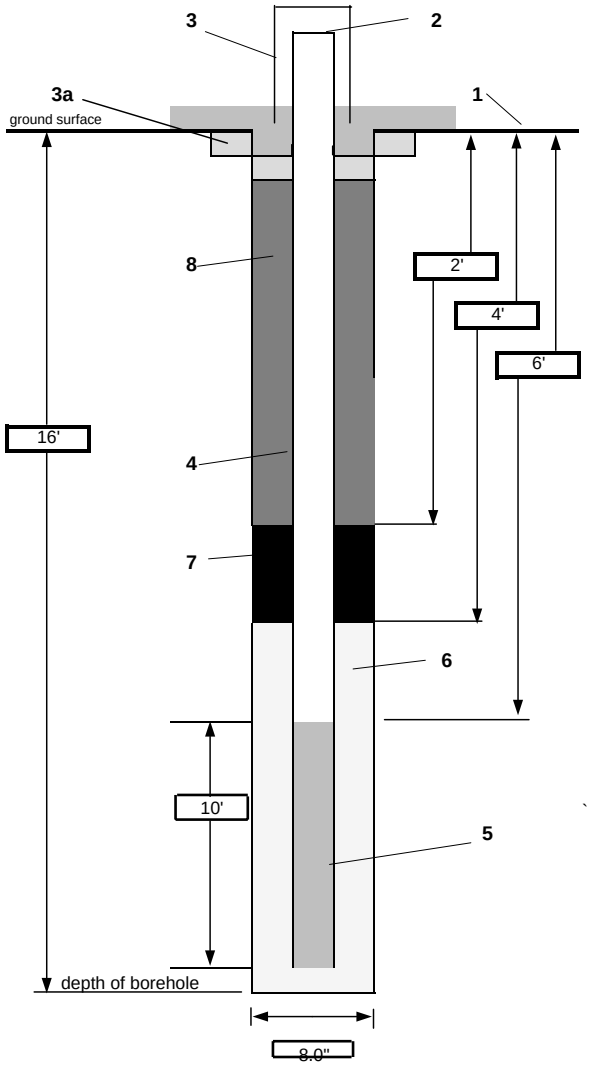
WELL COMPLETION DIAGRAM

PROJECT : NSWC Indian Head LOCATION : Site 5

DRILLING CONTRACTOR : Groundwater Systems, Herndon, VA

DRILLING METHOD AND EQUIPMENT USED : 4-1/4-inch Hollow-stem Augers

WATER LEVELS : START : 8/07/01 END : 8/07/01 LOGGER : E. Corack



1- Ground elevation at well	31.6
2- Top of casing elevation	34.46
3- Wellhead protection cover type	Riser casing with ballards
a) drain tube	sand drain
b) concrete pad dimensions	4 ft x 4 ft pad
4- Dia./type of well casing	9'3.5" length, 2" PVC Schedule 40
5- Type/slot size of screen	10' length, 2" PVC Schedule 40 10 slot
6- Type screen filter	DSI #1 filter sand
a) quantity used	
7- Type of seal	3/8" Bentonite Chips
a) quantity used	
8- Grout	
a) Grout mix used	(concrete pad down to bentonite)
b) Method of placement	
c) Vol. Of well casing grout	
Development method	surge/submersible pump
Development time	
Estimated purge volume	54 gallons

Comments Survey Datum: North American Vertical Datum 1988 (NAVD 8

PROJECT NUMBER	WELL NUMBER		
145185.FI.MW	IS05MW03	SHEET 1	OF 1

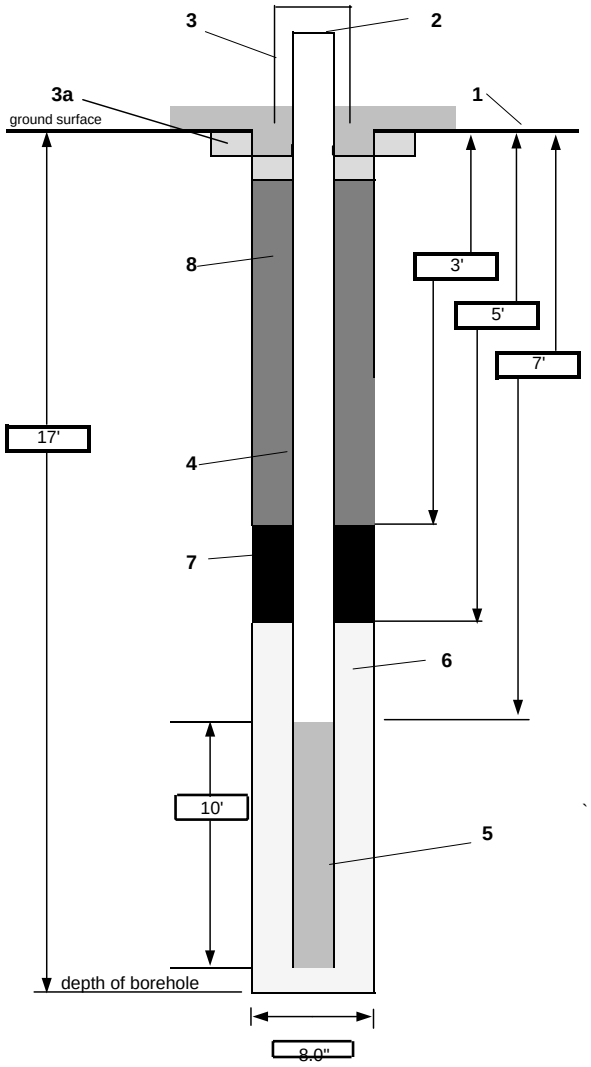
WELL COMPLETION DIAGRAM

PROJECT : NSWC Indian Head LOCATION : Site 5

DRILLING CONTRACTOR : Groundwater Systems, Herndon, VA

DRILLING METHOD AND EQUIPMENT USED : 4-1/4-inch Hollow-stem Augers

WATER LEVELS : START : 8/06/01 END : 8/06/01 LOGGER : E. Corack



1- Ground elevation at well	26.6
2- Top of casing elevation	28.46
3- Wellhead protection cover type	Riser casing with ballards
a) drain tube	sand drain
b) concrete pad dimensions	4 ft x 4 ft pad
4- Dia./type of well casing	9'1.5" length, 2" PVC Schedule 40
5- Type/slot size of screen	10' length, 2" PVC Schedule 40 10 slot
6- Type screen filter	DSI #1 filter sand
a) quantity used	
7- Type of seal	3/8" Bentonite Chips
a) quantity used	
8- Grout	
a) Grout mix used	(concrete pad down to bentonite)
b) Method of placement	
c) Vol. Of well casing grout	
Development method	surge/submersible pump
Development time	
Estimated purge volume	40 gallons

Comments Survey Datum: North American Vertical Datum 1988 (NAVD 8

Appendix C
Raw Data Tables

Table C-1
Groundwater Raw Data
Site 5 SSA
IHDIV-NSWC
Indian Head, Maryland

Station ID	IS05MW01		IS05MW02				IS05MW03		IS42MW02		IS42MW07	
Sample ID	IS05MW010801		IS05MW020801		IS05MW060801		IS05MW030801		IS05MW040801		IS05MW050801	
Sample Date	08/21/01		08/21/01		08/21/01		08/21/01		08/21/01		08/21/01	
Chemical Name												
Volatile Organic Compounds (UG/L)												
1,1,1-Trichloroethane	10	U	10	U	10	R	10	U	10	U	2.1	J
1,1,2,2-Tetrachloroethane	10	U	10	U	10	R	10	U	10	U	10	U
1,1,2-Trichloro-1,2,2-trifluoroethane(Freon-113)	10	U	10	U	10	R	10	U	10	U	10	U
1,1,2-Trichloroethane	10	U	10	U	10	R	10	U	10	U	10	U
1,1-Dichloroethane	10	U	10	U	10	R	10	U	10	U	4.3	J
1,1-Dichloroethene	10	U	10	U	10	R	10	U	10	U	10	U
1,2,4-Trichlorobenzene	10	U	10	U	10	R	10	U	10	U	10	U
1,2-Dibromo-3-chloropropane	10	U	10	U	10	R	10	U	10	U	10	U
1,2-Dibromoethane	10	U	10	U	10	R	10	U	10	U	10	U
1,2-Dichlorobenzene	10	U	10	U	10	R	10	U	10	U	10	U
1,2-Dichloroethane	10	U	10	U	10	R	10	U	10	U	10	U
1,2-Dichloropropane	10	U	10	U	10	R	10	U	10	U	10	U
1,3-Dichlorobenzene	10	U	10	U	10	R	10	U	10	U	10	U
1,4-Dichlorobenzene	10	U	10	U	10	R	10	U	10	U	10	U
2-Butanone	10	R	10	R	10	R	10	R	10	R	10	R
2-Hexanone	10	U	10	U	10	R	10	U	10	U	10	U
4-Methyl-2-pentanone	10	U	10	U	10	R	10	U	10	U	10	U
Acetone	8	B	15	B	9	R	10	U	10	U	9.1	B
Benzene	10	U	10	U	10	R	10	U	10	U	10	U
Bromodichloromethane	10	U	10	U	10	R	10	U	10	U	10	U
Bromoform	10	U	10	U	10	R	10	U	10	U	10	U
Bromomethane	10	U	10	U	10	R	10	U	10	U	10	U
Carbon disulfide	10	U	10	U	10	R	10	U	10	U	10	U
Carbon tetrachloride	10	U	10	U	10	R	10	U	10	U	10	U
Chlorobenzene	10	U	10	U	10	R	10	U	10	U	10	U
Chloroethane	10	U	10	U	10	R	10	U	10	U	10	U
Chloroform	10	U	10	U	10	R	10	U	10	U	10	U
Chloromethane	10	U	10	U	10	R	10	U	10	U	10	U
Cumene	10	U	10	U	10	R	10	U	10	U	10	U
Cyclohexane	10	U	10	U	10	R	10	U	10	U	10	U
Dibromochloromethane	10	U	10	U	10	R	10	U	10	U	10	U
Dichlorodifluoromethane(Freon-12)	10	U	10	U	10	R	10	U	10	U	10	U
Ethylbenzene	10	U	10	U	10	R	10	U	10	U	10	U

B - Analyte not detected above associated blank
J - Reported value is estimated
K - Reported value is biased high
L - Reported value is biased low
R - Unreliable result
U - Analyte not detected

Table C-1
Groundwater Raw Data
Site 5 SSA
IHDIV-NSWC
Indian Head, Maryland

Station ID	IS05MW01		IS05MW02				IS05MW03		IS42MW02		IS42MW07	
Sample ID	IS05MW010801		IS05MW020801		IS05MW060801		IS05MW030801		IS05MW040801		IS05MW050801	
Sample Date	08/21/01		08/21/01		08/21/01		08/21/01		08/21/01		08/21/01	
Chemical Name												
Methyl acetate	10	U	10	U	10	R	10	U	10	U	10	U
Methyl-tert-butyl ether (MTBE)	10	U	10	U	10	R	10	U	10	U	10	U
Methylcyclohexane	10	U	10	U	10	R	10	U	10	U	10	U
Methylene chloride	1.6	B	10	U	1.6	R	10	U	10	U	10	U
Styrene	10	U	10	U	10	R	10	U	10	U	10	U
Tetrachloroethene	10	U	10	U	10	R	10	U	10	U	1	J
Toluene	10	U	10	U	10	R	10	U	10	U	10	U
Trichloroethene	10	U	10	U	10	R	10	U	10	U	10	U
Trichlorofluoromethane(Freon-11)	10	U	10	U	10	R	10	U	10	U	10	U
Vinyl chloride	10	U	10	U	10	R	10	U	10	U	10	U
Xylene, total	10	U	10	U	10	R	10	U	10	U	10	U
cis-1,2-Dichloroethene	10	U	10	U	10	R	10	U	10	U	10	U
cis-1,3-Dichloropropene	10	U	10	U	10	R	10	U	10	U	10	U
o-Xylene	10	U	10	U	10	R	10	U	10	U	10	U
trans-1,2-Dichloroethene	10	U	10	U	10	R	10	U	10	U	10	U
trans-1,3-Dichloropropene	10	U	10	U	10	R	10	U	10	U	10	U
Semi-volatile Organic Compounds (UG/L)												
1,1-Biphenyl	10	U	10	U	10	U	10	U	10	U	10	U
2,2'-Oxybis(1-chloropropane)	10	U	10	U	10	U	10	U	10	U	10	U
2,4,5-Trichlorophenol	25	U	25	U	25	U	25	U	25	U	25	U
2,4,6-Trichlorophenol	10	U	10	U	10	U	10	U	10	U	10	U
2,4-Dichlorophenol	10	U	10	U	10	U	10	U	10	U	10	U
2,4-Dimethylphenol	10	U	10	U	10	U	10	U	10	U	10	U
2,4-Dinitrophenol	25	U	25	U	25	U	25	U	25	U	25	U
2,4-Dinitrotoluene	10	U	10	U	10	U	10	U	10	U	10	U
2,6-Dinitrotoluene	10	U	10	U	10	U	10	U	10	U	10	U
2-Chloronaphthalene	10	U	10	U	10	U	10	U	10	U	10	U
2-Chlorophenol	10	U	10	U	10	U	10	U	10	U	10	U
2-Methylnaphthalene	10	U	10	U	10	U	10	U	10	U	10	U
2-Methylphenol	10	U	10	U	10	U	10	U	10	U	10	U
2-Nitroaniline	25	U	25	U	25	U	25	U	25	U	25	U
2-Nitrophenol	10	U	10	U	10	U	10	U	10	U	10	U
3,3'-Dichlorobenzidine	10	U	10	U	10	U	10	U	10	U	10	U
3- and 4-Methylphenol	10	U	10	U	10	U	10	U	10	U	10	U

B - Analyte not detected above associated blank
J - Reported value is estimated
K - Reported value is biased high
L - Reported value is biased low
R - Unreliable result
U - Analyte not detected

Table C-1
Groundwater Raw Data
Site 5 SSA
IHDIV-NSWC
Indian Head, Maryland

Station ID	IS05MW01		IS05MW02		IS05MW02		IS05MW03		IS42MW02		IS42MW07	
Sample ID	IS05MW010801		IS05MW020801		IS05MW060801		IS05MW030801		IS05MW040801		IS05MW050801	
Sample Date	08/21/01		08/21/01		08/21/01		08/21/01		08/21/01		08/21/01	
Chemical Name												
3-Nitroaniline	25	U	25	U	25	U	25	U	25	U	25	U
4,6-Dinitro-2-methylphenol	25	U	25	U	25	U	25	U	25	U	25	U
4-Bromophenyl-phenylether	10	U	10	U	10	U	10	U	10	U	10	U
4-Chloro-3-methylphenol	10	U	10	U	10	U	10	U	10	U	10	U
4-Chloroaniline	10	U	10	U	10	U	10	U	10	U	10	U
4-Chlorophenyl-phenylether	10	U	10	U	10	U	10	U	10	U	10	U
4-Nitroaniline	25	U	25	U	25	U	25	U	25	U	25	U
4-Nitrophenol	25	U	25	U	25	U	25	U	25	U	25	U
Acenaphthene	10	U	10	U	10	U	10	U	10	U	10	U
Acenaphthylene	10	U	10	U	10	U	10	U	10	U	10	U
Acetophenone	10	U	10	U	10	U	10	U	10	U	10	U
Anthracene	10	U	10	U	10	U	10	U	10	U	10	U
Atrazine	10	U	10	U	10	U	10	U	10	U	10	U
Benzaldehyde	10	U	10	U	10	U	10	U	10	U	10	U
Benzo(a)anthracene	10	U	10	U	10	U	10	U	10	U	10	U
Benzo(a)pyrene	10	U	10	U	10	U	10	U	10	U	10	U
Benzo(b)fluoranthene	10	U	10	U	10	U	10	U	10	U	10	U
Benzo(g,h,i)perylene	10	U	10	U	10	U	10	U	10	U	10	U
Benzo(k)fluoranthene	10	U	10	U	10	U	10	U	10	U	10	U
Butylbenzylphthalate	10	U	10	U	10	U	10	U	10	U	10	U
Caprolactam	10	U	10	U	10	U	10	U	10	U	10	U
Carbazole	10	U	10	U	10	U	10	U	10	U	10	U
Chrysene	10	U	10	U	10	U	10	U	10	U	10	U
Di-n-butylphthalate	10	U	10	U	10	U	10	U	10	U	10	U
Di-n-octylphthalate	10	U	10	U	10	U	10	U	10	U	10	U
Dibenz(a,h)anthracene	10	U	10	U	10	U	10	U	10	U	10	U
Dibenzofuran	10	U	10	U	10	U	10	U	10	U	10	U
Diethylphthalate	10	U	10	U	10	U	10	U	10	U	10	U
Dimethyl phthalate	10	U	10	U	10	U	10	U	10	U	10	U
Fluoranthene	10	U	10	U	10	U	10	U	10	U	10	U
Fluorene	10	U	10	U	10	U	10	U	10	U	10	U
Hexachlorobenzene	10	U	10	U	10	U	10	U	10	U	10	U
Hexachlorobutadiene	10	U	10	U	10	U	10	U	10	U	10	U
Hexachlorocyclopentadiene	10	U	10	U	10	U	10	U	10	U	10	U
Hexachloroethane	10	U	10	U	10	U	10	U	10	U	10	U

B - Analyte not detected above associated blank
J - Reported value is estimated
K - Reported value is biased high
L - Reported value is biased low
R - Unreliable result
U - Analyte not detected

Table C-1
Groundwater Raw Data
Site 5 SSA
IHDIV-NSWC
Indian Head, Maryland

Station ID	IS05MW01		IS05MW02				IS05MW03		IS42MW02		IS42MW07	
Sample ID	IS05MW010801		IS05MW020801		IS05MW060801		IS05MW030801		IS05MW040801		IS05MW050801	
Sample Date	08/21/01		08/21/01		08/21/01		08/21/01		08/21/01		08/21/01	
Chemical Name												
Indeno(1,2,3-cd)pyrene	10	U	10	U	10	U	10	U	10	U	10	U
Isophorone	10	U	10	U	10	U	10	U	10	U	10	U
Naphthalene	10	U	10	U	10	U	10	U	10	U	10	U
Nitrobenzene	10	U	10	U	10	U	10	U	10	U	10	U
Pentachlorophenol	25	U	25	U	25	U	25	U	25	U	25	U
Phenanthrene	10	U	10	U	10	U	10	U	10	U	10	U
Phenol	10	U	10	U	10	U	10	U	10	U	10	U
Pyrene	10	U	10	U	10	U	10	U	10	U	10	U
bis(2-Chloroethoxy)methane	10	U	10	U	10	U	10	U	10	U	10	U
bis(2-Chloroethyl)ether	10	U	10	U	10	U	10	U	10	U	10	U
bis(2-Ethylhexyl)phthalate	10	U	10	U	10	U	10	U	10	U	10	U
n-Nitroso-di-n-propylamine	10	U	10	U	10	U	10	U	10	U	10	U
n-Nitrosodiphenylamine	10	U	10	U	10	U	10	U	10	U	10	U
Total Metals (UG/L)												
Aluminum	1,760		2,750		1,800		3,050		45.9	J	41,200	
Antimony	3.7	U	3.7	U	3.7	U	3.7	U	3.7	U	3.7	U
Arsenic	5	U	5	U	5	U	5	U	15.5		19.9	
Barium	258		82.9	J	74.9	J	122	J	187	J	836	
Beryllium	2.3	J	0.62	B	0.59	B	0.86	B	0.22	B	4.8	J
Cadmium	3	U	3	U	3	U	3	U	3	U	3	U
Calcium	3,250	J	5,000	J	4,320	J	818	J	8,030		12,300	
Chromium	10.3		41.5		14.8		5	U	5	U	228	
Cobalt	51.5		20.2	J	18	J	16.3	J	3.9	J	41.2	J
Copper	20.2	B	43.8	B	55.3	B	38.6	B	35	B	98.6	
Iron	1,950	J	4,440	J	3,050	J	4,610	J	51,200	J	66,600	J
Lead	8.1		7.3		6.9		8.9		4.6		80.2	
Magnesium	4,620	J	2,130	J	1,900	J	2,190	J	2,890	J	12,400	
Manganese	163		79.3		68.9		119		819		903	
Mercury	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.24	
Nickel	57.5		43.7		23.2	J	12.3	J	4	U	221	
Potassium	1,250	J	1,010	J	767	J	624	J	756	J	3,090	J
Selenium	5	U	5	U	5	U	5	U	7		7.2	
Silver	5	U	5	U	5	U	5	U	5	U	5	U
Sodium	86,200	J	35,500		31,900	J	13,200	J	39,000	J	44,900	J

B - Analyte not detected above associated blank
J - Reported value is estimated
K - Reported value is biased high
L - Reported value is biased low
R - Unreliable result
U - Analyte not detected

Table C-1
Groundwater Raw Data
Site 5 SSA
IHDIV-NSWC
Indian Head, Maryland

Station ID	IS05MW01		IS05MW02				IS05MW03		IS42MW02		IS42MW07	
Sample ID	IS05MW010801		IS05MW020801		IS05MW060801		IS05MW030801		IS05MW040801		IS05MW050801	
Sample Date	08/21/01		08/21/01		08/21/01		08/21/01		08/21/01		08/21/01	
Chemical Name												
Thallium	5.7	U	5.7	J	5.7	U	5.7	U	5.7	U	5.7	U
Vanadium	4.2	J	6.8	J	4.6	J	5.5	J	3.2	U	74.9	
Zinc	123		88.9		79.8		88.8		65.9		300	
Dissolved Metals (UG/L)												
Aluminum	85.6	B	16.9	U	16.9	U	16.9	U	16.9	U	101	B
Antimony	9.1	B	8.9	U	10	J	8.9	U	8.9	U	9.4	
Arsenic	6.2	U	6.2	U	6.2	U	6.2	U	6.2	U	6.2	U
Barium	195	B	31.9	B	162	B	4.7	B	1.3	U	203	B
Beryllium	1.9	B	0.26	B	0.1	U	0.1	U	0.1	U	1.7	B
Cadmium	0.6	U	0.6	U	0.6	U	0.6	U	0.6	U	0.6	U
Calcium	2,330	B	470	B	7,980	B	628		98.6	B	3,380	J
Chromium	0.72	J	0.6	U	0.6	U	0.6	U	0.6	U	0.6	U
Cobalt	41.4	B	11.1	B	3.2	B	0.9	U	0.9	U	45.5	B
Copper	11.4	B	4.5	B	3.4	B	4.2	B	48.9		26.7	
Iron	505	R	277	R	43,200		55.7	R	51.2	R	830	R
Lead	5.2		3	U	3	U	3	U	3	U	4.1	
Magnesium	3,760	B	1,330	B	2,850	B	464	B	21	B	4,080	J
Manganese	120	R	70.8	R	824	R	13.7	R	0.32	B	182	
Mercury	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U	0.2	U
Nickel	23.1	B	1.6	U	1.6	U	1.6	U	1.6	U	27.5	B
Potassium	780	B	142	B	743	B	207	B	18.4	U	1,000	B
Selenium	1.6	U	1.6	U	1.6	U	1.6	U	1.6	U	1.6	U
Silver	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U	1.7	U
Sodium	65,500	R	11,700	R	35,500	R	36,100	R	357	U	69,800	R
Thallium	4.3	U	4.3	U	13.6		5		4.3	U	4.3	U
Vanadium	1.2	U	1.2	U	1.2	U	1.2	U	1.2	U	1.2	U
Zinc	85.1	R	35.6	R	11	R	15.9	R	41.2	R	119	R
Wet Chemistry (MG/L)												
Hardness	28		20		18		12		32		80	
Total organic carbon (TOC)	3.1		2.1		1.9		3.5		1.9		3.9	
pH	4.33		5.26		5.24		4.98		5.95		5.87	

B - Analyte not detected above associated blank
J - Reported value is estimated
K - Reported value is biased high
L - Reported value is biased low
R - Unreliable result
U - Analyte not detected

Table C-2
Groundwater Raw Data
2002 Sampling Event
Site 5 SSA
IHDIV-NSWC
Indian Head, Maryland

Station ID	IS05MW01	IS05MW02		IS05MW03	IS42MW02		IS42MW07	
Sample ID	IS05MW010202	IS05MW020202	IS05MW020202P	IS05MW030202	IS42MW002F002	IS42MW002U002	IS42MW007F002	IS42MW007U002
Sample Date	02/21/02	02/21/02	02/21/02	02/21/02	01/23/02	01/23/02	01/23/02	01/23/02
Chemical Name								
Volatile Organic Compounds (UG/L)								
1,1,1-Trichloroethane	NA	NA	NA	NA	NA	1 U	NA	1
1,1,2,2-Tetrachloroethane	NA	NA	NA	NA	NA	1 U	NA	1 U
1,1,2-Trichloroethane	NA	NA	NA	NA	NA	1 U	NA	1 U
1,1-Dichloroethane	NA	NA	NA	NA	NA	1 U	NA	1
1,1-Dichloroethene	NA	NA	NA	NA	NA	1 U	NA	1 J
1,2,4-Trichlorobenzene	NA	NA	NA	NA	NA	1 U	NA	1 U
1,2-Dibromo-3-chloropropane	NA	NA	NA	NA	NA	1 U	NA	1 U
1,2-Dibromoethane	NA	NA	NA	NA	NA	1 U	NA	1 U
1,2-Dichlorobenzene	NA	NA	NA	NA	NA	1 U	NA	1 U
1,2-Dichloroethane	NA	NA	NA	NA	NA	1 U	NA	1 U
1,2-Dichloropropane	NA	NA	NA	NA	NA	1 U	NA	1 U
1,3-Dichlorobenzene	NA	NA	NA	NA	NA	1 U	NA	1 U
1,4-Dichlorobenzene	NA	NA	NA	NA	NA	1 U	NA	1 U
2-Butanone	NA	NA	NA	NA	NA	5 U	NA	5 U
2-Hexanone	NA	NA	NA	NA	NA	5 U	NA	5 U
4-Methyl-2-pentanone	NA	NA	NA	NA	NA	5 U	NA	5 U
Acetone	NA	NA	NA	NA	NA	5 UR	NA	5 UR
Benzene	NA	NA	NA	NA	NA	1 U	NA	1 U
Bromochloromethane	NA	NA	NA	NA	NA	1 U	NA	1 U
Bromodichloromethane	NA	NA	NA	NA	NA	1 U	NA	1 U
Bromoform	NA	NA	NA	NA	NA	1 U	NA	1 U
Bromomethane	NA	NA	NA	NA	NA	1 U	NA	1 U
Carbon disulfide	NA	NA	NA	NA	NA	1 U	NA	1 U
Carbon tetrachloride	NA	NA	NA	NA	NA	1 U	NA	1 U
Chlorobenzene	NA	NA	NA	NA	NA	1	NA	1 U
Chloroethane	NA	NA	NA	NA	NA	1 U	NA	1 U
Chloroform	NA	NA	NA	NA	NA	1 U	NA	1 U
Chloromethane	NA	NA	NA	NA	NA	1 U	NA	1 U
Dibromochloromethane	NA	NA	NA	NA	NA	1 U	NA	1 U
Ethyl ether	NA	NA	NA	NA	NA	1	NA	1 U
Ethylbenzene	NA	NA	NA	NA	NA	1 U	NA	1 U
Methylene chloride	NA	NA	NA	NA	NA	2 U	NA	2
Styrene	NA	NA	NA	NA	NA	1 U	NA	1 U
Tetrachloroethene	NA	NA	NA	NA	NA	1 U	NA	1 J

Table C-2
Groundwater Raw Data
2002 Sampling Event
Site 5 SSA
IHDIV-NSWC
Indian Head, Maryland

Station ID	IS05MW01	IS05MW02		IS05MW03	IS42MW02		IS42MW07	
Sample ID	IS05MW010202	IS05MW020202	IS05MW020202P	IS05MW030202	IS42MW002F002	IS42MW002U002	IS42MW007F002	IS42MW007U002
Sample Date	02/21/02	02/21/02	02/21/02	02/21/02	01/23/02	01/23/02	01/23/02	01/23/02
Chemical Name								
Toluene	NA	NA	NA	NA	NA	1 U	NA	1 U
Trichloroethene	NA	NA	NA	NA	NA	1 U	NA	1 U
Vinyl chloride	NA	NA	NA	NA	NA	1 U	NA	1 U
Xylene, total	NA	NA	NA	NA	NA	1 U	NA	1 U
cis-1,2-Dichloroethene	NA	NA	NA	NA	NA	1	NA	1 U
cis-1,3-Dichloropropene	NA	NA	NA	NA	NA	1 U	NA	1 U
trans-1,2-Dichloroethene	NA	NA	NA	NA	NA	1 U	NA	1 U
trans-1,3-Dichloropropene	NA	NA	NA	NA	NA	1 U	NA	1 U
Semi-volatile Organic Compounds (UG/L)								
2,2'-Oxybis(1-chloropropane)	NA	NA	NA	NA	NA	5 U	NA	5 U
2,4,5-Trichlorophenol	NA	NA	NA	NA	NA	20 U	NA	20 U
2,4,6-Trichlorophenol	NA	NA	NA	NA	NA	5 U	NA	5 U
2,4-Dichlorophenol	NA	NA	NA	NA	NA	5 U	NA	5 U
2,4-Dimethylphenol	NA	NA	NA	NA	NA	5 U	NA	5 U
2,4-Dinitrophenol	NA	NA	NA	NA	NA	20 U	NA	20 U
2,4-Dinitrotoluene	NA	NA	NA	NA	NA	5 U	NA	5 U
2,6-Dinitrotoluene	NA	NA	NA	NA	NA	5 U	NA	5 U
2-Chloronaphthalene	NA	NA	NA	NA	NA	5 U	NA	5 U
2-Chlorophenol	NA	NA	NA	NA	NA	5 U	NA	5 U
2-Methylnaphthalene	NA	NA	NA	NA	NA	5 U	NA	5 U
2-Methylphenol	NA	NA	NA	NA	NA	5 U	NA	5 U
2-Nitroaniline	NA	NA	NA	NA	NA	20 U	NA	20 U
2-Nitrophenol	NA	NA	NA	NA	NA	5 U	NA	5 U
3,3'-Dichlorobenzidine	NA	NA	NA	NA	NA	5 U	NA	5 U
3-Nitroaniline	NA	NA	NA	NA	NA	20 U	NA	20 U
4,6-Dinitro-2-methylphenol	NA	NA	NA	NA	NA	20 U	NA	20 U
4-Bromophenyl-phenylether	NA	NA	NA	NA	NA	5 U	NA	5 U
4-Chloro-3-methylphenol	NA	NA	NA	NA	NA	5 U	NA	5 U
4-Chloroaniline	NA	NA	NA	NA	NA	5 U	NA	5 U
4-Chlorophenyl-phenylether	NA	NA	NA	NA	NA	5 U	NA	5 U
4-Methylphenol	NA	NA	NA	NA	NA	5 U	NA	5 U
4-Nitroaniline	NA	NA	NA	NA	NA	20 U	NA	20 U
4-Nitrophenol	NA	NA	NA	NA	NA	20 U	NA	20 U
Acenaphthene	NA	NA	NA	NA	NA	5 U	NA	5 U
Acenaphthylene	NA	NA	NA	NA	NA	5 U	NA	5 U

Table C-2
Groundwater Raw Data
2002 Sampling Event
Site 5 SSA
IHDIV-NSWC
Indian Head, Maryland

Station ID	IS05MW01	IS05MW02		IS05MW03	IS42MW02		IS42MW07	
Sample ID	IS05MW010202	IS05MW020202	IS05MW020202P	IS05MW030202	IS42MW002F002	IS42MW002U002	IS42MW007F002	IS42MW007U002
Sample Date	02/21/02	02/21/02	02/21/02	02/21/02	01/23/02	01/23/02	01/23/02	01/23/02
Chemical Name								
Anthracene	NA	NA	NA	NA	NA	5 U	NA	5 U
Benzo(a)anthracene	NA	NA	NA	NA	NA	5 U	NA	5 U
Benzo(a)pyrene	NA	NA	NA	NA	NA	5 U	NA	5 U
Benzo(b)fluoranthene	NA	NA	NA	NA	NA	5 U	NA	5 U
Benzo(g,h,i)perylene	NA	NA	NA	NA	NA	5 U	NA	5 U
Benzo(k)fluoranthene	NA	NA	NA	NA	NA	5 U	NA	5 U
Butylbenzylphthalate	NA	NA	NA	NA	NA	5 U	NA	5 U
Chrysene	NA	NA	NA	NA	NA	5 U	NA	5 U
Di-n-butylphthalate	NA	NA	NA	NA	NA	5 U	NA	5 U
Di-n-octylphthalate	NA	NA	NA	NA	NA	5 U	NA	5 U
Dibenz(a,h)anthracene	NA	NA	NA	NA	NA	5 U	NA	5 U
Dibenzofuran	NA	NA	NA	NA	NA	5 U	NA	5 U
Diethylphthalate	NA	NA	NA	NA	NA	5 U	NA	5 U
Dimethyl phthalate	NA	NA	NA	NA	NA	5 U	NA	5 U
Fluoranthene	NA	NA	NA	NA	NA	5 U	NA	5 U
Fluorene	NA	NA	NA	NA	NA	5 U	NA	5 U
Hexachlorobenzene	NA	NA	NA	NA	NA	5 U	NA	5 U
Hexachlorobutadiene	NA	NA	NA	NA	NA	5 U	NA	5 U
Hexachlorocyclopentadiene	NA	NA	NA	NA	NA	5 U	NA	5 U
Hexachloroethane	NA	NA	NA	NA	NA	5 U	NA	5 U
Indeno(1,2,3-cd)pyrene	NA	NA	NA	NA	NA	5 U	NA	5 U
Isophorone	NA	NA	NA	NA	NA	5 U	NA	5 U
Naphthalene	NA	NA	NA	NA	NA	5 U	NA	5 U
Nitrobenzene	NA	NA	NA	NA	NA	5 U	NA	5 U
Pentachlorophenol	NA	NA	NA	NA	NA	20 U	NA	20 U
Phenanthrene	NA	NA	NA	NA	NA	5 U	NA	5 U
Phenol	NA	NA	NA	NA	NA	5 U	NA	5 U
Pyrene	NA	NA	NA	NA	NA	5 U	NA	5 U
bis(2-Chloroethoxy)methane	NA	NA	NA	NA	NA	5 U	NA	5 U
bis(2-Chloroethyl)ether	NA	NA	NA	NA	NA	5 U	NA	5 U
bis(2-Ethylhexyl)phthalate	NA	NA	NA	NA	NA	5 J	NA	5 U
n-Nitroso-di-n-propylamine	NA	NA	NA	NA	NA	5 U	NA	5 U
n-Nitrosodiphenylamine	NA	NA	NA	NA	NA	5 U	NA	5 U
Explosives (UG/L)								
1,3,5-Trinitrobenzene	NA	NA	NA	NA	NA	0.2 U	NA	0.2 U

Table C-2
Groundwater Raw Data
2002 Sampling Event
Site 5 SSA
IHDIV-NSWC
Indian Head, Maryland

Station ID	IS05MW01	IS05MW02		IS05MW03	IS42MW02		IS42MW07	
Sample ID	IS05MW010202	IS05MW020202	IS05MW020202P	IS05MW030202	IS42MW002F002	IS42MW002U002	IS42MW007F002	IS42MW007U002
Sample Date	02/21/02	02/21/02	02/21/02	02/21/02	01/23/02	01/23/02	01/23/02	01/23/02
Chemical Name								
1,3-Dinitrobenzene	NA	NA	NA	NA	NA	0.2 U	NA	0.2 U
2,4,6-Trinitrotoluene	NA	NA	NA	NA	NA	0.2 U	NA	0.2 U
2,4-Dinitrotoluene	NA	NA	NA	NA	NA	0.2 U	NA	0.2 U
2,6-Dinitrotoluene	NA	NA	NA	NA	NA	0.2 U	NA	0.2 U
2-Amino-4,6-dinitrotoluene	NA	NA	NA	NA	NA	0.2 U	NA	0.2 U
2-Nitrotoluene	NA	NA	NA	NA	NA	0.2 U	NA	0.2 U
3-Nitrotoluene	NA	NA	NA	NA	NA	0.2 U	NA	0.2 U
4-Amino-2,6-dinitrotoluene	NA	NA	NA	NA	NA	0.2 U	NA	0.2 U
4-Nitrotoluene	NA	NA	NA	NA	NA	0.2 U	NA	0.2 U
HMX	NA	NA	NA	NA	NA	0.5 U	NA	0.5 U
Nitrobenzene	NA	NA	NA	NA	NA	0.2 U	NA	0.2 U
Nitrocellulose	NA	NA	NA	NA	NA	500 U	NA	500 U
Nitroglycerin	NA	NA	NA	NA	NA	2.5 U	NA	2.5 U
Nitroguanidine	NA	NA	NA	NA	NA	20 U	NA	20 U
Perchlorate	NA	NA	NA	NA	NA	4 U	NA	4 U
RDX	NA	NA	NA	NA	NA	0.5 UJ	NA	0.5 U
Tetryl	NA	NA	NA	NA	NA	0.2 U	NA	0.2 U
Total Metals (UG/L)								
Aluminum	893 B	9,210	9,800	5,720	NA	7 U	NA	7
Antimony	1.8 U	1.8 U	1.8 U	1.8 U	NA	2 B	NA	2 B
Arsenic	5 U	5 U	5 U	5 U	NA	2 U	NA	2 K
Barium	211	99.9 J	104 J	107 J	NA	0.3	NA	0.3
Beryllium	1.7 J	1.1 J	1.1 J	0.72 J	NA	0.2 U	NA	0.2
Cadmium	0.41 J	0.49 B	0.51 B	0.54 B	NA	0.2 K	NA	0.2 K
Calcium	4,610 J	1,960 J	1,800 J	770 B	NA	67	NA	67
Chromium	27.7	34.6	102	54.5	NA	0.5 U	NA	0.5
Cobalt	58.3	23.9 J	24.9 J	16.2 B	NA	0.5	NA	0.5 K
Copper	8.7 U	11.9 B	13.3 B	9 J	NA	1 U	NA	1 K
Iron	1,430	12,200	12,600	13,200	NA	12	NA	12
Lead	8.6	10.9	15.7	9.2	NA	0.4 U	NA	0.4
Magnesium	4,640 J	2,360 J	2,540 J	2,480 J	NA	1	NA	1
Manganese	335	85.2	95.1	111	NA	1	NA	1
Mercury	0.09 U	0.12 J	0.15 J	0.16 J	NA	0.067 U	NA	0.068 U
Nickel	66.5	34.9 B	79.7	48 B	NA	0.4 J	NA	0.4 J
Potassium	1,140 J	2,040 J	2,140 J	1,470 J	NA	66 B	NA	66 K

Table C-2
Groundwater Raw Data
2002 Sampling Event
Site 5 SSA
IHDIV-NSWC
Indian Head, Maryland

Station ID	IS05MW01	IS05MW02		IS05MW03	IS42MW02		IS42MW07	
Sample ID	IS05MW010202	IS05MW020202	IS05MW020202P	IS05MW030202	IS42MW002F002	IS42MW002U002	IS42MW007F002	IS42MW007U002
Sample Date	02/21/02	02/21/02	02/21/02	02/21/02	01/23/02	01/23/02	01/23/02	01/23/02
Chemical Name								
Selenium	3.7 U	3.7 U	3.7 U	3.7 U	NA	4 U	NA	4 U
Silver	6.1 U	6.1 U	6.1 U	6.1 U	NA	0.5 U	NA	0.5 B
Sodium	65,300	22,000	21,600	13,200	NA	116	NA	116
Thallium	2.4 U	2.4 U	2.4 U	2.4 U	NA	3 U	NA	3 K
Vanadium	4.5 U	21.2 J	22 J	11.2 J	NA	0.6 B	NA	0.6 K
Zinc	66.8	46.4	50.7	21.4	NA	2 B	NA	2
PEST/PCB(UG/L)	NA	NA	NA	NA	NA	NA	NA	NA
4,4'-DDD	NA	NA	NA	NA	NA	0.02 U	NA	0.02 U
4,4'-DDE	NA	NA	NA	NA	NA	0.02 U	NA	0.02 U
4,4'-DDT	NA	NA	NA	NA	NA	0.02 U	NA	0.02 U
Aldrin	NA	NA	NA	NA	NA	0.01 U	NA	0.01 U
Aroclor-1016	NA	NA	NA	NA	NA	0.2 U	NA	0.2 U
Aroclor-1221	NA	NA	NA	NA	NA	0.4 U	NA	0.4 U
Aroclor-1232	NA	NA	NA	NA	NA	0.2 U	NA	0.2 U
Aroclor-1242	NA	NA	NA	NA	NA	0.2 U	NA	0.2 U
Aroclor-1248	NA	NA	NA	NA	NA	0.2 U	NA	0.2 U
Aroclor-1254	NA	NA	NA	NA	NA	0.2 U	NA	0.2 U
Aroclor-1260	NA	NA	NA	NA	NA	0.2 U	NA	0.2 U
Dieldrin	NA	NA	NA	NA	NA	0.02 U	NA	0.02 U
Endosulfan I	NA	NA	NA	NA	NA	0.01 U	NA	0.01 U
Endosulfan II	NA	NA	NA	NA	NA	0.02 U	NA	0.02 U
Endosulfan sulfate	NA	NA	NA	NA	NA	0.02 U	NA	0.02 U
Endrin	NA	NA	NA	NA	NA	0.02 U	NA	0.02 U
Endrin aldehyde	NA	NA	NA	NA	NA	0.02 U	NA	0.02 U
Endrin ketone	NA	NA	NA	NA	NA	0.02 U	NA	0.02 U
Heptachlor	NA	NA	NA	NA	NA	0.01 U	NA	0.01 U
Heptachlor epoxide	NA	NA	NA	NA	NA	0.01 U	NA	0.01 U
Methoxychlor	NA	NA	NA	NA	NA	0.1 U	NA	0.1 U
Toxaphene	NA	NA	NA	NA	NA	1 U	NA	1 U
alpha-BHC	NA	NA	NA	NA	NA	0.01 U	NA	0.01 U
alpha-Chlordane	NA	NA	NA	NA	NA	0.01 U	NA	0.01 U
beta-BHC	NA	NA	NA	NA	NA	0.01 U	NA	0.01 U
delta-BHC	NA	NA	NA	NA	NA	0.01 U	NA	0.01 U
gamma-BHC (Lindane)	NA	NA	NA	NA	NA	0.01 U	NA	0.01 U
gamma-Chlordane	NA	NA	NA	NA	NA	0.01 U	NA	0.01 U

Table C-2
Groundwater Raw Data
2002 Sampling Event
Site 5 SSA
IHDIV-NSWC
Indian Head, Maryland

Station ID	IS05MW01	IS05MW02		IS05MW03	IS42MW02		IS42MW07	
Sample ID	IS05MW010202	IS05MW020202	IS05MW020202P	IS05MW030202	IS42MW002F002	IS42MW002U002	IS42MW007F002	IS42MW007U002
Sample Date	02/21/02	02/21/02	02/21/02	02/21/02	01/23/02	01/23/02	01/23/02	01/23/02
Chemical Name								
Dissolved Metals (UG/L)								
Aluminum	461 B	79.7 B	62 U	201	7 B	NA	7 B	NA
Antimony	2.4 J	1.8 U	1.8 U	1.8 U	2 U	NA	2 B	NA
Arsenic	5 U	5 U	5 U	5 U	2 U	NA	2 U	NA
Barium	235	211	24.9 B	39.4 B	0.3	NA	0.3 B	NA
Beryllium	1.8 J	1.8 J	0.48 U	0.48 U	0.2 U	NA	0.2 U	NA
Cadmium	0.38 B	0.35 U	0.35 U	0.35 U	0.2 K	NA	0.2 U	NA
Calcium	5,100	4,310 J	1,190 J	712 B	67	NA	67 B	NA
Chromium	60.1	6.4 U	6.4 U	6.4 U	0.5 U	NA	0.5 B	NA
Cobalt	62.9	57.9	13.8 J	11.4 J	0.5	NA	0.5 U	NA
Copper	15.2 J	8.7 U	8.7 U	8.7 U	1 U	NA	1 B	NA
Iron	1,310	469	69.4 B	182 B	12	NA	12 B	NA
Lead	10.6	7.8	1.8 U	1.8 U	0.4 U	NA	0.4 B	NA
Magnesium	5,120	4,710 J	1,080 J	1,670 J	1	NA	7.5 B	NA
Manganese	386	306	42.3	73.3	1 K	NA	1 B	NA
Mercury	0.09 U	0.09 U	0.09 U	0.11 J	0.067 U	NA	0.067 B	NA
Nickel	93.8	52.3	11.5 J	11.7 J	0.4 J	NA	0.4 B	NA
Potassium	1,200 J	1,050 J	301 J	273 J	66 B	NA	66 B	NA
Selenium	3.7 U	3.7 U	3.7 U	3.7 U	4 U	NA	4 U	NA
Silver	6.1 U	6.1 U	6.1 U	6.1 U	0.5 B	NA	0.5 B	NA
Sodium	69,000	68,600	20,600	13,700	116	NA	116	NA
Thallium	2.4 U	2.4 U	2.4 U	2.4 U	3 U	NA	3 U	NA
Vanadium	4.5 U	4.5 U	4.5 U	4.5 U	0.6 B	NA	0.6 B	NA
Zinc	79.5	61.7	7.1 U	7.1 U	2 B	NA	2 B	NA

NA - Not analyzed
B - Analyte not detected above associated blank
J - Reported value is estimated
K - Reported value may be biased high
U - Analyte not detected
UJ - Not detected, quantitation limit may be inaccurate
shaded cells designate detections

Table C-3
Surface Water Raw Data
2002 Sampling Event
Site 5 SSA
IHDIV-NSWC
Indian Head, Maryland

Station ID	IS05SW03	IS05SW04	IS05SW05	
Sample ID	IS05SW030202	IS05SW040202	IS05SW050202	IS05SW050202P
Sample Date	02/21/02	02/21/02	02/21/02	02/21/02
Chemical Name				
Total Metals (UG/L)				
Aluminum	12,200	7,430	259 B	1,800
Antimony	1.8 U	1.8 U	1.8 U	1.8 U
Arsenic	5 U	5 U	5 U	5 U
Barium	277	73.5 J	12.8 B	28.6 B
Beryllium	0.67 J	0.59 J	0.48 U	0.48 U
Cadmium	9.3	0.69 J	0.35 U	0.35 U
Calcium	17,500	5,860	8,830	9,550
Chromium	23.3	10.7	6.4 U	6.4 U
Cobalt	10.4 J	12.2 J	3.3 U	4.6 J
Copper	64.1	10.4 J	9.6 J	18.5 J
Iron	224,000	10,500	762	4,270
Lead	2.2 J	5.4	1.8 U	3.5
Magnesium	5,880	1,880 J	1,980 J	2,370 J
Manganese	1,160	755	164	587
Mercury	0.17 J	0.14 J	0.09 U	0.08 U
Nickel	20.3 J	11.5 J	7.3 U	7.3 U
Potassium	4,800 J	4,320 J	1,370 J	1,670 J
Selenium	3.7 U	3.7 U	3.7 U	3.7 U
Silver	6.1 U	11.6	6.1 U	6.1 U
Sodium	44,300	64,700	16,100	16,800
Thallium	2.4 U	2.4 U	2.4 U	2.4 U
Vanadium	34.7 J	18.1 J	4.5 U	4.8 J
Zinc	192	49.3	7.1 U	30.3
Dissolved Metals (UG/L)				
Aluminum	62 U	108 B	62 U	147 B
Antimony	1.8 U	1.8 U	1.8 U	1.8 U
Arsenic	5 U	5 U	5 U	5 U
Barium	55.7 B	20.1 J	12.4 B	12 B
Beryllium	0.48 U	0.48 U	0.48 U	0.48 U
Cadmium	0.79 J	0.35 U	0.35 U	0.35 U

Table C-3
Surface Water Raw Data
2002 Sampling Event
Site 5 SSA
IHDIV-NSWC
Indian Head, Maryland

Station ID	IS05SW03	IS05SW04	IS05SW05	
Sample ID	IS05SW030202	IS05SW040202	IS05SW050202	IS05SW050202P
Sample Date	02/21/02	02/21/02	02/21/02	02/21/02
Chemical Name				
Calcium	15,400	5,280	9,320	8,950
Chromium	6.4 U	6.4 U	6.4 U	6.4 U
Cobalt	3.3 U	5.2 J	3.3 U	3.3 U
Copper	8.7 U	8.7 U	8.7 U	8.7 U
Iron	25,700	1,350	303	432
Lead	1.8 U	1.8 U	1.8 U	1.8 U
Magnesium	4,250 J	1,340 J	2,110 J	1,940 J
Manganese	638	678	160	159
Mercury	0.09 U	0.09 J	0.08 U	0.11 J
Nickel	7.3 U	7.3 U	7.3 U	7.3 U
Potassium	3,470 J	3,650 J	1,500 J	1,370 J
Selenium	3.7 U	3.7 U	3.7 U	3.7 U
Silver	6.1 U	6.1 U	6.1 U	6.1 U
Sodium	36,600	63,900	17,000	16,300
Thallium	2.4 U	2.4 U	2.4 U	2.4 U
Vanadium	4.5 U	4.5 U	4.5 U	4.5 U
Zinc	7.1 U	7.1 U	7.1 U	7.1 U
Wet Chemistry (MG/L)				
Hardness	67.9	22.4	30.2	33.6
Total organic carbon (TOC)	7	17	9	5 U

B - Analyte not detected above associated blank
J - Reported value is estimated
U - Analyte not detected
shaded cells designate detections

Table C-4
Sediment Raw Data
2001 Sampling Event
Site 5 SSA
IHDIV-NSWC
Indian Head, Maryland

Station ID	IS05SD01	IS05SD02		IS05SD03
Sample ID	IS05SD01	IS05SD02	IS05SD04	IS05SD03
Sample Date	08/20/01	08/20/01	08/20/01	08/20/01
Chemical Name				
Total Metals (MG/KG)				
Silver	0.73 J	7.8	14.8	0.51 J
Wet Chemistry (MG/KG)				
Total organic carbon (TOC)	15,000	12,000	22,000	16,000
pH	6.95	6.77	7.11	6.88

J - Reported value is estimated
shaded cells designate detections

Table C-5
Sediment Raw Data
2002 Sampling Event
Site 5 SSA
IHDIV-NSWC
Indian Head, Maryland

Station ID	IS05SD03	IS05SD04	IS05SD05	
Sample ID	IS05SD030202	IS05SD040202	IS05SD050202	IS05SD050202P
Sample Date	02/21/02	02/21/02	02/21/02	02/21/02
Chemical Name				
Total Metals (MG/KG)				
Aluminum	11,200	2,710	2,120	2,410
Antimony	0.71 UL	0.33 UL	0.32 UL	0.32 UL
Arsenic	4.8	2.1	2.7	3.6
Barium	94.3	17.7 J	12.9 J	16 J
Beryllium	0.77 J	0.42 J	0.36 J	0.47 J
Cadmium	3	0.5 J	0.47 B	0.54 B
Calcium	1,520 J	113 J	265 J	631 J
Chromium	21.1	12.5	12.7	14.8
Cobalt	14.8 J	6.8 J	4.1 J	5 J
Copper	43.7 J	3.2 J	5 J	6.4 J
Iron	30,000 J	7,090 J	8,960 J	10,600 J
Lead	23 K	4.1 K	3.9 K	5.7 K
Magnesium	1,270 J	1,060	949	1,520
Manganese	191 K	74.1 K	70.6 K	112 K
Mercury	0.23	0.04 J	0.05 J	0.12
Nickel	19.6 K	14.6 K	19.1 K	13.1 K
Potassium	834 J	198 J	171 J	186 J
Selenium	1.5 U	0.68 U	0.66 U	0.65 U
Silver	15.8	3.2	4	2.5
Sodium	185 J	44.4 U	43.1 U	42.4 U
Thallium	0.94 U	0.44 U	0.43 U	0.42 U
Vanadium	35.1	12.7	12.7	16
Zinc	150	15.7	13.8	20.1
Wet Chemistry (MG/KG)				
Total organic carbon (TOC)	12,200	2,000	1,600	1,600

B - Analyte not detected above associated blank
J - Reported value is estimated
K - Reported value may be biased high
U - Analyte not detected
UL - Not detected, quantitation limit is probably higher
shaded cells designate detections

Table 3-6
Field Parameters for Surface Water
2001 & 2002 Sampling Events
Site 5 SSA
IHDIV-NSWC
Indian Head, Maryland

Surface Water Sampling Location	Sample Identification	pH	Specific Conductance (µS/cm)	Dissolved Oxygen (mg/L)
2001 Sampling Event				
IS05SW01	IS05SW01	8.71	516	0.26
IS05SW02	IS05SW02	9.31	662	0.25
IS05SW03	IS05SW03	8.77	412	8.60
2002 Sampling Event				
IS05SW03	IS05SW030202	5.77	265	0.00 [2]
IS05SW04	IS05SW040202	5.38	229	0.00 [2]
IS05SW05	IS05SW050202	5.32	103	9.76

[1] Locations IS05SW01 and IS05SW02 changed in 2002, but IS05SW03 remained the same.
[2] DO readings of zero likely due to meter errors. The instrument was recalibrated repeatedly. These readings were taken on the last day of sampling, so another meter could not be brought to the site in time. DO data is used to provide insight into conditions in the groundwater or surface water at the site. These measurements are generally qualitative, and lacking this data does not affect the results of the SSA.

µS/cm = microsiemens per centimeter
mg/l = milligrams per liter

Table C-7
Groundwater and Surface Water Duplicate and Parent Samples
2002 Sampling Event
Site 5 SSA
IHDIV-NSWC
Indian Head, Maryland

Station ID	IS05MW02				IS05SW05			
	Parent Sample		Duplicate Sample		Parent Sample		Duplicate Sample	
Sample ID	IS05MW020202		IS05MW020202P		IS05SW020202		IS05SW020202P	
Sample Date	02/21/02		02/21/02		02/21/02		02/21/02	
Chemical Name								
Total Metals (UG/L)								
Aluminum	9,210		9,800		259	B	1,800	
Antimony	1.8	U	1.8	U	1.8	U	1.8	U
Arsenic	5	U	5	U	5	U	5	U
Barium	99.9	J	104	J	12.8	B	28.6	B
Beryllium	1.1	J	1.1	J	0.48	U	0.48	U
Cadmium	0.49	B	0.51	B	0.35	U	0.35	U
Calcium	1,960	J	1,800	J	8,830		9,550	
Chromium	34.6		102		6.4	U	6.4	U
Cobalt	23.9	J	24.9	J	3.3	U	4.6	J
Copper	11.9	B	13.3	B	9.6	J	18.5	J
Iron	12,200		12,600		762		4,270	
Lead	10.9		15.7		1.8	U	3.5	
Magnesium	2,360	J	2,540	J	1,980	J	2,370	J
Manganese	85.2		95.1		164		587	
Mercury	0.12	J	0.15	J	0.09	U	0.08	U
Nickel	34.9	B	79.7		7.3	U	7.3	U
Potassium	2,040	J	2,140	J	1,370	J	1,670	J
Selenium	3.7	U	3.7	U	3.7	U	3.7	U
Silver	6.1	U	6.1	U	6.1	U	6.1	U
Sodium	22,000		21,600		16,100		16,800	
Thallium	2.4	U	2.4	U	2.4	U	2.4	U
Vanadium	21.2	J	22	J	4.5	U	4.8	J
Zinc	46.4		50.7		7.1	U	30.3	
Dissolved Metals (UG/L)								
Aluminum	79.7	B	62	U	62	U	147	B
Antimony	1.8	U	1.8	U	1.8	U	1.8	U
Arsenic	5	U	5	U	5	U	5	U
Barium	211		24.9	B	12.4	B	12	B
Beryllium	1.8	J	0.48	U	0.48	U	0.48	U

NA - Not analyzed
B - Analyte not detected above associated blank
J - Reported value is estimated
U - Analyte not detected

*P indicates a duplicate sample

Table C-7
Groundwater and Surface Water Duplicate and Parent Samples
2002 Sampling Event
Site 5 SSA
IHDIV-NSWC
Indian Head, Maryland

Station ID	IS05MW02				IS05SW05			
	Parent Sample		Duplicate Sample		Parent Sample		Duplicate Sample	
Sample ID	IS05MW020202		IS05MW020202P		IS05SW020202		IS05SW020202P	
Sample Date	02/21/02		02/21/02		02/21/02		02/21/02	
Chemical Name								
Cadmium	0.35	U	0.35	U	0.35	U	0.35	U
Calcium	4,310	J	1,190	J	9,320		8,950	
Chromium	6.4	U	6.4	U	6.4	U	6.4	U
Cobalt	57.9		13.8	J	3.3	U	3.3	U
Copper	8.7	U	8.7	U	8.7	U	8.7	U
Iron	469		69.4	B	303		432	
Lead	7.8		1.8	U	1.8	U	1.8	U
Magnesium	4,710	J	1,080	J	2,110	J	1,940	J
Manganese	306		42.3		160		159	
Mercury	0.09	U	0.09	U	0.08	U	0.11	J
Nickel	52.3		11.5	J	7.3	U	7.3	U
Potassium	1,050	J	301	J	1,500	J	1,370	J
Selenium	3.7	U	3.7	U	3.7	U	3.7	U
Silver	6.1	U	6.1	U	6.1	U	6.1	U
Sodium	68,600		20,600		17,000		16,300	
Thallium	2.4	U	2.4	U	2.4	U	2.4	U
Vanadium	4.5	U	4.5	U	4.5	U	4.5	U
Zinc	61.7		7.1	U	7.1	U	7.1	U
Wet Chemistry (MG/L)								
Hardness	NA		NA		30.2		33.6	
Total organic carbon (TOC)	NA		NA		9		5	U

NA - Not analyzed
B - Analyte not detected above associated blank
J - Reported value is estimated
U - Analyte not detected

*P indicates a duplicate sample

Appendix D
Ecological Risk Tables

Table D-1
Surface Water Screening Statistics
Site 5 SSA
IHDIV-NSWC
Indian Head, Maryland

Chemical	Reporting Limit Range	Frequency of Detection	Maximum Concentration Detected	Sample ID of Maximum Concentration	Arithmetic Mean	Screening Value
Inorganics (UG/L)						
Silver	1.70 - 1.70	3 / 3	66.3	IS05SW01	44.7	0.36
Dissolved Metals (UG/L)						
Silver	1.70 - 1.70	0 / 3	--	--	0.85	0.36

NSV - No Screening Value
1 - Shaded cells indicate hazard quotient based on reporting limits

Table D-2
Sediment Screening Statistics
Site 5 SSA
IHDIV-NSWC
Indian Head, Maryland

Chemical	Reporting Limit Range	Frequency of Detection	Maximum Concentration Detected	Sample ID of Maximum Concentration	Arithmetic Mean	Screening Value*
Inorganics (MG/KG)						
Silver	0.21 - 0.23	3 / 3	14.8	IS05SD02	5.35	1.00

*Region 3 BTAG value for sediment fauna (USEPA, 1995)

NSV - No Screening Value
1 - Shaded cells indicate hazard quotient based on reporting limits

Appendix E
Technical Memorandum (CH2M HILL, 2003)

Indian Head Site 5 Site Screening Assessment Chemicals of Concern (Revised)

PREPARED FOR: IHIRT

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DATE: November 17, 2003

Purpose

Per discussions at the July 16th and 17th, 2003 Indian Head Installation Restoration Team meeting, CH2M HILL has reviewed the list of chemicals of concern (COCs) that were identified in the human health screening evaluation (Section 5.1) of the Indian Head Site 5 Draft Final (Version 2) Site Screening Assessment (SSA). The COCs were arsenic, chromium, 1,1-dichloroethene, tetrachloroethene, and bis(2-ethylhexyl)phthalate in groundwater and iron in surface water.

Evaluation of COCs

1,1-Dichloroethene in Groundwater

The Site 5 SSA was prepared using the EPA Region III Risk-Based Concentration (RBC) table from April 2002. The EPA Region III RBC for 1,1-dichloroethene has since changed based on updated toxicity information. The oral cancer slope factor for 1,1-dichloroethene was withdrawn from IRIS. It was determined that the study used to derive the 1,1-dichloroethene slope factor did not show statistically significant increases in tumor incidence attributable to oral exposure. Therefore, the weight of evidence for cancer was determined inadequate and an oral slope factor was not derived. The withdrawal of the 1,1-dichloroethene oral cancer slope factor resulted in the re-calculation of the tap water RBC based on non-carcinogenic effects. The current tap water RBC for 1,1-dichloroethene is 350 ug/L. The maximum detected concentration of 1,1-dichloroethene, 1 ug/L, is below the adjusted RBC of 35 ug/L. Therefore, 1,1-dichloroethene is not a COC for groundwater.

Tetrachloroethene in Groundwater

The tap water RBC for tetrachloroethene has also changed from the value in the April 2002 EPA Region III RBC Table. The new value is presented in a June 17, 2003 memorandum, "Risk-Based Concentration Table, Update to April 2003 Version", from Jennifer Hubbard/USEPA. The new tap water RBC for tetrachloroethene is 0.1 ug/L. This value is a little lower than the previous tap water RBC. Therefore, based on the risk ratio methodology, tetrachloroethene would remain a COC. However, tetrachlorethene can be removed from the COC list, as discussed in the following paragraph.

The detected concentrations of tetrachloroethene are below the Maximum Contaminant Levels (MCLs). These are legally enforceable standards that apply to public water systems. Primary standards protect public health by limiting the levels of contaminants in drinking water. Since the detected concentrations of tetrachloroethene are below the MCL, if groundwater was used as a water supply (the assumption used for the SSA), no remedial action would be necessary for the groundwater for this constituent.

Additionally, based on the elimination of 1,1-dichloroethene as a COC due to the withdrawal of the cancer slope factor for this constituent, the Cumulative Apparent Cancer Risk (equal to the sum of Corresponding Risks Levels for each constituent) will not be greater than 5E-05, and therefore, there are no unacceptable cancer risks associated with Site 5. Therefore, none of the carcinogenic constituents, including tetrachloroethene, are retained as COCs.

Bis(2-ethylhexyl)phthalate in Groundwater

The detected concentrations of bis(2-ethylhexyl)phthalate are also below the MCL. Using similar reasoning as outlined above for tetrachloroethene, bis(2-ethylhexyl)phthalate will not be retained as a COC.

Arsenic in Groundwater

The detected concentrations of arsenic are also below the MCL. Using similar reasoning as outlined above for tetrachloroethene and bis(2-ethylhexyl)phthalate, arsenic will not be retained as a COC.

Chromium in Groundwater

The detected concentrations of chromium exceed both the MCL and the adjusted RBC. However, it should be noted that total chromium data was screened against the hexavalent chromium RBC. Chromium is a naturally occurring element (as a component of more than 80 identified minerals) that occurs in four valence states (+6, +4, +3, and +2). Cr (4) and Cr (2) are thermodynamically unstable and are rarely found in the environment. Cr (6) and Cr (3) are commonly encountered in the subsurface environment as naturally occurring, and as a result of anthropogenic influences. Chromium (3) is the most stable form of chromium. Under the conditions found in most subsurface environments, the majority of chromium will be present as Cr(3). The proportions of chromium present as +3 and +6 can be predicted for a given set of pH, oxidation-reduction potential, and concentration values, using an eH/pH diagram. For the conditions at Site 5 (summarized in table, below), the eH/pH diagram predicts that chromium in the groundwater will be in the form of Cr(3) (see attached figure, from *Eh/pH Diagrams for Geochemistry*, Dr. Douglas G. Brookins, 1988).

Sample ID	pH	Oxidation/Reduction Potential (mV)
IS05MW010202	4.19	198
IS05MW020202	4.03	227
IS05MW030202	3.97	243
IS42MW002002	5.63	48
IS42MW007002	5.70	221

Based on the assumption that all of the chromium is in the form of Cr(3), the maximum detected concentration of chromium (102 ug/L) would be below the applicable adjusted RBC for Chromium (3) of 550 ug/L.

Additionally, the highest detected chromium concentration was 102 ug/L. This result was a field duplicate, and the result of the corresponding parent sample was 34.6 ug/L (IS05MW020202), so the 102 mg/l result may be biased high.

Based on the above arguments, chromium will not be retained as a COC for groundwater.

Iron in Surface Water

Iron was retained as a COC in the SSA for the surface water. There was no background data available to determine if the iron in the surface water is associated with background conditions or is related to site use. The concentration of iron in only one of the three samples exceeded the applicable screening level. However, since only three samples were available, the maximum concentration of iron was used in the evaluation. Further, the iron level in this sample exceeds the recommended daily allowance (RDA).

However, it should be noted that following Navy risk assessment policy (*U.S. Navy Human Health Risk Assessment Guidance*, Prepared for: Naval Facilities Engineering Command, Navy Environmental Health Center, Prepared by: Pioneer Technologies Corporation (U.S. Navy, 2001)], iron would not be considered a COC because it is considered an essential nutrient, and essential nutrients should be eliminated from consideration in the risk assessment because they are not associated with toxicity in humans under normal conditions.

Therefore, although iron exceeds the RDA, following Navy guidance, iron should not be retained as a COC.

Conclusion and Recommendation

Based on the discussions above, there are no remaining COCs. Based on the use of the EPA Region III tap water RBCs, which are based on residential exposure to groundwater, for the Site 5 site screening assessment, and the additional discussion above, exposure to Site 5 groundwater would be expected to pose no unacceptable risks under a residential exposure scenario. Therefore, Site 5 is recommended for no further action.