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FINAL

Work Plan for Remedial Investigation at Site 28

Naval Surface Warfare Center
Indian Head Division
Indian Head, Maryland

Contract Task Order 0111

April 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

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Executive Summary

This Remedial Investigation (RI) Work Plan for Site 28, located at the Indian Head Division, Naval Surface Warfare Center (IHDIV-NSWC), Indian Head, Maryland, was prepared in response to Contract Task Order 0111, under the Comprehensive Long-Term Environmental Action Navy, contract number N62470-95-D-6007. It addresses all work activities required to conduct the RI and provides the framework and process that will be used to complete the tasks.

The specific site covered by this Work Plan—Site 28, also referred to as the Original Burning Ground, Slavins Dock Area, and Wildlife Area—is located on the main installation of IHDIV-NSWC. The site encompasses a former zinc recovery furnace, Artesian Well 14, and the Shoreline Burning Cage.

During World War I, the Navy initiated a metal recycling program, which continues to the present day. As part of the recycling program, the Zinc Recovery Furnace (Building 415) was erected in 1928 and used until it was demolished in the early 1950s. Artesian Well 14 was installed in 1918 and at one time was used as a potable well. It became an observation well in 1988 and remains an observation well today. A small burning cage used to burn debris, such as wooden crates, existed to the south of Artesian Well 14. In 1990, surface debris was removed from several sites at Indian Head, including Site 28.

An Initial Assessment Study (IAS) in 1982 found that smokeless powder and other contaminated wastes were burned at the site. The finding was based on materials manufactured when the site was in operation, circa 1890s to 1942. The IAS concluded that there was not enough information to characterize the potential hazard at the site; therefore, the site was not recommended for a Navy Assessment and Control of Installation Pollutants (NACIP) confirmation study. Soil samples collected in August 1993, May 2000, and July 2000 contained levels of zinc as high as 7,350 parts per million (ppm). A sediment sample collected in October 2000 during a Toxicity Identification Evaluation (TIE) in Mattawoman Creek offshore of Site 28 contained pore water concentrations of zinc as high as 25,000 ppb.

There are currently insufficient data to characterize the impact of metals from the site on sediment, surface water, soil, and groundwater. To address these data gaps, this investigation will focus on the collection of geological, hydrogeological, and chemical data to characterize the nature and extent of metals and other potential contaminants in soil, sediment, surface water, and groundwater at Site 28. For this investigation the site will be divided into Zones A and B. Zone A encompasses the portion of Site 28 where the zinc recovery furnace was likely located, and Zone B encompasses the probable location of the shoreline burning cage. The first phase of the investigation will consist of collecting surface and subsurface soil samples, in situ groundwater samples, surface water samples, and sediment samples in Zone A; surface and subsurface soil samples in Zone B; and sediment samples from Mattawoman Creek. The data generated during this phase of the investigation will be used to determine the location of monitoring wells that will be installed during a second phase. Data obtained for the various media will be used to assess ecological and human health risks. Table ES-1 summarizes the tasks covered in this Work Plan.

Table ES-1
Summary of Site 28 Remedial Investigation Work Plan Tasks
Site 28 RI Work Plan
IHDIV-NSWC
Indian Head, Maryland

Site Location	Media	Work Plan Summary	Number of Primary Samples	Ecological Risk Assessment	Human Health Risk Assessment
Zone A	Surface Soil	Characterize the vertical and lateral extent of organics and metals in soil. Collect surface soil samples from various locations.	29*	yes	yes
	Subsurface Soil	Characterize the vertical and lateral extent of organics and metals in soil. Collect subsurface soil samples from various locations.	29*	yes	yes
	In Situ Groundwater	Qualitative assessment of groundwater to aid in the placement of monitoring wells. Collected at various locations around Zone A	12	no	no
	Groundwater from Monitoring Wells	Quantitative assessment of groundwater quality. Collected from wells installed at locations determined by the *in situ* groundwater samples.	4	yes	yes
	Surface Water	Assess surface water quality. Collect surface water samples from corresponding sediment locations along the swales.	3	yes	yes
	Sediment	Characterize the lateral extent of organics and metals in sediments. Collect sediment samples from various locations along the swales.	3	yes	yes
Zone B	Surface Soil	Characterize the vertical and lateral extent of organics and metals in soil. Collect surface soil samples from various locations.	10*	yes	yes
	Subsurface Soil	Characterize the vertical and lateral extent of organics and metals in soil. Collect subsurface soil samples from various locations.	10*	yes	yes
Mattawoman Creek	Sediment	Characterize the vertical and lateral extent of metals in sediment of Mattawoman Creek adjacent to Site 28. Collect sediment samples from Mattawoman Creek in a grid pattern adjacent to Site 28.	30	yes**	yes

Notes
* Two field discretionary samples are included in these totals.
**The 15 surface sediment samples (0-6 inches) will be evaluated in the ecological risk assessment.

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Acronyms and Abbreviations

B&RE	Brown & Root Environmental
BERA	Baseline Ecological Risk Assessment
bgs	below ground surface
CLEAN	Comprehensive Long-term Environmental Action Navy
CLP	Contract Laboratory Program
CNO	Chief of Naval Operations
COC	Chemical of Concern
COPC	Chemical of Potential Concern
CTO	Contract Task Order
DO	Dissolved Oxygen
DPT	Direct Push Technology
ERA	Ecological Risk Assessment
EPC	Exposure Point Concentration
FTL	Field Team Leader
HASP	Health and Safety Plan
HHRA	Human Health Risk Assessment
HRS	Hazard Ranking System
HQ	Hazard Quotient
IAS	Initial Assessment Study
IDW	Investigation-Derived Wastes
IHDIV-NSWC	Indian Head Division, Naval Surface Warfare Center
IR	Installation Restoration
MCL	Maximum Contaminant Level
MDE	Maryland Department of the Environment
MDNR	Maryland Department of Natural Resources
mg/L	milligrams per liter
MS/MSD	Matrix Spike and Matrix Spike Duplicate
msl	mean sea level
NACIP	Navy Assessment and Control of Installation Pollutants
NAVFAC	Naval Facilities Engineering Command
NEESA	Naval Energy and Environmental Support Activity
NOAEL	no-observed-adverse-effect level
NOS	Naval Ordnance Station
NPL	National Priorities List
NWI	National Wetlands Inventory
ORP	Oxidation/Reduction Potential
ppm	parts per million

QA/QC	Quality Assurance and Quality Control
QAPP	Quality Assurance Project Plan
RBC	Risk-Based Concentration
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation
RPM	Remedial Project Manager
SDWA	Safe Drinking Water Act
SPAWARS	Space and Naval Warfare Systems Command
SERA	Screening Ecological Risk Assessment
SVOC	Semivolatile Organic Compound
SOP	Standard Operating Procedure
TAL	Target Analyte List
TCL	Target Compound List
TCLP	Toxicity Characteristic Leaching Procedure
TIE	Toxicity Identification Evaluation
TOC	Total Organic Carbon
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
VOC	Volatile Organic Compound

1 Introduction

This Remedial Investigation (RI) Work Plan for Site 28, located at the Indian Head Division, Naval Surface Warfare Center (IHDIV-NSWC), Indian Head, Maryland, was prepared in response to Contract Task Order (CTO) 0111, under the Comprehensive Long-term Environmental Action Navy (CLEAN), contract number N62470-95-D-6007. It addresses all work activities required to conduct the RI and provides the framework and process that will be utilized to complete the tasks.

This RI Work Plan is a supplement to the following master planning documents:

- Master Work Plan, prepared by Brown & Root Environmental (B&RE), April 1997
- Master Field Sampling Plan, prepared by B&RE, April 1997
- Standard Operating Procedures (SOPs), prepared by B&RE, April 1997
- Master Quality Assurance Project Plan (QAPP), prepared by B&RE, April 1997
- Health and Safety Guidance Document, prepared by B&RE, April 1997
- Addendum to B&RE Master Work Plans, prepared by CH2M HILL, March 2000
- Addendum to Health and Safety Plan, to be prepared by CH2M HILL

The above-referenced master planning documents will provide the methods and procedures that will be used to perform the environmental investigative work proposed herein for Site 28. Unless otherwise noted, all SOPs referenced in this Work Plan are contained in the Master Work Plan.

1.1 Objectives and Scope

The objective of this Work Plan is to present historical information for Site 28, evaluate that information, determine the need for further investigation, and propose a plan for further investigation. Further, the RI objectives at Site 28 are to:

- Verify the presence or absence of contamination in soil, groundwater, surface water, and sediment resulting from past activities at the site
- Define the extent of contamination
- Evaluate the need for remediation based on the critical information developed in the human health and ecological risk assessments

These objectives were established based on a review and evaluation of site historical information.

These objectives will be accomplished through the following field and laboratory activities: (1) collecting and analyzing surface and subsurface soil samples; (2) collecting and analyzing in situ groundwater samples; (3) collecting and analyzing surface water and sediment in the swales and collection of sediment samples in Mattawoman Creek; and (4) installing and sampling permanent monitoring wells during a second phase of the field effort.

1.2 Document Organization

This RI Work Plan is organized as follows: Section 1 presents the objectives, document organization, and project organization; Section 2 presents a general description of the facility and the site, a summary of the site history, and a description of previous investigations; and Section 3 presents a description of the field investigation program. Figures and tables are provided at the end of each section.

1.3 Project Organization

CH2M HILL will conduct this remedial investigation with support from the Navy. The Navy RPM will be Mr. Jeff Morris.

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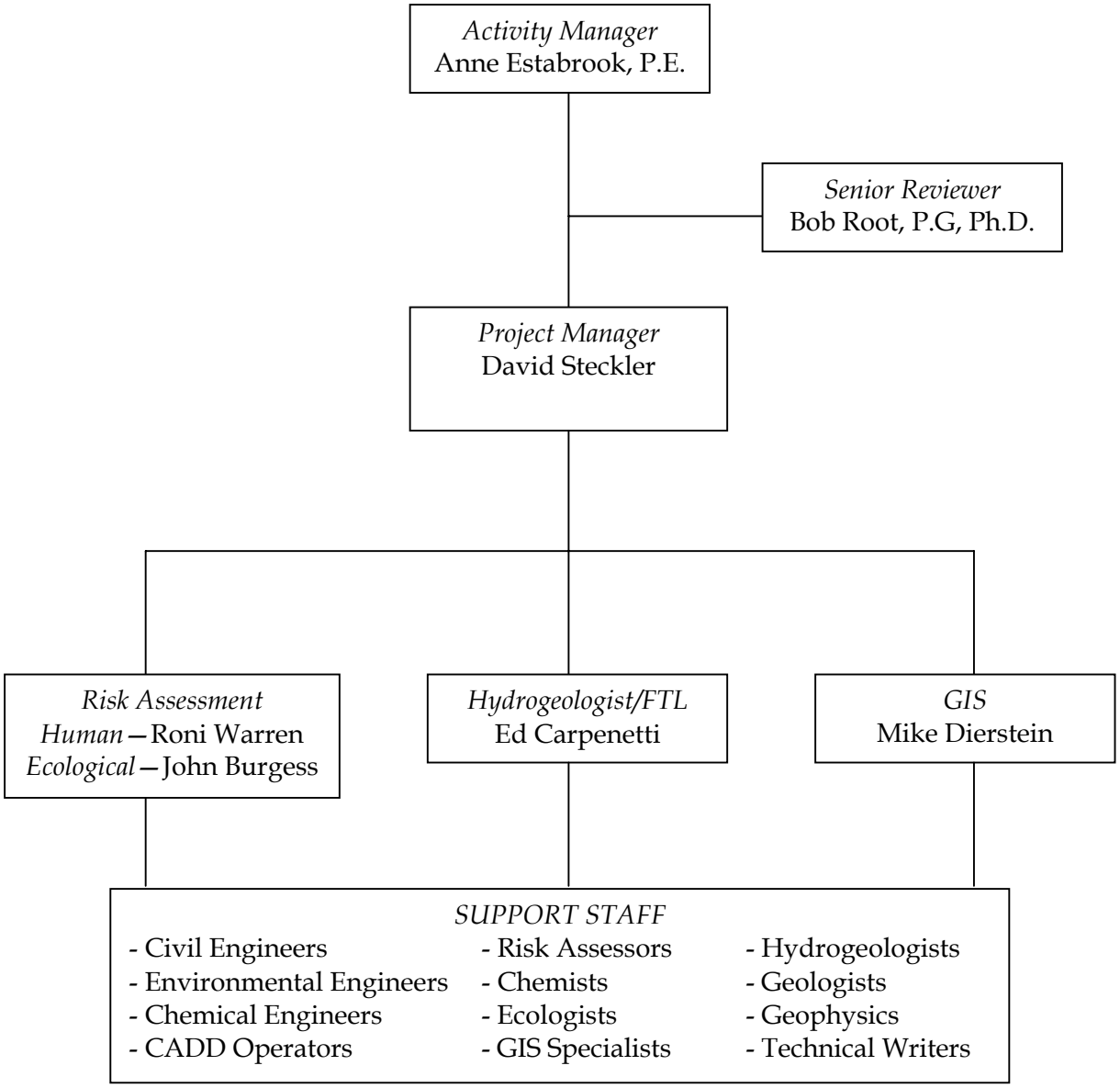
The CH2M HILL Project Organization is shown in Figure 1-1.

FIGURE 1-1
Project Organization Chart



2 Background Information

This section of the Work Plan describes background information associated with IHDIV-NSWC and Site 28. Section 2.1 contains a description of the facility, operations, land use, and geological setting of the IHDIV-NSWC facility as well as the ecological communities present. Section 2.2 contains the history, site description, and results of previous investigations. Similar information on IHDIV-NSWC and other sites at the facility is provided in other documents (NEESA, 1983, 1988, 1992, and B&RE, 1997).

2.1 IHDIV-NSWC Facility

2.1.1 Facility Description and Setting

IHDIV-NSWC is a military facility located in northwestern Charles County, Maryland, approximately 25 miles southwest of Washington, D.C. (Figure 2-1). The facility provides services, research, development, testing, and evaluation in energetics (B&RE, 1997).

IHDIV-NSWC consists of the main installation on the Cornwallis Neck Peninsula and the Stump Neck Annex. The main installation covers 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. The main installation includes Marsh Island and Thoroughfare Island, which are located in Mattawoman Creek. Elevations range from sea level to 111 feet above mean sea level (msl) on Cornwallis Neck.

Both the main installation (Cornwallis Neck Peninsula) and the Stump Neck Annex are on the National Priorities List (NPL). The main installation and Stump Neck Annex are separated by Mattawoman Creek (noncontiguous), have separate United States Environmental Protection Agency (USEPA) identification numbers, and perform dissimilar operations.

2.1.2 Historical and Current Uses of IHDIV-NSWC

IHDIV-NSWC was established in 1890 and is the Navy's oldest continuously operating ordnance station. At various times during its operation, IHDIV-NSWC has served 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 property provided a safety buffer for the testing of larger naval guns that were tested by firing into the Potomac River, and at Stump Neck.

The Indian Head installation was enlarged by another 1,160 acres of adjacent land in 1918, during World War I. This expansion included the purchase of Hopewell Farm and Hog Island, which was at that time an islet in Mattawoman Creek and has since become attached to the Cornwallis Neck peninsula. 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 at 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 as a Defense Access Road in 1943. Development and improvements at Indian Head continued throughout the 1950s and 1960s; in 1966, IHDIV-NSWC was renamed the Naval Ordnance Station (NOS), and Rum Point, an 80-acre promontory in Mattawoman Creek near Stump Neck, was acquired. Bullitt Neck was obtained in five small acquisitions in 1965 and 1966 in order to meet safety and security needs arising from explosive magazines on the Indian Head station (Parsons, 2000).

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 the following specialized fields: energetic chemicals; guns, rockets, and missile propulsion; ordnance devices; explosives; safety and environmental protection; and simulators and training (Parsons, 2000). Current military land use includes operations and training; production; maintenance and utilities; research, development, testing, and evaluation; explosive storage; supply and nonexplosive storage; administration; community facilities and services; housing; and open space.

Forest stands make up approximately 47 percent, or 1,603 acres, of IHDIV-NSWC and include pine, pine-hardwood, and hardwood forest cover types. 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 land to the east and south of the main installation and Stump Neck Annex. The town of Indian Head is located just east of IHDIV-NSWC, where most residential developments are located. Indian Head Highway (Route 210) extends eastward from IHDIV-NSWC's main gate, attracting businesses and providing access to residential areas off the main highway. The Potomac River borders the main installation to the north and west, and Stump Neck borders it to the west. Mason Neck National Wildlife Refuge is located across the Potomac River, north of the main installation. 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 Physiography and Geology

IHDIV-NSWC lies within the Atlantic Coastal Plain physiographic province and is underlain by unconsolidated sand, gravel, and clay from the Pleistocene and Cretaceous Periods. The soil in this area consists 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):

- **Beltsville-Gravelly Land-Bourne**—The soils within this association are level to moderately sloping, moderately well-drained and loamy, and moderately deep. They also include dense, root-inhibiting fragipans and steep, gravelly soil materials.
- **Beltsville-Exum-Wickham**—This association is characterized by level to moderately sloping, moderately well-drained and well-drained loamy soils. Soils within this association are moderately deep and include dense, root-inhibiting fragipans and steep, gravelly soil materials.
- **Evesboro-Keyport-Elkton**—This association is characterized by level to moderately sloping, excessively drained, sandy soils and moderately well-drained and poorly drained level-to-gently-sloping loamy soils with clayey subsoil.
- **Bibb-Tidal Marsh-Swamp**—This association is characterized by level or nearly level, poorly drained, and generally located on floodplains and in miscellaneous unclassified wetlands.

2.1.5 Surface Water and Drainage

Major water bodies at Indian Head 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. Near IHDIV-NSWC, salinity ranges from 0.01 to 3.0 parts per thousand, with the highest salinity values recorded during dry summer months. Mattawoman and Chicamuxen Creeks are tidal tributaries to the lower Potomac River. Chicamuxen Creek is more saline than Mattawoman Creek because it is more strongly influenced by the estuarine waters of the lower Potomac River.

The Potomac River bounds Cornwallis Neck to the north and northwest. Owing to the peninsula's topography, most of the surface water on Cornwallis Neck drains 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.

The Patapsco Formation aquifer supplies IHDIV-NSWC with the majority of groundwater required for production. It is recharged chiefly through precipitation, and the water filters through the soil and is held primarily in sandy/gravelly formations (Parsons, 2000). A single production well, Well 16A, serves IHDIV-NSWC and is screened in the deeper Patuxent aquifer.

2.1.6 Climatic Conditions

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. Because of its proximity to the Potomac River and its tributaries, IHDIV-NSWC experiences less extreme temperatures, higher precipitation, and higher humidity than do 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).

2.1.7 Ecological Communities

2.1.7.1 Terrestrial Systems

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 forested areas on IHDIV-NSWC are dominated by oak, hickory, tulip tree (*Liriodendron tulipifera*), and pine. Flowering dogwood (*Cornus florida*), redbud (*Cercis canadensis*), and American holly (*Ilex opaca*) are typical of the upland understory. 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.

2.1.7.2 Wetland Systems

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

At Indian Head, the tidal estuarine systems are associated with the Potomac River, Mattawoman Creek, and Chicamuxen Creek. Mattawoman Creek marshes are typically dominated by wild rice (*Zizania aquatica*), big cordgrass (*Spartina cynosuriodes*), cattail (*Typha* spp.), rose-mallow (*Hibiscus moscheutos*), tickseed sunflowers (*Bidens* spp.), pickerelweed (*Pontederia cordata*), and arrow arum (*Peltandra virginica*). Intertidal shoreline fringe marshes are extremely rare and are dominated by water willow (*Justica americana*) or American threesquare (*Scirpus pungens*). The broad expansive marsh of Chicamuxen Creek contains an extremely diverse flora. An informal survey of this marsh conducted in 1988 identified more than 80 species of plants (MDNR, 1992).

2.1.7.3 Fauna

The diverse ecological communities at Indian Head support many wildlife species. The Integrated Natural Resources Management Plan for IHDIV-NSWC provides a list of fauna inhabiting the base (Parsons, 2000). Fifteen species of damselflies, 26 species of dragonflies, 48 species of butterflies, 29 species of mammals, 23 species of reptiles, 20 species of amphibians, and 119 species of birds have been observed at the base.

2.1.7.4 Rare, Threatened, and Endangered Species

The Maryland Natural Heritage Program conducted a survey of rare, threatened, and endangered species in 1991 and 1992 (MDNR, 1992). The survey focused on areas with a high potential for supporting rare, threatened, and endangered species. Tables 2-1 and 2-2 list the rare, threatened, and endangered flora and fauna, respectively, identified on IHDIV-NSWC during the survey. The species lists presented in the tables were revised based on data available on the MDNR website (MDNR, 2001). Of these listed species, the bald eagle (*Haliaeetus leucocephalus*) is the only known federally listed threatened species identified on IHDIV-NSWC.

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. These protection areas include Bullitt Neck Point, Cornwallis Neck Marshes, Hog Island Cove, Thoroughfare Island, Chicamuxen Creek Marsh, Magnolia Seep, Porter Woods, Rum Point, Stump Neck Beaver Marsh, and West Stump Neck Shoreline.

2.2 Site 28

2.2.1 History and Description

Site 28, also referred to variously as the "Original NOS Burning Ground," the "Slavins Dock Area," and the "Wildlife Area," is located on the main installation of IHDIV-NSWC (Figure 2-2). The site encompasses the former site of a zinc recovery furnace, Artesian Well 14, and the Shoreline Burning Cage (Figure 2-3). During World War I, the U.S. Navy initiated a metal-recycling program, which was vital during World War II and continues to present day. In 1928, the Zinc Recovery Furnace, designated as Building 415, was erected. The last station map the building appears on is dated October 31, 1952, indicating that the building was demolished in the early 1950s (Dolph, 2001). Artesian Well 14 was installed in 1918 to a depth of 430 feet using cable drilling (Public Works of the Navy, Potable Well Inventory and Well Number Changes, date unknown). Until 1988, it was used as a potable well; afterward it became an observation well. A small burning cage to the south of Artesian Well 14 was used to burn debris, such as wooden crates. The exact location of the former burning cage is unknown. The burning ground is shown outside of the existing perimeter fence on at least one historical map; however, burned debris, glass, and slaglike materials were observed inside the fence in an area adjacent to the mouth of Swale 4.

2.2.2 Previous Investigations

In June 1982, Naval Energy and Environment Support Activity (NEESA) conducted an Initial Assessment Study (IAS) to evaluate sites at IHDIV-NSWC and to determine if a potential threat to human health or the environment existed. The findings for Site 28 are provided in the IAS report; in it the 1.8-acre site was referred to as the "original NOS burning ground." File searches did not provide information on the types of materials that were burned. That smokeless powder was burned at the site was concluded on the basis of materials manufactured when the site was in operation, circa 1890s to 1942. Various contaminated wastes were also burned openly. During IAS site reconnaissance, no visible signs of burned materials were observed. The conclusion was that there was not enough information to characterize the potential hazard to the site. Similarly, the site was not recommended for a Navy Assessment and Control of Installation Pollutants (NACIP) Confirmation Study.

Several soil-sampling events were conducted following the IAS. In August 1993, a soil sample from Site 28, referred to then as the "Slavins Dock area," was collected about 20 feet southwest of Artesian Well 14 and analyzed for soil texture, pH, and fertility. The pH for the sandy loam soil was 6.7. The soil test results indicated that copper, magnesium, sulphate, and zinc were present in amounts of 25, 30, 22.7, and 14,700 pounds per acre, respectively. For zinc, this translates into 7,350 ppm.

In May 2000, the analytical results of total lead and total zinc in a soil sample (soil sample 1) collected from Site 28 near "Wildlife Area Well 14" indicated concentration levels of 9.37 and 515 ppm, respectively. In July 2000, a soil sample (IR2855-000712) was collected and analyzed for various metals. The analysis detected cadmium (1.2 ppm), lead (3.8 ppm), and selenium (1.8 ppm) in the sample.

In October 2000, a sediment sample was collected in Mattawoman Creek just off the shoreline of Site 28 for a Toxicity Identification Evaluation (TIE) associated with Site 42 (SAIC, 2001). The sediment sample had a measured pore water concentration of zinc of 25,000 µg/L.

TetraTech NUS is conducting an ongoing study of the Mattawoman Creek that includes using the Rapid Sediment Screening technology developed by Space and Naval Warfare Systems Command (SPAWARS). A review of the data collected for the Mattawoman Creek study indicated that additional site-specific data are required to evaluateSite 28's effect on the environment. Accordingly, additional sampling is proposed (see Section 3).

Table 2-1
Rare Flora Found at NSWC Indian Head Division
Site 28 RI Work Plan
IHDIV-NSWC
Indian Head, Maryland

Common Name	Scientific Name	Federal Status	State Status	Global/State Rank
Tickseed sunflower	Bidens coronata	NS	NS	G5/S2S3
Narrow melicgrass	Melica mutica	NS	T	G5/S1
Large-seeded forget-me-not	Myosotis macrosperma	NS	NS	G5/S2S3
Smallflower baby blue eyes	Nemophila aphylla	NS	NS	G5/S1

Sources:
Maryland Department of Natural Resources (MDNR), Natural Heritage Program
Rare, Threatened,and Endangered Animal Species and Area Survey for the Naval Surface Warfare Center, Indian Head Division 1991 - 1992 , 1992.
MDNR, *Current and Historical Rare, Threatened, and Endangered Plant Species of Charles County, Maryland* , July 5, 2001. Last Updated November 7, 2002

*Although listed in the state Threatened and Endangered Species List as endangered extirpated, state regulations provide that such species be afforded the same protection as an endangered species upon the discovery of a viable, naturally occurring population.

**Source: Virginia Tech, 1995.

Federal Codes
E = Endangered
NS = No status

State Codes
E = Endangered
EE = Endangered extirpated
T = Threatened

Global Ranks
G4 = Apparently secure globally, though it may be quite rare in parts of its range.
G5 = Demonstrably secure globally, though it may be rare in parts of its range.

State Ranks
S1 = Critically imperiled in the state because of extreme rarity, equivalent to being ranked as state rare.
S2 = Imperiled in the state because of rarity; equivalent to being ranked state rare.
S3 = Rare or uncommon in the state; equivalent to being ranked as watch list.
S4 = Apparently secure in state, with many occurrences.
SH = Of historical occurrence in the state but not verified in the past 20 years.
SU = Possibly in peril in the state, but status uncertain.

Table 2-2
Rare Fauna Found at IHDIV-NSWC
Site 28 RI Work Plan
IHDIV-NSWC
Indian Head, Maryland

Common Name	Scientific Name	Federal Status	State Status	Global/State Rank
Birds				
Bald eagle	Haliaeetus leucocephalus	LT	T	G4/S2S3B
Invertebrates				
Carolina satyr	Hermeuptychia sosybius	NS	NS	G5/S1S3
Frosted elfin	Incisalia irus	NS	E	G3/S1
Treetop emerald	Somatochlora provocans	NS	NS	G3G4/S1

Sources:
Maryland Department of Natural Resources (MDNR), Natural Heritage Program
Rare, Threatened,and Endangered Animal Species and Area Survey for the Naval Surface Warfare Center, Indian Head Division 1991 - 1992, 1992.
MDNR, *Current and Historical Rare, Threatened, and Endangered Animal Species of Charles County, Maryland*, July 5, 2001. Last Updated November 7, 2002

Federal Codes
LT = Threatened
NS = No status
LE = Endangered

State Codes
E = Endangered
I = In need of conservation
T = Threatened
NS = No status

Global Ranks
G1 = Highly globally rare.
G2 = Globally rare.
G3 = Either very rare and local throughout its range or found locally in a restricted range.
G4 = Apparently secure globally, though it may be quite rare in parts of its range.
G5 = Demonstrably secure globally, though it may be rare in parts of its range.
T3 = Infraspecific taxon is being ranked differently than the full species.

State Ranks
S1 = Critically imperiled in the state because of extreme rarity, equivalent to being ranked as state rare.
S2 = Imperiled in the state because of rarity; equivalent to being ranked state rare.
S3 = Rare or uncommon in the state; equivalent to being ranked as watch list.
SH = Of historical occurrence in the state but not verified in the past 20 years.

152962.ri_dr<f2-1.fh8>wdc.damb.12/05/01

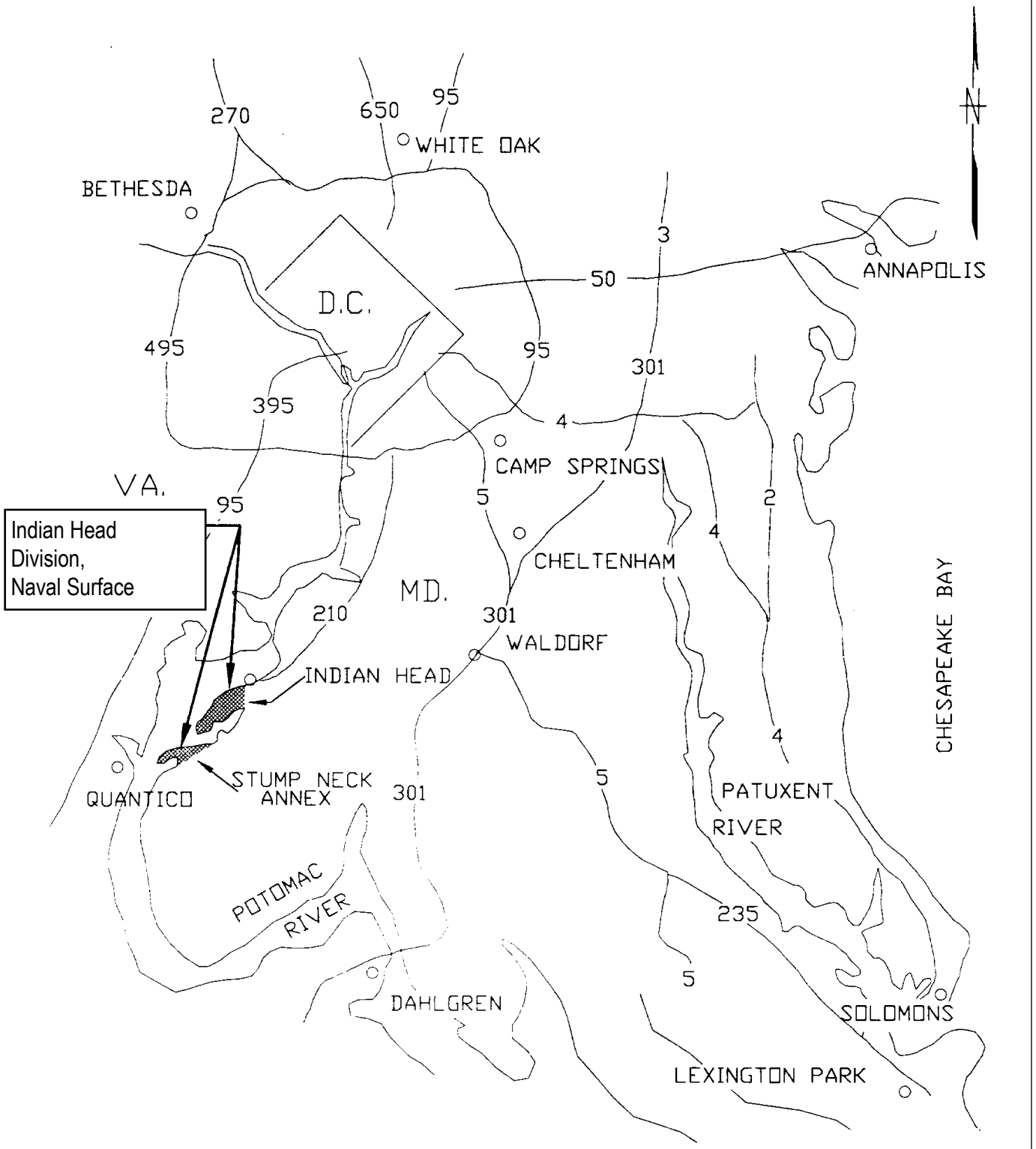


Figure 2-1
VICINITY MAP
Site 28 RI Work Plan
IHDIV-NSWC
Indian Head, Maryland

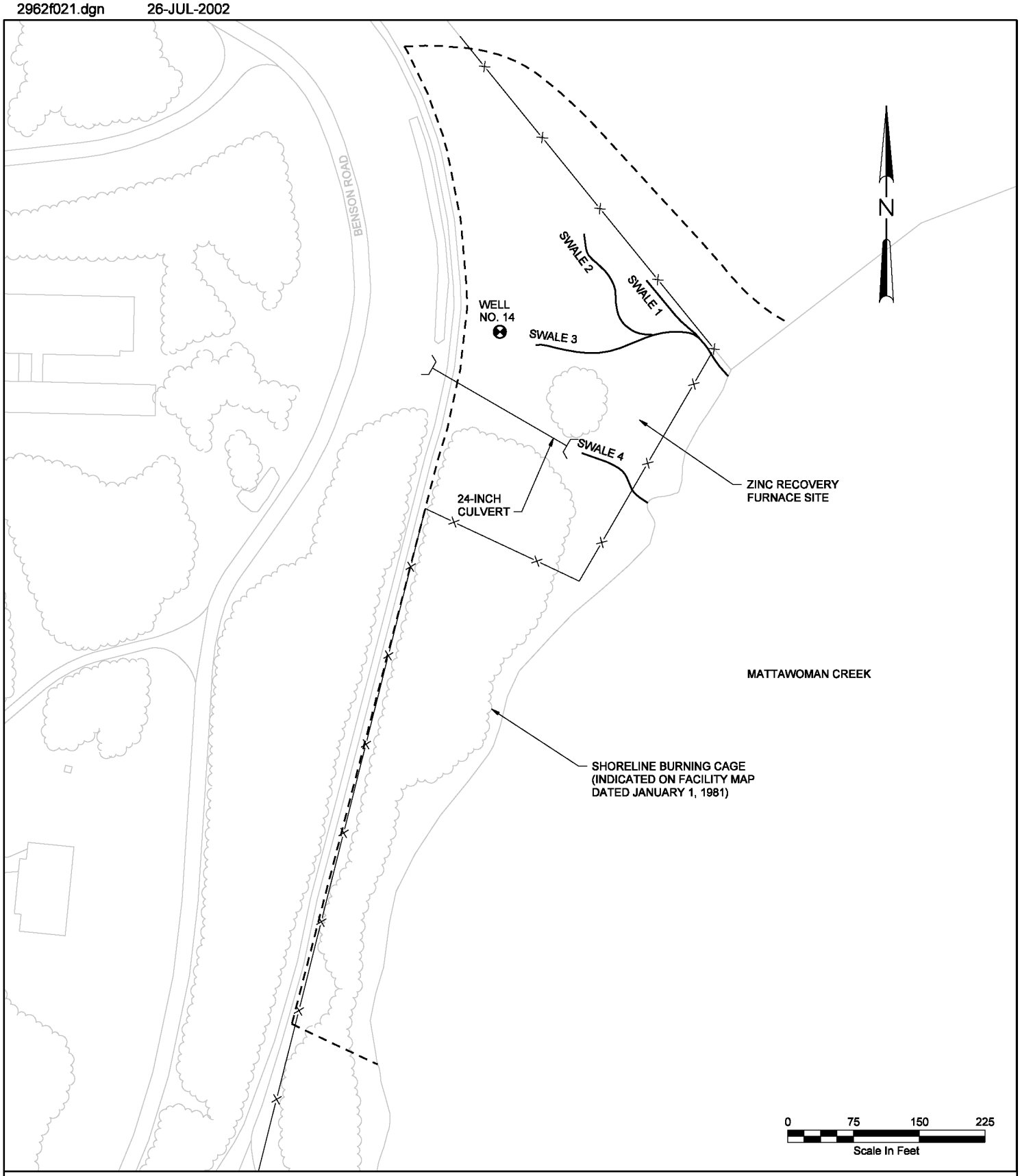
CH2MHILL

2962f020.dgn 06-DEC-2001

Figure 2-2
LOCATION OF SITE 28
SITE 28 RI WORK PLAN
IHDIV-NSWC
INDIAN HEAD, MARYLAND

CH2MHILL

2962f021.dgn 26-JUL-2002



LEGEND

-X——X- FENCE LINE

– – – – – APPROXIMATE SITE BOUNDARY FOR RI

NOTE: SWALE LOCATIONS ARE APPROXIMATE.

FIGURE 2-3
SITE 28
SITE 28 RI WORK PLAN
IHDIV-NSWC
INDIAN HEAD, MARYLAND

CH2MHILL

3 Remedial Investigation Technical Approach

This section discusses the technical approach for the work to be performed in support of the Site 28 RI. There is currently insufficient data to characterize the impact of inorganics in soil, groundwater, surface water, and sediment at Site 28. To address these data gaps, this investigation will focus on the collection of geological, hydrogeological, and chemical data to characterize the nature and extent of contaminants at the site. The first phase of the investigation will consist of collecting surface and subsurface soil samples, in-situ groundwater samples, surface water samples, and sediment samples at the site. Groundwater data will be analyzed and evaluated to determine installation locations for monitoring wells that will be installed and sampled during the second phase of the investigation.

Figure 3-1 shows Zones A and B proposed for the investigation. It should be noted that as a result of past site activities, results of previous investigations, and site visits conducted by CH2M HILL, the Site 28 was expanded to include areas beyond the IHDIV-NSWC fence line (though still within the property boundaries).

3.1 Field Activities

This section provides information on the field investigation methods and protocol for collecting surface soil, subsurface soil, groundwater, surface water, and sediment samples.

3.1.1 Mobilization/Demobilization and Decontamination

The field crew will consist of a Field Team Leader (FTL), qualified technician(s), and specialized subcontractor(s). Prior to mobilization, all field team members will review the project plans, including the site-specific Health and Safety Plan (HASP) provided in the Master Work Plan addendum (CH2M HILL, March 2000), the CH2M HILL IHDIV-NSWC Safety Improvement Plan (May 9, 2001), and the IHDIV-NSWC Hazard Control Briefing.

All equipment required for field operations will be brought to the site by the CH2M HILL field team and its subcontractors. Demobilization will entail following proper decontamination procedures for all site personnel and equipment. All sampling equipment used for collecting samples will be decontaminated prior to beginning field sampling, between collection of each sample, and at the end of the sampling event. All down-hole equipment required for drilling and or DPT will be decontaminated prior to beginning drilling or pushing, between holes, and at the end of the drilling or DPT operations. Decontamination procedures are discussed in IHDIV-NSWC SOP SA-13. The investigation-derived waste (IDW) will be handled in accordance with IHDIV-NSWC SOP SA-13, and field records will be kept as directed in IHDIV-NSWC SOP SA-12.

3.1.2 Zone A

3.1.2.1 Description

Zone A comprises the area between the north and south fence lines, the area outside of the fence line to the north, and shoreline to the east. Within Zone A is the location of the former zinc recovery furnace building and the former burning cage (Figure 3-1). The parameters proposed are based on past site activities.

3.1.2.2 Surface and Subsurface Soil Sampling

Surface and subsurface soil samples will be collected on a stratified grid pattern to determine the lateral and vertical extents of inorganic and organic constituents in Zone A (Figure 3-2). The grid, in general, consists of a series of 100-ft^2 and 50-ft^2 sections in the area where the zinc recovery furnace was most likely located, as well as where loading operations would have taken place between the furnace and railroad tracks, which are currently the gravel road west of Site 28.

Surface and subsurface soil samples will be collected from 27 locations (Figure 3-2). Additionally, samples will be collected from up to two locations at the discretion of the field team on the basis of stressed vegetation or other visual evidence of contamination. Two site-specific background surface and subsurface soil samples will be collected across the road to the west of Site 28 (Figure 3-2). Surface soil samples will be collected from 0 to 6 in. below ground surface (bgs), and subsurface soil samples will be collected from 1 to 3 ft bgs. Both surface and subsurface soil samples will be collected with a track-mounted DPT rig using a macrocore sampler wherever possible. In locations where DPT-rig access is restricted (e.g., outside the Base fence line) , samples will be collected manually with trowels and hand augers. Locations outside of the fence line will be accessed by traversing the shoreline of Mattawoman Creek, or by boat from Slavins Dock, north of Site 28.

Surface and subsurface soil samples will be analyzed at an offsite laboratory for Target Compound List (TCL) volatile organic compounds (VOCs), TCL semivolatile organic compounds (SVOCs), Target Analyte List (TAL) metals, explosives (including nitroguanidine [NG], nitroglycerin [NQ], pentaerythritol tetranitrate [PETN], and perchlorate). Surface soil samples will also be analyzed for pH, total organic carbon (TOC), and grain-size distribution. Associated quality assurance and quality control (QA/QC) samples, consisting of matrix spike and matrix spike duplicates (MS/MSDs), field duplicates, field blanks, equipment rinsate blanks, and trip blanks, will be collected. Samples will be analyzed in accordance with the Navy guidance for Level D. Sampling activities (collection, handling, and decontamination of sampling equipment) will be performed in accordance with existing SOPs. Table 3-1 summarizes the sampling and analysis program; Table 3-2 provides the sample bottleware, preservation, and holding-time requirements.

3.1.2.3 *3.1.2.2* *In Situ* Groundwater Sampling

Approximately 12 *in situ* groundwater samples will be collected from the locations shown in Figure 3-2. Two site-specific background groundwater samples will be collected across the road to the west of Site 28 (Figure 3-2). The *in situ* groundwater samples will be collected at

a depth just below the water table at each location using a track-mounted direct-push rig fitted with a screened grab sampler and a peristaltic pump with disposable tubing.

The samples will be analyzed at an offsite laboratory for TCL VOCs, TCL SVOCs, TAL dissolved metals, and explosives (including NG, NQ, PETN, and perchlorate). Because these data will not be validated, the associated QA/QC samples will consist of only one field duplicate sample only. Analysis of the samples will be performed in accordance with the Navy guidance. Sampling activities (collection, handling, and decontamination of sampling equipment) will be performed in accordance with existing SOPs. Table 3-1 summarizes the sampling and analysis program; Table 3-2 provides the sample bottleware, preservation, and holding-time requirements.

3.1.2.4 Sediment Sampling

There are four well-defined swales in Zone A (Figure 3-2). The path of these swales may change slightly depending on the erosion and groundwater seepage that take place between extreme weather events. On the basis of site topography, it is likely that significant standing water in Swales 1 through 3 is rare. Because the swales are runoff channels/gullies, sediment samples collected in Swales 1 through 3 will be considered surface soil, rather than sediment, from an exposure perspective, and will be treated as such in the risk assessment. On the basis of the November 2001 site visit by a CH2M HILL ecologist, Swale 4 was the only swale with flowing water. Substrate samples collected from Swale 4 will be considered sediment. Swale 4 runs through an area with groundwater seeps and wetland vegetation. In addition to groundwater discharge and site runoff, Swale 4 also receives runoff via a 24-inch culvert from Benson Road and the hillside above the site. Therefore, approximately three sediment samples will be collected in the swales at the locations marked on Figure 3-2. No site-specific background samples will be collected for surface water or sediment. Sediment samples will be collected from 0 to 6 in. bgs at the surface water locations. Sediment samples collected from the swales will be analyzed at an offsite laboratory for TCL VOCs, TCL SVOCs, TAL metals, explosives (including NG, NQ, PETN, and perchlorate), pH, TOC, and grain-size distribution. Associated QA/QC samples, consisting of MS/MSDs, field duplicates, field blanks, equipment rinsate blanks, and trip blanks will be collected for sediment samples.

3.1.2.5 Surface Water Sampling

Surface water samples will be collected by using a peristaltic pump and disposable tubing due to the likely shallowness of the surface water in the swales. The samples collected for dissolved metals analysis will be filtered at the time of collection using an inline 45 micron filter. Approximately three surface water samples will be collected in the swales at the marked locations on Figure 3-2. Care will be taken not to stir sediment when and if surface water is sampled. Thus, surface water will be collected first followed by sediment sampling. Surface water samples will be analyzed at an offsite laboratory for TCL VOCs, TCL SVOCs, explosives (including NG, NQ, PETN, and perchlorate), TAL metals (total and dissolved), dissolved organic carbon, and hardness. Field measurements will include specific conductivity, oxidation/reduction potential (ORP), dissolved oxygen (DO), pH, and temperature. Associated QA/QC samples, consisting of MS/MSDs, field duplicates, field blanks, equipment rinsate blanks, and trip blanks will be collected for surface water samples. Analysis of the samples will be performed in accordance with the Navy guidance

for Level D. Sampling activities (collection, handling, and decontamination of sampling equipment) will be performed in accordance with existing SOPs. Table 3-1 summarizes the sampling and analysis program, while Table 3-2 provides the sample bottleware, preservation, and holding time requirements.

3.1.2.6 Permanent Monitoring Well Installation and Sampling

A Phase II RI will be conducted if the analytical results of the in situ groundwater samples collected during Phase I indicate that inorganic or organic concentrations exceed regulatory screening criteria. Phase II will consist of installing shallow monitoring wells (number to be determined in an addendum to this Work Plan to be prepared at a later date) at Site 28. These monitoring wells will provide groundwater data for the human health risk assessment (HHRA) and ecological risk assessment (ERA), since only data generated from monitoring well samples can be validated to support HHRAs and ERAs. Groundwater will be collected from these wells and analyzed for TCL VOCs, TCL SVOCs, TAL metals, and explosives (including NG, NQ, PETN, and perchlorate).

3.1.3 Zone B

3.1.3.1 Description

Zone B is reported as the "Burning Ground" in the IAS and as the "Shoreline Burning Cage" by a naval historian (Dolph, 2001). This area, outside of the IHDIV-NSWC fence line but within navy property, is to the south of Zone A (Figure 3-1). The area proposed for sampling extends approximately 600 feet south from the southern Zone A fence line. Zone B will be accessed by traversing the shoreline of Mattawoman Creek, or by boat, from Slavins Dock, just north of Site 28.

3.1.3.2 Surface and Subsurface Soil Sampling

Surface and subsurface soil samples will be collected from the eight locations shown in Figure 3-2. Additionally, samples will be collected from two locations at the discretion of the field team on the basis of stressed vegetation or visual evidence of contamination. Two site-specific background surface and subsurface soil samples will be collected across the gravel road to the west of Site 28 (Figure 3-2). Surface soil samples will be collected from 0 to 6 in. bgs, and subsurface soil samples will be collected from 1 to 3 ft bgs. Since Zone B is inaccessible with a DPT rig, the samples will be collected with trowels and hand augers.

Surface and subsurface soil samples in Zone B will be analyzed at an offsite laboratory for TCL VOCs, TCL SVOCs, TAL metals, and explosives (including NG, NQ, PETN, and perchlorate). Surface soil samples will also be analyzed for pH, TOC, and grain size (distribution). Associated QA/QC samples, consisting of MS/MSDs, field duplicates, field blanks, equipment rinsate blanks, and trip blanks will be collected. The samples will be analyzed according to Navy guidance for Level D. Sampling activities (collection, handling, and decontamination of sampling equipment) will be performed in accordance with existing SOPs. Table 3-1 summarizes the sampling and analysis program; Table 3-2 provides the sample bottleware, preservation, and holding-time requirements.

3.1.4 Sediment Sampling in Mattawoman Creek

An investigation into the lateral and vertical extent of possible inorganic contamination in the sediment of Mattawoman Creek adjacent to Site 28 is planned because a previous investigation related to Site 42 (SAIC, 2001) found elevated zinc concentrations in the pore water of a sediment sample collected just offshore of Site 28. A review of the available data from the Mattawoman Creek Study (TTNUS, 2002) and the SPAWARS rapid screening pilot study (SPAWARS, undated) revealed that no VOCs, pesticides, or PCBs were detected in any of the sediment samples collected from the creek in the vicinity of Site 28. Therefore, it was determined that analyzing for these chemical parameters in future sampling efforts in Mattawoman Creek in relation to the Site 28 investigation was not warranted (CH2M HILL, 2003). The available data suggest that certain metals, primarily cadmium, copper, lead, and zinc, are elevated in the sediments of Mattawoman Creek adjacent to the site. Therefore, the initial sampling effort will be focused on evaluating the spatial and vertical extent of metal concentrations in the area of the creek adjacent to Site 28. However, in an effort to ensure a conservative approach, sediment samples collected from three sampling locations will also be analyzed for SVOCs and explosives (including NG, NQ PETN, and perchlorate).

Sediment will be collected at 15 locations (Figure 3-3). Two samples will be collected at each location: surface (0 to 6 inches below the surface water–sediment interface) and subsurface (6 to 12 inches below the surface water–sediment interface). Five sample locations are planned for the near-shore area adjacent to Site 28, five sample locations are planned for the creek channel, and five sample locations are planned for the near-shore area of the sandbar across the channel from Site 28. Sediment samples will be collected using a gravity corer with disposable core liners and core catchers, wherever possible. A petite Ponar dredge will be used as a back-up sampling method if adequate core samples cannot be collected.

The sample collected from 0 to 6 inches will be used to support the ecological risk assessment for Site 28; the sample collected from 6 to 12 inches will be used to aid in remediation and risk management decisions. As noted above, all samples will be analyzed for TAL metals. In addition, six of the samples, collected from three locations, will be analyzed for TCL SVOCs and explosives (including NG, NQ, PETN, and perchlorate). The sampling locations for these samples will be determined during the field effort and will be based upon the observed locations of greatest deposition in each sampling area (i.e., one sample location along the near-shore area adjacent to the site, one sample location in the creek channel, and one location from the near-shore area of the sandbar across the channel from Site 28). The samples collected from 0 to 6 inches samples will be analyzed for grain size, as well.

3.1.5 Surveying

All sampling station locations will be surveyed for horizontal coordinates to the nearest 1 foot using a portable backpack Global Positioning System (GPS). A registered surveyor will survey the monitoring wells for elevation to the nearest 0.01-foot.

3.1.6 Investigation-Derived Waste

Investigation-derived waste (IDW) will consist of soil cuttings, purged groundwater, and decontamination water generated during the field activities. All IDW will be handled in accordance with IHDIV-NSWC SOP SA-13 and will be disposed of following laboratory analysis to determine if it is hazardous or nonhazardous waste. A staging area for the IDW will be coordinated with base personnel prior to initiating field activities. All IDW drums will be marked with the following information:

Investigation-Derived Waste
Soil Cuttings / Purge Water / Decontamination Water
IHDIV-NSWC, Site 28
Onsite Contact: Heidi Morgan x2265

IDW composite samples will be collected for solid and liquid media and analyzed for toxicity characteristic leaching procedure (TCLP), ignitability, corrosivity, and reactivity for disposal purposes.

3.2 Sample Handling

Sample handling includes the field-related considerations regarding the selection of sample containers and preservatives, allowable holding times, and the analyses required. These topics are discussed above and are presented in Table 3-2. The sample identification system to be applied to the samples and the shipping requirements are discussed below.

3.2.1 Sample Identification System

Each sample will be designated by an alphanumeric code that identifies the site and matrix sampled and contains a sequential sample number. Site-specific procedures are elaborated below.

The following is a general guide for sample identification:

First Segment of Sample Number: Naval Installation Abbreviation	Second Segment of Sample Number: Site Number	Third Segment of Sample Number		
		Sample Type	Sample Location	Additional Qualifiers (Sample Depth, Date)
A	ANN	AA	NN	NNNN

Symbol definition:

"A" = Alphabetic
"N" = Numeric

Naval installation abbreviation:

A = One-letter abbreviation identifying the Naval Installation where the sample was collected (e.g., Indian Head = I)

Site number:

ANN = One letter and two numbers identifying the site on the facility where the sample was collected (e.g., S28 = Site 28)

Sample type:

SS = Surface soil sample
SB = Subsurface soil sample
SD = Sediment sample
SW = Surface water sample
GW = Grab groundwater sample
MW = Monitoring well sample
WS = Waste (solid)
TB = Trip blank
EB = Equipment blank
FB = Field blank

Sample Location:

MM = QC samples—2-digit month of sampling event
NN = Primary samples—2-digit number indicating sample location

Additional Qualifiers:

MMYY = Monitoring well, surface water, and waste samples—2-digit month and 2-digit year of sampling event (e.g., May 2003 = 0503)
BDED = Surface soil, subsurface soil, sediment, and grab groundwater samples—2-digit begining depth and 2-digit end depth rounded up to nearest foot (e.g., 2′– 3′ = 0203)
DDYY = QC Samples—2-digit day and 2-digit year of sampling event

Examples of this numbering approach are:

IS28SS040001	The fourth surface soil sample collected from 0 ft to 1 ft
IS28MW020302	The groundwater sample collected from IS28MW02 in May 2003
IS28WS010503	The first waste sample collected from drums in May 2003

Examples of this numbering approach for QA/QC samples are:

IS28FB051503	Field blank collected at Site 28 on May 15, 2003
IS28TB051503	Trip blank collected at Site 28 on May 15, 2003
IS28EB051503	Equipment blank collected at Site 28 on May 15, 2003

Sample Packaging and Shipping

Samples will be packaged in accordance with IHDIV-NSWC SOP SA-11, *Non-Radiological Sample Handling*. The sample will be tightly packed in a cooler with bubble wrap packaging material and ice as a preservative. The samples will be either picked up at the site by the analytical laboratory or shipped to the laboratory via Federal Express. The FTL is responsible for completion of the following forms:

- Sample labels and chain-of-custody seals

- Chain-of-custody forms
- Appropriate labels and forms required for shipment

Custody of the samples will be maintained and documented at all times. Chain-of-custody will begin with the collection of the samples in the field and will continue through the analysis of the sample at the analytical laboratory.

3.3 Data Quality Objectives

3.3.1 Step 1: State the Problem

As noted in the introduction, land use activities at Site 28 included the burning of smokeless powder and other contaminated wastes and the operation of a zinc recovery furnace. Sampling conducted following the IAS and as part the TIE study identified high levels of zinc in Site 28 soils and sediment in Mattawoman Creek.

3.3.2 Step 2: Identify the Decision

This RI will define the nature and extent of contamination, identify contaminant transport mechanisms, and quantify the risk to human health and the environment from the site. Further, if risks are identified at the site, the data generated during the RI will be used to evaluate remediation alternatives.

3.3.3 Step 3: Identify Inputs to the Decision

Current information about the site consists of literature reviews and analytical data generated following the IAS and during the Mattawoman Creek and TIE studies. Additionally, site visits have been conducted to examine current conditions. It should be noted that the precise location of the zinc recovery furnace and former burning cage are not known.

3.3.4 Step 4: Define the Boundaries of the Study

Site 28 is bounded to the east by Mattawoman Creek (although Mattawoman Creek will be investigated as part of this RI); to the west by an unnamed road; to the north the site boundary extends approximately 75 feet past the northern fence line; and to the south the site boundary extends approximately 600 feet past the southern fence line.

3.3.5 Step 5: Develop a Decision Rule

The analytical results will be the basis for many project decisions, including risk management decisions and the development of remedial alternatives; therefore, the analysis of soil, sediment, groundwater and surface water samples will require a high level of QC at the laboratory. Further, complete analytical data packages and third-party data validation will be required.

A PID will be used in the field to screen soils and for health and safety monitoring. The instruments will be calibrated daily. The person calibrating the instrument will enter the calibration information in the field log book.

The QC requirements specified in this Indian Head Basewide QAPP and the SOPs attached to the base-wide Field Sampling Plan (FSP; Brown and Root, 1997) will be followed to establish analytical quality.

3.3.6 Step 6: Specify Limits on Decision Errors

The probability of sampling and measurement errors that exist at any site under investigation necessitates the development of sampling guidelines and the collection of quality control samples. Sampling techniques are discussed (or referenced) in detail in the FSP.

QC samples will be used to verify the accuracy and precision of the data generated during the RI. When data are suspect because a QC sample is outside of a laboratory's established control limits, the data user will be notified through the laboratory report's case narrative and the data validator's report. Data validation is an important step in determining how the data can be used by the risk assessors and for the development of remedial alternatives. All data used for risk assessment will be validated following Region III modifications to the USEPA National Functional Guidelines for Validating Inorganic Data (USEPA, 1993) and the USEPA National Functional Guidelines for Validating Organic and Data (USEPA, 1994).

3.3.7 Step 7: Optimize the Design

The specific objectives of the RI are to: 1) verify the presence or absence of contamination in soil, groundwater, surface water, and sediment resulting from past activities at the site; 2) define the extent of contamination; and 3) evaluate the need for remediation. The RI is designed to collect enough data to meet these objectives while avoiding any unnecessary sample collection.

Human Health Risk Assessment

A human health risk assessment will be performed for Site 28 in accordance with Section 3 of the Master WP (B&RE, 1997) and current USEPA guidance documents. Surface and subsurface soil, shallow groundwater, surface water, and sediment samples will be collected and the analytical results used to evaluate whether the concentrations of site contaminants pose a significant threat to human health. This section presents an outline of the evaluation process of the human health risk assessment, which includes the screening methods for selecting chemicals of potential concern (COPCs) and exposure scenarios.

The proposal in this Work Plan is to collect *in situ* groundwater samples during Phase I. The *in situ* groundwater samples will be evaluated to determine the optimal number and locations or permanent monitoring wells to be installed in a second phase of the investigation. The *in situ* groundwater data will not be used in the human health risk evaluation. Groundwater data from monitoring wells will be used in the human health evaluation.

COPCs will be selected on the basis of a comparison of maximum detected concentrations of constituents in the various media to Region III risk-based concentrations (RBCs). RBCs that are based on noncarcinogenic effects will be divided by 10 to account for cumulative exposure (i.e., a hazard quotient of 0.1). RBCs based on carcinogenic effects will be used as presented in the most current RBC table (EPA, 2002). Constituents having a maximum

detected concentration less than the RBC will not be retained as COPCs for the HHRA. Lead concentrations in groundwater will be compared to the Safe Drinking Water Act (SDWA) action level of 15 ppb. If the lead concentration exceeds the screening value, it will be discussed qualitatively in the toxicity assessment section in the risk assessment report. Lead concentrations in soil will be compared to 400 mg/kg. Constituents such as magnesium, calcium, potassium, and sodium that are essential human nutrients will not be considered for quantitative evaluation in the risk assessment if they are detected at concentrations that are not considered toxic (i.e., at or near naturally occurring levels). Data collected from Mattawoman Creek will be used in risk calculations. In addition to screening the data against the RBCs to select the COPCs, a table will be provided to identify those constituents that are COPCs based solely on industrial use of the site.

Site 28 is located in an area of the facility that is expected to be used recreationally (e.g., for bird watching) but not residentially. Navy policy, however, requires the evaluation of a hypothetical conservative scenario of future residential use. Therefore, the exposure scenarios that will be evaluated in the Site 28 HHRA are exposure to:

- Soil by the industrial worker, adult or adolescent trespasser, adult or child recreational user, adult or child resident, and construction worker through inhalation of fugitive dust, incidental ingestion, and dermal contact while at the site
- Groundwater by the residential adult through ingestion of the water and inhalation of volatiles while showering
- Groundwater by the residential child through ingestion of the water and dermal contact while bathing
- Groundwater by the construction worker through inhalation of volatiles from an open excavation and incidental ingestion of, and dermal contact with, groundwater during excavation activities
- Surface water by the recreational adult or child through incidental ingestion and dermal contact while wading in the drainage swale or Mattawoman Creek
- Sediment by the recreational adult or child through incidental ingestion and dermal contact while wading in the drainage swale or Mattawoman Creek

The analytical results from the soil from Zone A and Zone B will be evaluated to determine if they represent two distinct areas. If the data vary, the two zones will be evaluated in the HHRA as two separate source areas. If the data are similar in concentrations of constituents detected, however, the two zones will be evaluated as a single area in the human health evaluation.

The Exposure Point Concentrations (EPCs) for groundwater for the future scenario will be determined using data from only the most contaminated wells. This will include the evaluation of the groundwater data to determine if there is an identifiable groundwater plume or multiple plumes. The groundwater data from the plume(s) will be conservatively used for determining the EPC for the residential scenario.

3.5 Ecological Risk Assessment

A Screening Ecological Risk Assessment (SERA) (Steps 1 and 2) and the first step of the Baseline Ecological Risk Assessment (BERA; Step 3A) will be performed for Site 28 in general accordance with Navy (CNO 1999; NAVFAC 2001) and USEPA (USEPA 1997) ERA guidance. Surface soil, sediment, surface water, and groundwater will be collected, and the analytical results will be used to assess if concentrations of site contaminants may pose risk to the ecosystem. Further, data generated during the Mattawoman Creek Study (TTNUS, 2002) deemed relevant to Site 28 will be included in the assessment, as will site specific data generated during the TIE study (SAIC, 2001).

This section presents a brief summary of the ecological setting of Site 28 and an overview of the process that will be incorporated for Steps 1 through 3A of the Site 28 ERA.

Site 28 is located between Benson Road and Mattawoman Creek (Figure 3-1) in an area of generally declining topography eastward. The site is divided into Zones A and B. Zone A includes a former zinc recovery furnace location, Artesian Well 14, and a portion of a former shoreline burning cage. The rest of this former burning area is believed to extend into Zone B as well. Site 28 includes a mixture of habitats. At the northern end of Zone A, there is a field with patchy herbaceous vegetation. The substrate is a mosaic of soil, gravel, rocks, and debris (e.g., metal parts). A series of three runoff gullies are also located in this area of Zone A. These gullies collect episodic storm water run-off and discharge to adjacent Mattawoman Creek. A fourth drainage feature collects water via a culvert that runs from west of the dirt road at Site 28, downgradient to Swale 4. This drainage also receives runoff from the site, and possibly groundwater discharge. The presence of water during a November 2001 site reconnaissance by CH2M HILL, during a dry period, and the presence of obligate wetlands vegetation suggests that water may be permanently present in this drainage. The drainage discharges to Mattawoman Creek. The remainder of the site (i.e., the southern portion of Zone A and most of Zone B) is a mixed-hardwood-forested area. The tree cover in this area is primarily deciduous (e.g., oak, maple, and sweet gum), with a few conifer species. The shoreline between Site 28 and Mattawoman Creek is tidally influenced. The shoreline is relatively bare of vegetation and is of sandy to muddy composition. The water level fluctuates according to tidal conditions.

In Step 1 of the ERA process for Site 28, the screening-level problem formulation will be conducted. This step will begin by accounting for existing habitats and biota (i.e., potential receptors) and compiling and reviewing existing data for the nature and extent of contamination at the site. In this step, a preliminary conceptual model will be developed that includes a qualitative evaluation of potential sources, fate and transport mechanisms, mechanisms of toxicity, potential receptors, and exposure pathways. Finally, preliminary assessment endpoints, measurement endpoints, and risk hypotheses will also be developed for the selected ecological receptor group.

In Step 2, direct exposure and food chain exposure estimates and risk calculations will be performed for each receptor group. The exposure estimate will be based on conservative media concentrations (e.g., maximum concentration, or the maximum detection limit for undetected chemicals) and conservative exposure parameters (i.e., maximum ingestion rates and minimum body weights). Risk calculations will result in hazard quotients (HQs). HQs

will be derived by dividing the maximum chemical concentration in the medium being evaluated by the corresponding medium-specific screening value, or by dividing the maximum exposure dose by the corresponding ingestion screening value (i.e., No Observed Adverse Effect Level). Chemicals with HQs greater than or equal to 1 will be considered COPCs). The list of Step 2 COPCs will also include detected chemicals that could not be evaluated due to lack of a medium-specific screening value or appropriate no-observed-adverse-effect-levels (NOAELs). If any COPCs are identified following Step 2, the risk assessment process continues into Step 3A.

In Step 3A, exposure assumptions will be refined and risk estimates, or HQs will be recalculated for all COPCs from Step 2. Refinements will include the use of central tendency estimates for media concentrations (i.e., mean concentration, or one half the mean detection limit for undetected chemicals) and exposure parameters (i.e., ingestion rates a body weights). If re-calculation with less conservative exposure assumptions supports an acceptable risk determination (i.e., HQs less than 1), then the site may exit the ecological risk assessment process following Step 3A (CNO 1999). If recalculation yields an HQ greater than or equal to 1 for a particular chemical, that chemical may be selected as a chemical of concern (COC). Risks from potential COCs will be characterized in context of the site setting and other factors (e.g., frequency of detection, background, toxicological information, chemical form considerations). If COCs are selected , the ERA process will need to continue with a revision of the problem formulation (Step 3B) and a baseline ecological risk assessment work plan.

Table 3-1
Summary of Sampling Program
Site 28 RI Work Plan
IHDIV-NSWC
Indian Head, Maryland

			Analyses							
Medium	**Sample ID**	**Sample Depth/Location**	**TCL VOC**	**TCL SVOC**	**TAL Metals**	**pH**	**TOC**	**Grain Size distribution**	**Explosives ***	**Hardness**
Surface Soil	IS28SS010001	0-6 inches bgs in Zone A	x	x	x	x	x	x	x	
	IS28SS020001	0-6 inches bgs in Zone A	x	x	x	x	x	x	x	
	IS28SS030001	0-6 inches bgs in Zone A	x	x	x	x	x	x	x	
	IS28SS040001	0-6 inches bgs in Zone A	x	x	x	x	x	x	x	
	IS28SS050001	0-6 inches bgs in Zone A	x	x	x	x	x	x	x	
	IS28SS060001	0-6 inches bgs in Zone A	x	x	x	x	x	x	x	
	IS28SS070001	0-6 inches bgs in Zone A	x	x	x	x	x	x	x	
	IS28SS080001	0-6 inches bgs in Zone A	x	x	x	x	x	x	x	
	IS28SS090001	0-6 inches bgs in Zone A	x	x	x	x	x	x	x	
	IS28SS100001	0-6 inches bgs in Zone A	x	x	x	x	x	x	x	
	IS28SS110001	0-6 inches bgs in Zone A	x	x	x	x	x	x	x	
	IS28SS120001	0-6 inches bgs in Zone A	x	x	x	x	x	x	x	
	IS28SS130001	0-6 inches bgs in Zone A	x	x	x	x	x	x	x	
	IS28SS140001	0-6 inches bgs in Zone A	x	x	x	x	x	x	x	
	IS28SS150001	0-6 inches bgs in Zone A	x	x	x	x	x	x	x	
	IS28SS160001	0-6 inches bgs in Zone A	x	x	x	x	x	x	x	
	IS28SS170001	0-6 inches bgs in Zone A	x	x	x	x	x	x	x	
	IS28SS180001	0-6 inches bgs in Zone A	x	x	x	x	x	x	x	
	IS28SS190001	0-6 inches bgs in Zone A	x	x	x	x	x	x	x	
	IS28SS200001	0-6 inches bgs in Zone A	x	x	x	x	x	x	x	
	IS28SS210001	0-6 inches bgs in Zone A	x	x	x	x	x	x	x	
	IS28SS220001	0-6 inches bgs in Zone A	x	x	x	x	x	x	x	
	IS28SS230001	0-6 inches bgs in Zone A	x	x	x	x	x	x	x	
	IS28SS240001	0-6 inches bgs in Zone A	x	x	x	x	x	x	x	
	IS28SS250001	0-6 inches bgs in Zone A	x	x	x	x	x	x	x	
	IS28SS260001	0-6 inches bgs in Zone A	x	x	x	x	x	x	x	
	IS28SS270001	0-6 inches bgs in Zone A	x	x	x	x	x	x	x	
	IS28SS280001	0-6 inches bgs (discretionary sample within Zone A)	x	x	x	x	x	x	x	
	IS28SS290001	0-6 inches bgs (discretionary sample within Zone A)	x	x	x	x	x	x	x	
	IS28SS300001	0-6 inches bgs (background sample for Zone A)	x	x	x	x	x	x	x	
	IS28SS310001	0-6 inches bgs (background sample for Zone A)	x	x	x	x	x	x	x	
	IS28SS320001	0-6 inches bgs in Zone B	x	x	x	x	x	x	x	
	IS28SS330001	0-6 inches bgs in Zone B	x	x	x	x	x	x	x	
	IS28SS340001	0-6 inches bgs in Zone B	x	x	x	x	x	x	x	
	IS28SS350001	0-6 inches bgs in Zone B	x	x	x	x	x	x	x	
	IS28SS360001	0-6 inches bgs in Zone B	x	x	x	x	x	x	x	
	IS28SS370001	0-6 inches bgs in Zone B	x	x	x	x	x	x	x	
	IS28SS380001	0-6 inches bgs in Zone B	x	x	x	x	x	x	x	
	IS28SS390001	0-6 inches bgs in Zone B	x	x	x	x	x	x	x	
	IS28SS400001	0-6 inches bgs (discretionary sample within Zone B)	x	x	x	x	x	x	x	
	IS28SS410001	0-6 inches bgs (discretionary sample within Zone B)	x	x	x	x	x	x	x	
	IS28SS420001	0-6 inches bgs (background sample for Zone B)	x	x	x	x	x	x	x	
	IS28SS430001	0-6 inches bgs (background sample for Zone B)	x	x	x	x	x	x	x	

Table 3-1
Summary of Sampling Program
Site 28 RI Work Plan
IHDIV-NSWC
Indian Head, Maryland

			Analyses							
Medium	**Sample ID**	**Sample Depth/Location**	**TCL VOC**	**TCL SVOC**	**TAL Metals**	**pH**	**TOC**	**Grain Size distribution**	**Explosives ***	**Hardness**
Subsurface Soil	IS28SB010103	1-3 feet bgs in Zone A	x	x	x				x	
	IS28SB020103	1-3 feet bgs in Zone A	x	x	x				x	
	IS28SB030103	1-3 feet bgs in Zone A	x	x	x				x	
	IS28SB040103	1-3 feet bgs in Zone A	x	x	x				x	
	IS28SB050103	1-3 feet bgs in Zone A	x	x	x				x	
	IS28SB060103	1-3 feet bgs in Zone A	x	x	x				x	
	IS28SB070103	1-3 feet bgs in Zone A	x	x	x				x	
	IS28SB080103	1-3 feet bgs in Zone A	x	x	x				x	
	IS28SB090103	1-3 feet bgs in Zone A	x	x	x				x	
	IS28SB100103	1-3 feet bgs in Zone A	x	x	x				x	
	IS28SB110103	1-3 feet bgs in Zone A	x	x	x				x	
	IS28SB120103	1-3 feet bgs in Zone A	x	x	x				x	
	IS28SB130103	1-3 feet bgs in Zone A	x	x	x				x	
	IS28SB140103	1-3 feet bgs in Zone A	x	x	x				x	
	IS28SB150103	1-3 feet bgs in Zone A	x	x	x				x	
	IS28SB160103	1-3 feet bgs in Zone A	x	x	x				x	
	IS28SB170103	1-3 feet bgs in Zone A	x	x	x				x	
	IS28SB180103	1-3 feet bgs in Zone A	x	x	x				x	
	IS28SB190103	1-3 feet bgs in Zone A	x	x	x				x	
	IS28SB200103	1-3 feet bgs in Zone A	x	x	x				x	
	IS28SB210103	1-3 feet bgs in Zone A	x	x	x				x	
	IS28SB220103	1-3 feet bgs in Zone A	x	x	x				x	
	IS28SB230103	1-3 feet bgs in Zone A	x	x	x				x	
	IS28SB240103	1-3 feet bgs in Zone A	x	x	x				x	
	IS28SB250103	1-3 feet bgs in Zone A	x	x	x				x	
	IS28SB260103	1-3 feet bgs in Zone A	x	x	x				x	
	IS28SB270103	1-3 feet bgs in Zone A	x	x	x				x	
	IS28SB280103	1-3 feet bgs (discretionary sample within Zone A)	x	x	x				x	
	IS28SB290103	1-3 feet bgs (discretionary sample within Zone A)	x	x	x				x	
	IS28SB300103	1-3 feet bgs (background sample for Zone A)	x	x	x				x	
	IS28SB310103	1-3 feet bgs (background sample for Zone A)	x	x	x				x	
	IS28SB320103	1-3 feet bgs in Zone B	x	x	x				x	
	IS28SB330103	1-3 feet bgs in Zone B	x	x	x				x	
	IS28SB340103	1-3 feet bgs in Zone B	x	x	x				x	
	IS28SB350103	1-3 feet bgs in Zone B	x	x	x				x	
	IS28SB360103	1-3 feet bgs in Zone B	x	x	x				x	
	IS28SB370103	1-3 feet bgs in Zone B	x	x	x				x	
	IS28SB380103	1-3 feet bgs in Zone B	x	x	x				x	
	IS28SB390103	1-3 feet bgs in Zone B	x	x	x				x	
	IS28SB400103	1-3 feet bgs (discretionary sample within Zone B)	x	x	x				x	
	IS28SB410103	1-3 feet bgs (discretionary sample within Zone B)	x	x	x				x	
	IS28SB420103	1-3 feet bgs (background sample for Zone B)	x	x	x				x	
	IS28SB430103	1-3 feet bgs (background sample for Zone B)	x	x	x				x	

Table 3-1
Summary of Sampling Program
Site 28 RI Work Plan
IHDIV-NSWC
Indian Head, Maryland

			Analyses							
Medium	**Sample ID**	**Sample Depth/Location**	**TCL VOC**	**TCL SVOC**	**TAL Metals**	**pH**	**TOC**	**Grain Size distribution**	**Explosives ***	**Hardness**
Sediment (in Swales)	IS28SD010000	0-6 inches bgs in swale in Zone A	x	x	x	x	x	x	x	
	IS28SD020000	0-6 inches bgs in swale in Zone A	x	x	x	x	x	x	x	
	IS28SD030000	0-6 inches bgs in swale in Zone A	x	x	x	x	x	x	x	
Sediment (in Mattawoman Creek)**	IS28SD040000	0-6 inches bgs in Mattawoman Creek		x	x		x	x	x	
	IS28SD050000	0-6 inches bgs in Mattawoman Creek		x	x		x	x	x	
	IS28SD060000	0-6 inches bgs in Mattawoman Creek		x	x		x	x	x	
	IS28SD070000	0-6 inches bgs in Mattawoman Creek			x			x		
	IS28SD080000	0-6 inches bgs in Mattawoman Creek			x			x		
	IS28SD090000	0-6 inches bgs in Mattawoman Creek			x			x		
	IS28SD100000	0-6 inches bgs in Mattawoman Creek			x			x		
	IS28SD110000	0-6 inches bgs in Mattawoman Creek			x			x		
	IS28SD120000	0-6 inches bgs in Mattawoman Creek			x			x		
	IS28SD130000	0-6 inches bgs in Mattawoman Creek			x			x		
	IS28SD140000	0-6 inches bgs in Mattawoman Creek			x			x		
	IS28SD150000	0-6 inches bgs in Mattawoman Creek			x			x		
	IS28SD160000	0-6 inches bgs in Mattawoman Creek			x			x		
	IS28SD170000	0-6 inches bgs in Mattawoman Creek			x			x		
	IS28SD180000	0-6 inches bgs in Mattawoman Creek			x			x		
	IS28SD040001	6-12 inches bgs in Mattawoman Creek		x	x				x	
	IS28SD050001	6-12 inches bgs in Mattawoman Creek		x	x				x	
	IS28SD060001	6-12 inches bgs in Mattawoman Creek		x	x				x	
	IS28SD070001	6-12 inches bgs in Mattawoman Creek			x					
	IS28SD080001	6-12 inches bgs in Mattawoman Creek			x					
	IS28SD090001	6-12 inches bgs in Mattawoman Creek			x					
	IS28SD100001	6-12 inches bgs in Mattawoman Creek			x					
	IS28SD110001	6-12 inches bgs in Mattawoman Creek			x					
	IS28SD120001	6-12 inches bgs in Mattawoman Creek			x					
	IS28SD130001	6-12 inches bgs in Mattawoman Creek			x					
	IS28SD140001	6-12 inches bgs in Mattawoman Creek			x					
	IS28SD150001	6-12 inches bgs in Mattawoman Creek			x					
	IS28SD160001	6-12 inches bgs in Mattawoman Creek			x					
	IS28SD170001	6-12 inches bgs in Mattawoman Creek			x					
	IS28SD180001	6-12 inches bgs in Mattawoman Creek			x					

Table 3-1
Summary of Sampling Program
Site 28 RI Work Plan
IHDIV-NSWC
Indian Head, Maryland

Medium	Sample ID	Sample Depth/Location	Analyses							
			TCL VOC	TCL SVOC	TAL Metals	pH	TOC	Grain Size distribution	Explosives *	Hardness
In Situ Groundwater	IS28GW01MMYY	Just below water table in Zone A	x	x	x				x	
	IS28GW02MMYY	Just below water table in Zone A	x	x	x				x	
	IS28GW03MMYY	Just below water table in Zone A	x	x	x				x	
	IS28GW04MMYY	Just below water table in Zone A	x	x	x				x	
	IS28GW05MMYY	Just below water table in Zone A	x	x	x				x	
	IS28GW06MMYY	Just below water table in Zone A	x	x	x				x	
	IS28GW07MMYY	Just below water table in Zone A	x	x	x				x	
	IS28GW08MMYY	Just below water table in Zone A	x	x	x				x	
	IS28GW09MMYY	Just below water table in Zone A	x	x	x				x	
	IS28GW10MMYY	Just below water table in Zone A	x	x	x				x	
	IS28GW11MMYY	Just below water table in Zone A	x	x	x				x	
	IS28GW12MMYY	Just below water table in Zone A	x	x	x				x	
	IS28GW13MMYY	Just below water table (background sample for Zone A)	x	x	x				x	
	IS28GW14MMYY	Just below water table (background sample for Zone A)	x	x	x				x	
Groundwater from Monitoring Wells	IS28MW01MMYY	Monitoring Well IS28MW01	x	x	x	x	x	x	x	x
	IS28MW02MMYY	Monitoring Well IS28MW02	x	x	x	x	x	x	x	x
	IS28MW03MMYY	Monitoring Well IS28MW03	x	x	x	x	x	x	x	x
	IS28MW04MMYY	Monitoring Well IS28MW04	x	x	x	x	x	x	x	x
Surface Water	IS28SW01MMYY	Swale in Zone A	x	x	x	x	x	x	x	x
	IS28SW02MMYY	Swale in Zone A	x	x	x	x	x	x	x	x
	IS28SW03MMYY	Swale in Zone A	x	x	x	x	x	x	x	x

Notes
MMYY = Two digit month and two digit year when sampled
Analytical methods for surface soil, subsurface soil, and sediments: TCL VOCs (OLM04), TCL SVOCs (OLM04), TAL Inorganics (ILM04), pH (SW-846 9045C), TOC (SW-846 9060), and Grain
Analytical methods for surface water and groundwater: TCL VOCs (OLM04), TCL SVOCs (OLM04), TAL Total and Dissolved Inorganics (ILM04), Total and Dissolved TOC (SW-846 9060),
Field Parameters for surface water using Horiba U-22 water quality meter: pH, specific conductivity, oxidation/reduction potential, dissolved oxygen, and temperature
* Explosives include PETN, perchlorate, nitroguanidine, and nitroglycerin
** Six of the samples (3 locations, 2 depths) will be analyzed for TAL Metals, TCL SVOCs, Explosives, TOC, and Grain Size. (locations will be determined during sampling based on visual observation of areas of greatest deposition)

Table 3-2
Bottleware, Preservation, and Holding Time Requirements
Site 28 RI Work Plan
IHDIV-NSWC
Indian Head, Maryland

Media	Analysis	Containers Per Sample	Container Type	Preservation	Holding Times
Surface Soil	TCL VOCs	3	Soil: 2x5-gram + 1x25-gram Encore™ Sampling receptacle	4 degrees C	48 hours
	TCL SVOCs	1	8-oz bottle, Teflon cap	4 degrees C	7 days to extraction; 40 days from extraction to analysis
	Grain size	1	16-oz bottle, Teflon cap	4 degrees C	28 days
	Explosives*	2	1-liter amber glass jars, Teflon cap	4 degrees C	7 days
	Perchlorate	1	4-oz glass jar, Teflon cap	4 degrees C	7 days
	TOC	1	8-oz bottle, Teflon cap	4 degrees C	28 days
	TAL Inorganics	1	4-oz bottle, Teflon cap	4 degrees C	6 months
Subsurface Soil	TCL VOCs	1	Soil: 2x5-gram + 1x25-gram Encore™ Sampling receptacle	4 degrees C	48 hours
	TCL SVOCs	1	8-oz bottle, Teflon cap	4 degrees C	7 days to extraction; 40 days from extraction to analysis
	Explosives*	2	1-liter amber glass jars, Teflon cap	4 degrees C	7 days
	Perchlorate	1	4-oz glass jar, Teflon cap	4 degrees C	7 days
	TAL Inorganics	1	4-oz bottle, Teflon cap	4 degrees C	6 months
Sediment	TCL VOCs	1	4-oz bottle, Teflon cap	4 degrees C	48 hours
	Grain size	1	16-oz bottle, Teflon cap	4 degrees C	28 days
	TOC	1	8-oz bottle, Teflon cap	4 degrees C	28 days
	Explosives*	2	1-liter amber glass jars, Teflon cap	4 degrees C	7 days
	Perchlorate	1	4-oz glass jar, Teflon cap	4 degrees C	7 days
	TCL SVOCs	1	8-oz bottle, Teflon cap	4 degrees C	7 days to extraction; 40 days from extraction to analysis
	TAL Inorganics	1	4-oz bottle, Teflon cap	4 degrees C	6 months
Groundwater	TCL VOCs	3	40-ml vial	HCl to pH less than or equal to 2; 4 degrees C	14 days
	TCL SVOCs	2	1-liter amber glass jars, Teflon cap	4 degrees C	7 days to extract; 40 days to analysis
	Explosives*	2	1-liter amber glass jars, Teflon cap	4 degrees C	7 days
	Perchlorate	1	4-oz glass jar, Teflon cap	4 degrees C	7 days
	Dissolved TAL Inorganics	1	1-liter polyethylene bottle	HNO3 to pH less than or equal to 2; 4 degrees C	6 months
Surface Water	TCL VOCs	3	40-ml vial	HCl to pH less than or equal to 2; 4 degrees C	14 days
	TCL SVOCs	2	1-liter amber glass jars, Teflon cap	4 degrees C	7 days to extract; 40 days to analysis
	Total TAL Inorganics	1	1-liter polyethylene bottle	HNO3 to pH less than or equal to 2; 4 degrees C	6 months
	Dissolved TAL Inorganics	1	1-liter polyethylene bottle	HNO3 to pH less than or equal to 2; 4 degrees C	6 months
	Explosives*	2	1-liter amber glass jars, Teflon cap	4 degrees C	7 days
	Perchlorate	1	4-oz glass jar, Teflon cap	4 degrees C	7 days
	Dissolved TOC	1	500-ml polyethylene bottle	HCl to pH less than or equal to 2; 4 degrees C	28 days
	Hardness	1	250-ml HDPE	HNO3 to pH less than or equal to 2; 4 degrees C	6 months

*Explosives include Nitroglycerin, Nitroguanidine, and PETN

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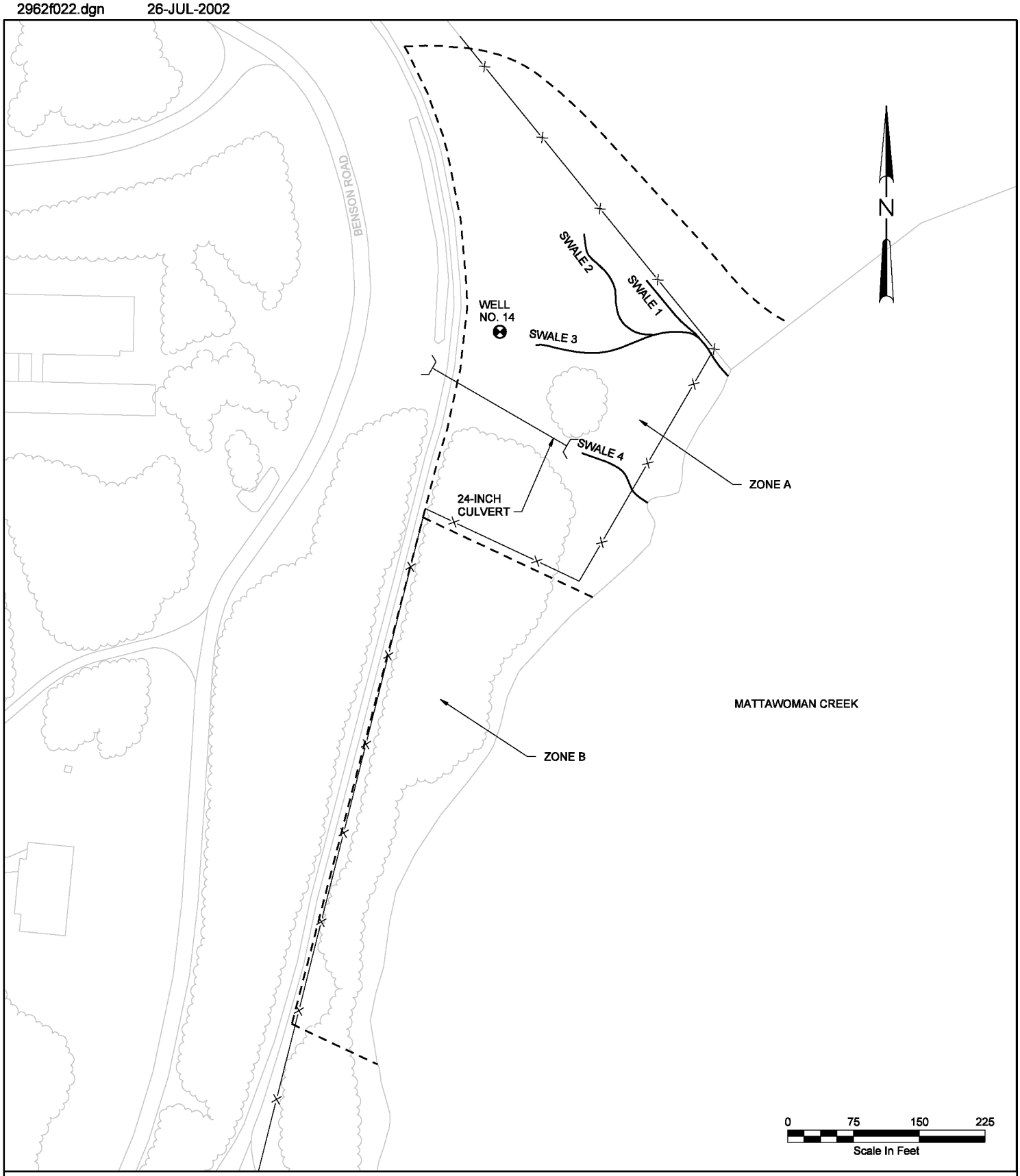

LEGEND

FENCE LINE

ZONE BOUNDARY

FIGURE 3-1
SITE 28 ZONES A AND B
SITE 28 RI WORK PLAN
IHDIV-NSWC
INDIAN HEAD, MARYLAND

NOTE: SWALE LOCATIONS ARE APPROXIMATE.

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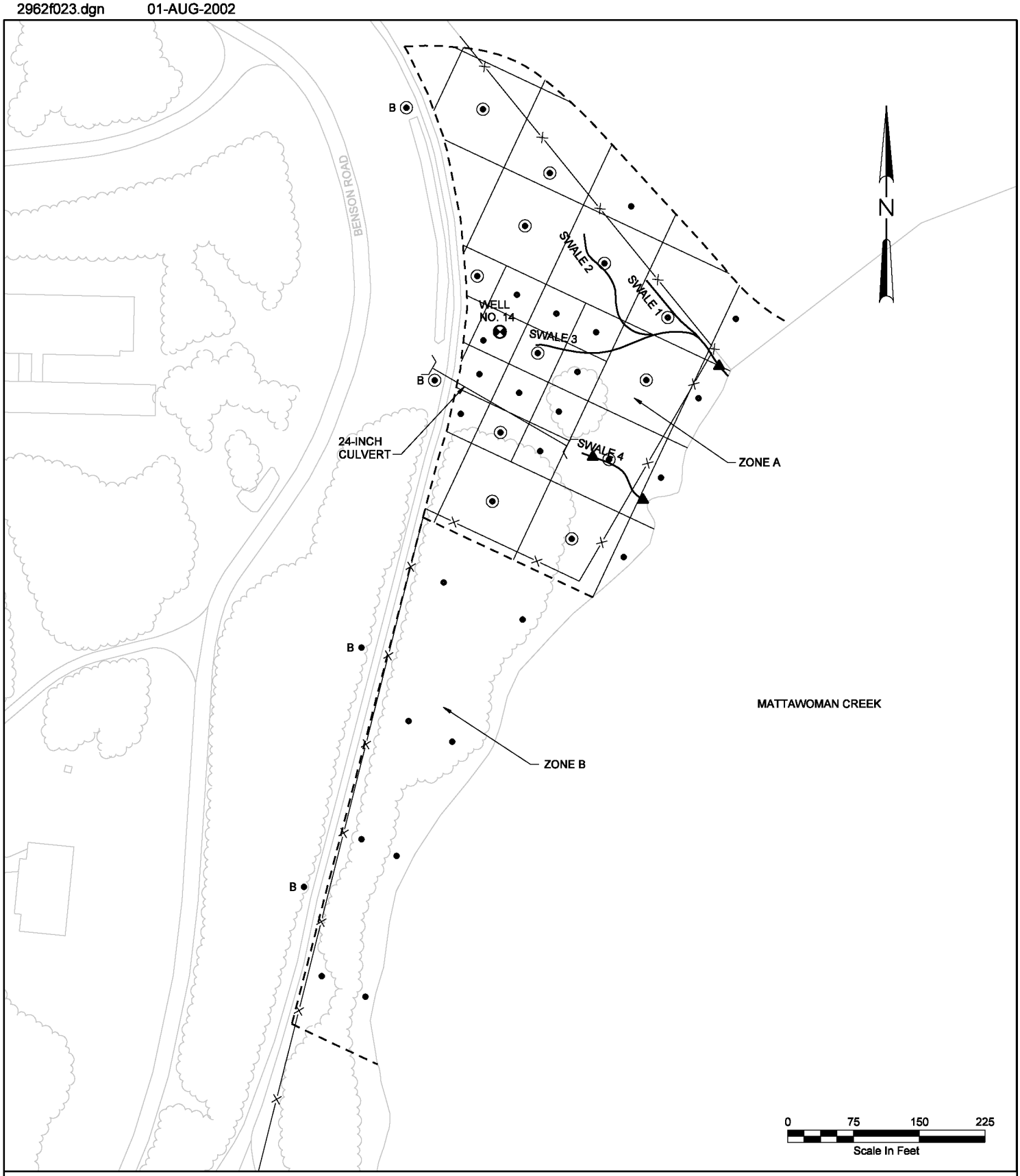

LEGEND

FENCE LINE	SURFACE AND SUBSURFACE SOIL SAMPLE AND DIRECT PUSH GROUNDWATER SAMPLE LOCATION
ZONE BOUNDARY	SURFACE WATER AND SEDIMENT LOCATION
GRID LINE	
SURFACE AND SUBSURFACE SOIL SAMPLE LOCATION	
B BACKGROUND SAMPLE	

NOTE: SWALE LOCATIONS ARE APPROXIMATE.

FIGURE 3-2
SITE 28 SAMPLING LOCATIONS
SITE 28 RI WORK PLAN
IHDIV-NSWC
INDIAN HEAD, MARYLAND

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LEGEND

- Sediment Sample Location
- IR Sites

N

0 250 500 Feet

Figure 3-3
Mattawoman Creek Sediment Sampling Locations
Site 28 RI Work Plan
IHDIV-NSWC
Indian Head, Maryland

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