N00174.AR.000109
NSWC INDIAN HEAD
5090.3a

Biomonitoring Plan

for

Site 8 - Nitroglycerin Plant Office
Indian Head Division
Naval Surface Warfare Center

Indian Head, Maryland

Northern Division
Naval Facilities Engineering Command

Contract Number N62472-90-D-1298

Contract Task Order 0099

October 1992

Rev. 1 (April 1993)

Halliburton NUS
CORPORATION

R-49-4-93-4

BIOMONITORING PLAN
SITE 8 - NITROGLYCERIN PLANT OFFICE
INDIAN HEAD DIVISION, NAVAL SURFACE WARFARE CENTER
INDIAN HEAD, MARYLAND

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) PROGRAM

Submitted to:
Northern Division
Environmental Branch, Code 18
Naval Facilities Engineering Command
10 Industrial Highway, MS #82
Lester, Pennsylvania 19113-2090

Submitted by:
Halliburton NUS Corporation
993 Old Eagle School Road, Suite 415
Wayne, Pennsylvania 19087-1710

Contract Number N62472-90-D-1298
Contract Task Order 0099

OCTOBER 1992
REV. 1 (APRIL 1993)

SUBMITTED BY:

ANTHONY P. KLIMEK, P.E.
PROJECT MANAGER
PITTSBURGH, PENNSYLVANIA

APPROVED FOR SUBMISSION BY:

for JOHN J. TREPANOWSKI, P.E.
PROGRAM MANAGER
WAYNE, PENNSYLVANIA

TABLE OF CONTENTS

SECTION		PAGE
1.0	**INTRODUCTION**	**1-1**
1.1	PROJECT BACKGROUND	1-2
1.2	ECOLOGICAL IMPACT OF MERCURY CONTAMINATION AT SITE 8	1-4
1.3	OBJECTIVE AND SAMPLING STRATEGY	1-6
1.4	PLAN FORMAT	1-7
2.0	**FIELD OPERATIONS**	**2-1**
2.1	MOBILIZATION/DEMOBILIZATION	2-1
2.2	FIELD SAMPLING	2-1
2.3	DECONTAMINATION	2-2
2.4	FIELD MEASUREMENTS	2-2
2.4.1	Equipment Calibration	2-2
2.4.2	Equipment Maintenance	2-3
2.5	RECORDKEEPING	2-3
2.6	HEALTH AND SAFETY	2-3
3.0	**SITE CHARACTERIZATION AND SAMPLING PROTOCOLS**	**3-1**
3.1	SITE 8 CHARACTERIZATION AND SITE-SPECIFIC CONCERNS	3-1
3.2	CONTROL SITES	3-2
3.3	SAMPLING PROTOCOLS	3-3
3.3.1	Water Quality Sampling	3-3
3.3.2	Periphyton Sampling	3-4
3.3.2	Macroinvertebrate Sampling	3-4
3.3.4	Fish Sampling	3-5
3.3.5	Amphibian Sampling	3-6
4.0	**SITE-SPECIFIC SAMPLING AND ANALYSIS PLAN**	**4-1**
4.1	SAMPLING SCHEDULE	4-1
4.2	WATER QUALITY SAMPLING	4-1
4.3	PERIPHYTON SAMPLING	4-1
4.4	MACROINVERTEBRATE SAMPLING	4-3
4.5	FISH FOR TISSUE RESIDUE ANALYSIS	4-3
4.6	AMPHIBIANS FOR TISSUE RESIDUE ANALYSIS	4-5
4.7	REPORTING	4-6
5.0	**PROJECT MANAGEMENT PLAN**	**5-1**
5.1	PROJECT ORGANIZATION	5-1
5.2	NAVY SUPPORT	5-1
5.3	CONTINGENCY PLAN	5-4
REFERENCES		**R-1**

APPENDICES

A	**PRELIMINARY BIOSURVEY**

TABLES

NUMBER		PAGE
4-1	Sampling Schedule for Biomonitoring Plan	4-2

FIGURES

NUMBER		PAGE
1-1	Site Location Map, Site 8- Nitroglycerin Plant Office	1-3
4-1	Site Plan of Pond/Marsh Area	4-4
5-1	Project Organization Chart	5-2

1.0 INTRODUCTION

The Northern Division of the Naval Facilities Engineering Command has issued Contract Task Order Number 0064 (CTO 64) to Halliburton NUS Corporation under the Comprehensive Long-Term Environmental Action Navy (CLEAN) Contract No. N62472-90-D-1298. CTO 64 is for environmental investigative work at the Navy Installation Restoration Program Site 8 - Nitroglycerin Plant Office (Installation Restoration Site 8), at the Indian Head Division, Naval Surface Warfare Center (NSWC) at Indian Head, Maryland. NSWC is a part of the Chesapeake Division (CHESDIV) of the Naval Facilities Engineering Command. The environmental work under CTO 64 consists of tasks to (1) investigate mercury contamination in the sediment/soils and surface water in and around Installation Restoration Site 8 to define the extent of contamination and support interim removal action if necessary, and (2) develop a Biomonitoring Plan to assess the extent of mercury contamination in the biota of the Installation Restoration Site 8 marsh and pond as well as evaluate the potential ecological impacts of any interim removal action. Halliburton NUS began field work to investigate the extent of contamination in the sediments/soils and surface water in August 1992 in accordance with an approved Abbreviated Field Sampling Plan (AFSP) (Halliburton NUS, 1992).

Halliburton NUS has developed this Biomonitoring Plan to complement the sediment/soil and surface water sampling, assess the biological consequences of the current contamination, and to document potential ecological effects and long-term recovery resulting from any future remedial actions at Installation Restoration Site 8. During development of this Biomonitoring Plan, Halliburton NUS relied heavily on guidance provided in three U.S. Environmental Protection Agency (USEPA) documents: Ecological Assessment of Hazardous Waste Sites: A Field and Laboratory Reference (USEPA, 1989), Protocol for Bioassessment of Hazardous Waste Sites (USEPA, 1983), and Assessment and Control of Bioconcentratable Contaminants in Surface Waters (USEPA, 1991). The Environmental Atlas of the Potomac Estuary (Maryland Department of Natural Resources, 1981) provided information on the biotic resources of the Potomac River estuary. Halliburton NUS also examined the scientific literature on mercury toxicity and mercury dynamics in nature, incorporating pertinent references as appropriate. In addition, Halliburton NUS consulted regional experts in estuarine ecology and the ecology of the Chesapeake Bay, as well as scientists studying a number of the species under consideration as "indicator" organisms, and incorporated many of their suggestions.

1.1 PROJECT BACKGROUND

The Indian Head NSWC consists of the main area and the Stump Neck Annex. The main area of Indian Head NSWC contains approximately 2,500 acres. Slightly less than 1,000 additional acres are located across Mattawoman Creek at the Stump Neck Annex. The Indian Head NSWC is located approximately 25 miles southwest of Washington, D.C., in Charles County, Maryland. The main area of Indian Head NSWC is located on a peninsula bounded by the Potomac River to the north and Mattawoman Creek to the south. As shown on Figure 1-1, Installation Restoration Site 8 (Site 8) is located in the approximate center of the main area of Indian Head NSWC; surface water from Site 8 discharges into Mattawoman Creek.

The Site 8 - Nitroglycerin Plant Office area consists of the following manmade structures and natural features: Building 766, a 3-inch drainpipe from Building 766 to a manhole, Manhole A, a concrete pipe that conveys water from the manhole under railroad tracks to an unnamed stream, approximately 1,300 feet of stream, and a pond/marsh area. The pond/marsh area is approximately 700 feet long and 200 feet wide; it includes both a marsh and open water. The pond discharges through a culvert (approximately 6-foot diameter) under Noble Road and into Mattawoman Creek.

For approximately 20 years, mercury was released in small amounts from sink and floor drains in Building 766, generally as a result of laboratory accidents (ABB-ES, 1992b). These internal sink and floor drains flow into the 3-inch drainpipe and into Manhole A of the storm drain system. The storm drain system discharges into a small stream that flows south and east approximately 1,300 feet, enters a cattail marsh and pond area, then empties into Mattawoman Creek. Previous investigations have determined that sediment and surface water of the stream, marsh, and pond contain elevated concentrations of mercury (ABB-ES, 1992a; ABB-ES, 1992b). It has been estimated that between 200 and 500 pounds of mercury were released to the environment at Site 8 (ABB-ES, 1992a).

ABB Environmental Services, Inc. (ABB-ES), formerly E. C. Jordan Company (Jordan), has conducted a number of investigations dealing with the mercury contamination at Site 8. This work included sediment, soil and surface water sampling. Halliburton NUS recently prepared and implemented an extensive field sampling program to define the extent of contamination. However, no biomonitoring program has been implemented at Site 8. A Biomonitoring Work Plan prepared (but never implemented) by ABB-ES (ABB Environmental Services, 1992a) served as the basis for this Halliburton NUS Biomonitoring Plan. This Biomonitoring Plan contains elements of the ABB-ES Biomonitoring Work Plan, in particular the site history and literature review of mercury toxicity, but the scope and focus of the sampling and analysis portions of the ABB-ES Plan have been completely revised. This Halliburton NUS Biomonitoring Plan is intended to be more practical in its approach, contains a

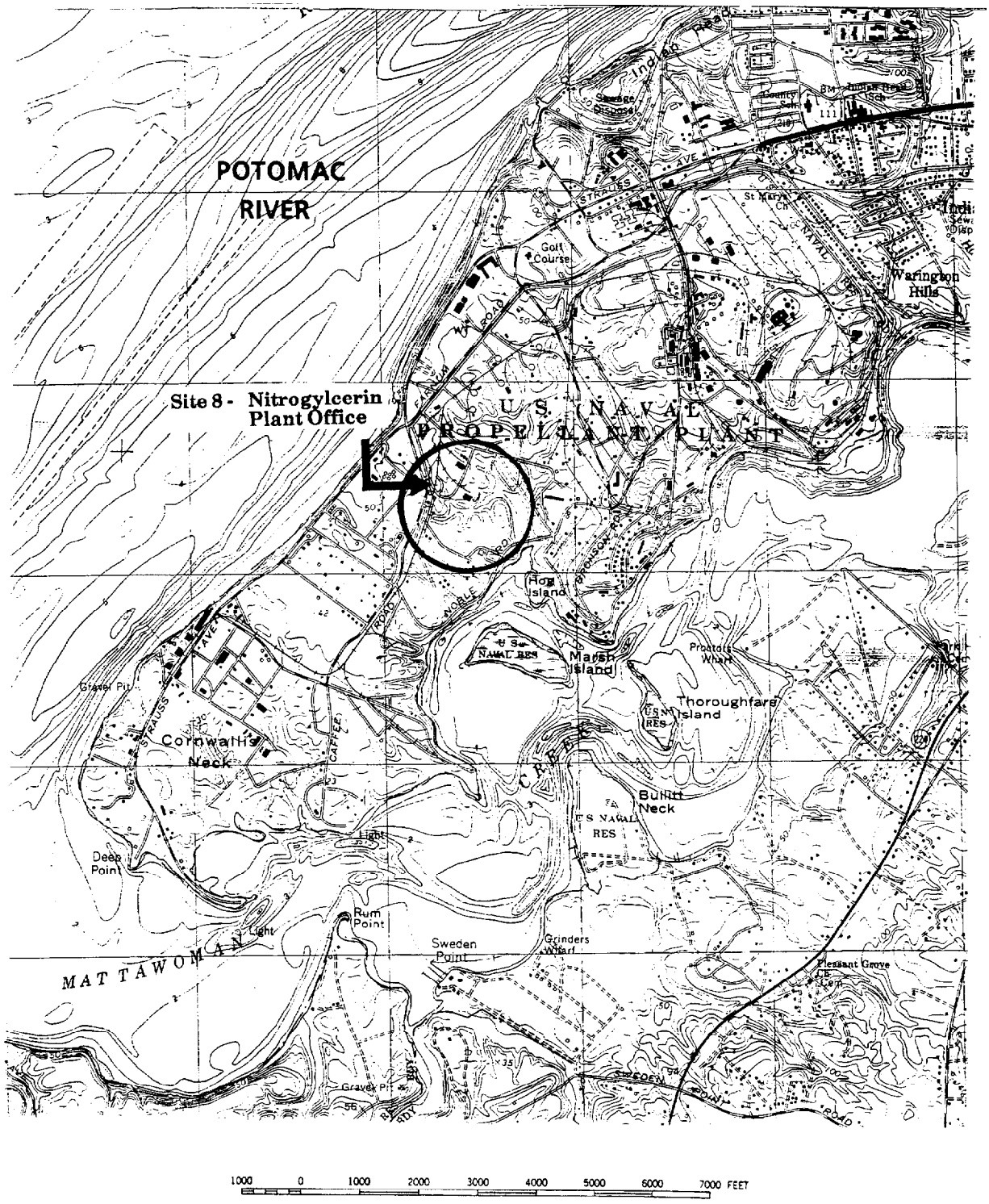

FIGURE 1-1
SITE LOCATION MAP
INSTALLATION RESTORATION PROGRAM
SITE 8 - NITROGLYCERIN PLANT OFFICE

HALLIBURTON NUS
Environmental Corporation

Source: 7.5 Minute USGS Quad Indian Head, MD-VA 1966 Photo Revised 1978

site-specific Sampling and Analysis Plan, and focuses on readily measureable attributes of the ecosystem. This Biomonitoring Plan concentrates on ecologically significant components of the ecosystem and de-emphasizes plant and animal communities that appear to be of minor significance.

1.2 ECOLOGICAL IMPACT OF MERCURY CONTAMINATION AT SITE 8

The ultimate fate and form of mercury in the environment has been the subject of numerous scientific investigations. Elemental mercury may become methylated under certain environmental conditions, and inorganic mercury can be methylated both by sediment-dwelling microorganisms and abiotic processes (Nriagu, 1979; USEPA, 1985; Phillips, et al., 1987). There is also evidence that the methylation process can occur in fish tissue as well (USEPA, 1985; Sorensen, 1991). Organic forms of mercury, including monomethylmercury and dimethylmercury, are more toxic than inorganic forms primarily because of their enhanced bioavailability and capacity to move into the biological food chain and affect biological tissue toxicologically (Eisler, 1987).

Studies indicate that absorption of methylmercury by aquatic organisms is enhanced by increased salinity and low pH (USEPA, 1985; Phillips, et al., 1987). Based on preliminary water quality measurements, rates of conversion to methylmercury are expected to be greatest in the pond habitat at the site. However, concentrations of total mercury are generally lower in the pond than in the stream and marsh areas (ABB-ES, 1992b).

Because the toxicological effects of mercury exposure are highly dependent upon the particular form of mercury present in the environment (USEPA, 1985), a speciation study was conducted in 1989-1990 by ABB Environmental Services (for a discussion of this study and results see ABB-ES, 1992b). This study provided additional data on the extent and magnitude of mercury contamination in soil and sediment. In addition, methylmercury, as well as other forms of mercury which can be readily methylated (e.g., elemental, bound), was detected in sediment throughout Site 8. As a result of this study, it was recommended that a biological assessment and monitoring program be designed and implemented to evaluate the effects of mercury on the environment at Site 8.

The U.S. Fish and Wildlife Service (USFWS) has conducted a biomonitoring program in Mattawoman Creek downstream of Site 8 since 1987 (USFWS, 1991). This program was designed to evaluate the uptake of mercury by recreationally and commercially important aquatic species that may have been exposed to mercury emanating from NSWC. During the most recent round of sampling, tissues of channel catfish (*ictalurus punctatus*) collected in the vicinity of Marsh Island (near the Site 8 outlet) had significantly higher mercury concentrations than samples collected from a control site located 4.5 miles above the Site 8 outlet on Mattawoman Creek. However, this phenomenon was observed only in

channel catfish during the most recent sampling; previous USFW reports did not report a similar observation. Also, tissue concentrations of mercury from large-mouth bass (*Micropterus salmoides*) and bluegill (*Lepomis macrochirus*) did not appear to be significantly different between sampling locations (USFWS, 1991). The USFWS recently questioned the placement of its original control site due to concerns about possible widespread mercury contamination in Mattawoman Creek and recommended that another control site be placed further away from Site 8 (USFWS, 1991). Consequently, the results of the USFWS studies must be considered preliminary, and may not adequately address the movement of mercury into Mattawoman Creek from Site 8.

Ecological impacts associated with mercury contamination of aquatic habitats have been studied in considerable detail (reviews in Eisler, 1987; Sorensen, 1991). Mercury is one of the most toxic inorganic compounds in nature, with many aquatic organisms deleteriously affected at exposure concentrations in the parts per billion range. In aquatic organisms, comparatively low concentrations of mercury can adversely affect reproduction, growth, behavior, metabolism, blood chemistry, osmoregulation, and oxygen exchange (Nriagu, 1979; Eisler, 1987). Mercury, which is a mutagen, teratogen, and carcinogen, also causes embryocidal, cytochemical, and histopathological effects (Eisler, 1987; Sorensen, 1991).

Exposure pathways by which aquatic and terrestrial organisms may be exposed to mercury at Site 8 were discussed briefly in the Engineering Evaluation and Cost Analysis Report prepared by ABB Environmental Services (ABB-ES, 1992b). Aquatic organisms may be exposed to contaminants in surface water and sediment through direct contact and incidental sediment ingestion. In addition, the consumption of contaminated prey items may represent a significant exposure route to higher trophic organisms such as fish. Dietary exposure may similarly be important for wading birds such as the great blue heron (*Ardea herodias*), whose diet is comprised largely of aquatic organisms (Scott, 1987), and semi-aquatic mammals such as the raccoon (*Procyon lotor*), mink (*Mustela vison*), and river otter (*Lutra canadensis*) all of which feed heavily on crustaceans, molluscs, and, in the case of mink and otter, fish (Webster et al., 1985).

In the forested areas surrounding the stream and pond, terrestrial animals such as white-tailed deer (*Odocoileus virginianus*) and a number of birds of prey [e.g., osprey (*Pandion haliaetus*) and northern harrier (*Circus cyaneus*)] may be exposed to mercury by feeding on contaminated biota or through the incidental ingestion of soil or sediment. This is not expected to be a significant route of exposure, however, because these species are wide ranging and spend only a small portion of their lives feeding in this relatively small area.

In an assessment of the potential impacts to ecological receptors at Site 8, it was concluded that little or no risk is expected at NSWC due to direct contact with surface water (Jordan, 1987). Exposure to contaminants in soils through direct contact is also limited because animal fur will impede absorption of mercury across the skin. In addition, the limited areal extent of mercury contamination in soil, as well as the relatively low concentrations detected, would suggest that potential risk to terrestrial wildlife is low (Jordan, 1987). However, direct contact with sediment may pose a hazard to aquatic organisms. In addition, risks to organisms that feed on aquatic organisms (e.g., fish, and some birds and mammals) are potentially high because of the tendency of mercury to accumulate in biological tissue.

1.3 OBJECTIVE AND SAMPLING STRATEGY

The objective of the Halliburton NUS Biomonitoring Plan is to obtain data of sufficient detail and quality to characterize the extent of mercury contamination in the biota of the Site 8 marsh pond. Two control sites were selected to provide information relative to Site 8, one located at the Beaver Dam in Stump Neck Annex on a tributary to Chicamuxen Creek and one in Mattawoman Creek where it is crossed by Route 225. These data will be used to determine whether further action is necessary or, in the event that an interim Removal Action is warranted, to characterize changes in the ecological community that may result from such an action.

This Biomonitoring Plan is part of an overall phased sampling strategy to achieve the project objective. The major phases of the strategy include the following:

- Preliminary Biosurvey (completed)
- Phase 1 (completed)
- Phase 2

On July 27 and 28, 1992 the United States Fish and Wildlife Service (USFWS) conducted a preliminary biosurvey of the Site 8 marsh and tidal pond. The goal of this preliminary survey was to determine, at a very gross level, what organisms were present and in what proportion. This information was intended to aid in the development of a more effective Phase 1 Biomonitoring Plan. The results of the preliminary biosurvey of Site 8 are presented in Appendix A. In summary, the preliminary survey determined that the marsh pond system supports a relatively low diversity and abundance of benthic organisms and fish. The macroinvertebrate community of the tidal pond was sparse, patchily distributed, and dominated by pollution-tolerant groups (chironomids and ologochaetes). Freshwater areas of the east coast typically have fewer bivalves, crustaceans, or polychaetes than the higher salinity areas of the lower estuary (Odum et al., 1984). Only five fish species were collected during the July 1992 biosurvey. The depauperate benthic and fish communities apparently are the result of a

number of interrelated factors, among them: (1) generally shallow water that is subject to frequent fluctuations in depth, temperature, and turbidity; (2) a lack of cover in the form of stumps, snags, or significant growth of submergent or emergent vegetation; (3) a poorly developed, unconsolidated substrate; and (4) potentially, mercury contamination upstream. This preliminary biosurvey was used to design Phase 1 of this Biomonitoring Plan.

Based on the results of the preliminary biosurvey, Phase 1 of the Biomonitoring resulted in samples being collected from: (1) the downstream portion of the unnamed stream, (2) the marsh through which this stream flows, and (3) the pond into which this stream drains. These samples were analyzed to identify the extent of contamination and baseline ecological conditions in the stream, marsh, and pond. During Phase 1 (which included two major sampling events), the sampling efforts were refined and will be incorporated into Phase 2. The Phase 1 effort indicated which organisms are most abundant, suggest species associations, identify predator-prey and food chain relationships, and suggest the direction of long-term monitoring.

Data obtained in the sampling and analysis work performed by Halliburton NUS in August and September 1992 (Phase 1) was used to determine the extent of contamination and was considered during preparation of this Biomonitoring Plan.

1.4 PLAN FORMAT

Section 1.0 of this Biomonitoring Plan contains relevant background information, information on the fate and transport of mercury at Site 8, potential ecological effects of mercury exposure at the site and the overall sampling strategy. Halliburton NUS used this background information to design the subject biomonitoring program. Section 2.0 is largely concerned with administrative and logistical matters, such as deployment of personnel and recordkeeping. Section 3.0 contains a biological site characterization summary, a rationale for choosing particular sampling methods and sampling protocols. Section 4.0 discusses the site-specific sampling procedures and production of deliverables. Section 5.0 is the Project Management Plan. The results of the preliminary biosurvey are presented in Appendix A.

2.0 FIELD OPERATIONS

Fieldwork will consist of collections of periphyton, benthic organisms, amphibians and fish (at a minimum), as well as measurements of water quality. Field surveys of selected semi-aquatic and wetlands-dwelling animals (e.g., turtles or waterfowl) may also be conducted.

The sampling effort will be conducted in two phases. During Phase 1, samples were collected to determine the overall nature and extent of mercury contamination in the biota of Site 8 and establish baseline ecological community characteristics. Also, during Phase 1 sampling protocols were refined, and areas of inquiry that appear to be unworkable or unproductive have been abandoned. Phase 2 sampling will build on the Phase 1 results and address any obvious data gaps that have been identified in Phase 1. Phases 1 and 2 will include both biological and water samples. This section describes general field operation procedures that will be used to implement the sampling program.

2.1 MOBILIZATION/DEMOBILIZATION

Following Navy approval of this Biomonitoring Plan, Halliburton NUS will begin mobilization activities. The field team will consist of a Halliburton NUS Field Operations Leader (FOL) and approximately two field samplers (as described in Section 5.0, it is envisioned that a subcontractor will provide field samplers and will be used to implement the sampling in April 1993. However, the USFW may be utilized in subsequent sampling. All field team members will review this Biomonitoring Plan and the site-specific Halliburton NUS Health and Safety Plan (HASP). In addition, a field team orientation meeting will be held to familiarize personnel with the scope of the field activities.

The Field Operations Leader (FOL) will coordinate mobilization activities with the subcontractor or the United States Fish and Wildlife Service (USFWS), as appropriate, and oversee all sampling activities during field operations.

2.2 FIELD SAMPLING

During field sampling, a complete sample log of each location will be maintained by the FOL. At a minimum, the Halliburton NUS field sample log will contain the following information:

- Date and time of sampling
- Stations/transects sampled

- Sample type (e.g., benthos)
- Sampling apparatus (e.g., Ekman dredge)
- Weather conditions (e.g., overcast or rainy)
- Name of field team members

2.3 DECONTAMINATION

The equipment involved in field sampling activities will be decontaminated prior to, during, and at completion of the sampling activities. Field analytical equipment such as pH, conductivity, and temperature instrument probes will be rinsed first with analyte-free water, then with the sample liquid. The decontamination fluids (such as analyte-free water) are not hazardous or toxic to aquatic life. Therefore, the decon water will be discharged onto the ground at the site.

2.4 FIELD MEASUREMENTS

Certain field measurements will be recorded during sampling activities, including temperature, dissolved oxygen, pH, conductivity, and salinity. Salinity will be measured once daily at each site (Site 8 and two Control Sites). Conductivity will be measured at each sampling location (or transect). All instruments used in the field will be calibrated according to the procedures described below.

2.4.1 Equipment Calibration

The following monitoring instruments may be used during field activities:

- Temperature probe
- Dissolved oxygen meter
- pH meter
- Salinity/conductivity meter

All instruments will be calibrated daily or according to the manufacturer's operating manual. Calibration will be documented on an equipment calibration log. During calibration, an appropriate maintenance check will be performed on each piece of equipment. If damaged or defective parts are identified during the maintenance check and it is determined that the damage could have an impact on the instrument's performance, the instrument will be removed from service until the defective parts are repaired or replaced.

2.4.2 Equipment Maintenance

Measuring equipment used in environmental monitoring or analysis and test equipment used for calibration and maintenance shall be controlled by established procedures. Measuring equipment shall have an initial calibration and shall be recalibrated at scheduled intervals against certified standards. Halliburton NUS maintains a large inventory of sampling and measurement equipment. In the event that failed equipment cannot be repaired, replacement equipment will be shipped to the site by overnight express to minimize downtime.

2.5 RECORDKEEPING

In addition to chain-of-custody records, standard forms will be completed for sample description and documentation. These shall include both sample log sheets (for biota) and a field notebook.

A bound/weatherproof field notebook shall be maintained by the Field Operations Leader (FOL). All information related to sampling or field activities will be recorded in the field notebook. This information will include, but is not limited to, sampling time, weather conditions, unusual events, field measurements, descriptions of photographs, etc. This book will also contain a summary of the day's activities.

At the completion of field activities, the FOL shall submit all field records, data sheets, field notebooks, chain-of-custody receipts, daily logs, etc. to the Project Manager.

2.6 HEALTH AND SAFETY

All field activities will be performed in accordance with the Site-Specific Health and Safety Plan for this project (as contained in Appendix C of the Final Abbreviated Field Sampling Plan, AFSP; Site 8 - Nitroglycerin Plant Office, Indian Head, Maryland, August 1992 Contract No. N62472-90-D-1298 Contrast Task Order Number 0064).

3.0 SITE CHARACTERIZATION AND SAMPLING PROTOCOLS

As previously described, the USFWS performed a preliminary biosurvey of the Site 8 Marsh/Pond in July 1992. The results of that survey are contained in Appendix A. The results of that survey were used to characterize the Marsh/Pond and to provide a basis to develop this Biomonitoring Plan. This section of the plan includes a characterization of the site, a discussion of control sites, and sampling protocols to implement this Biomonitoring Plan.

3.1 SITE 8 CHARACTERIZATION AND SITE-SPECIFIC CONCERNS

The Site 8 marsh/pond appears to be a simple, detritus-based system with a short food chain. Energy (in the form of food) is transferred from non-living organic matter to deritus-feeding organisms (e.g., benthic macroinvertebrates) and their predators (e.g., fish). This contrasts with plankton-based systems, where energy flows via photosynthetic activity from phytoplankton to zooplankton to planktivorous fishes to carnivorous fishes. This trophic structure is suggested by a number of physical and biological characteristics of the system. The pond, which is shallow, creek-fed, and less than 3 acres in surface area, must have a relatively short turnover time. Periodic flushing of the system from the two tributary streams is expected during periods of high rainfall and stream discharge. In general, phytoplankton and zooplankton are of marginal importance in ponds or small lakes with significant rates of flushing and short retention times (Hynes, 1970).

The dominant benthic invertebrates (chironomids and ollgochaetes) in the pond are both sediment dwellers that depend on organic material in the bottom muds rather than plankton for their nutritional needs. Chironomids, depending on which group they belong to, are herbivores or detritivores, feeding on attached algae, higher aquatic plants, and organic detritus (Pennak, 1978). Ollgochaetes feed on bottom mud, retaining the organic component of mud passing through the digestive canal (Pennak, 1978). Both groups are known to tolerate low concentrations of dissolved oxygen, and certain genera within each group are regarded as indicators of water quality degradation.

The two most abundant fish species (*Fundulus heterodotus* and *Gambusia affinis*) in the Site 8 pond are omnivores that eat plant matter, insects (larvae and adults), and small fish (Carlander, 1969; Lee, 1980). None of the five fish species collected in preliminary sampling is planktivorous. All these physical and biological factors suggest that phytoplankton and zooplankton, although certainly present and "important" in the abstract, should not be the focus of the biomonitoring.

The periphyton are useful in biomonitoring because their abundance and composition are directly governed by water quality. As noted in Standard Methods for the Examination of Water and Wastewater (APHA, 1985), periphyton, unlike plankton, often show "dramatic" responses immediately below pollution sources. Schindler (1987) suggests that monitoring periphyton with periphytometers is useful to detect ecosystem stress because algae and other microorganisms that colonize artificial substrates are small and rapidly reproducing; thus, they are early indicators of disturbances (e.g., pollution) in aquatic ecosystems. Schindler (1987) argues that benthic communities are also excellent subjects for biomonitoring, because pollutants tend to be concentrated in sediments (rather than in the water column) and benthic organisms may be exposed to higher concentrations of pollutants than pelagic or planktonic forms.

Odum (1984) provides a hypothetical model of energy flow in a freshwater marsh, theorizing that freshwater wetlands are detritus-based systems, "with a variety of omnivorous benthic fauna serving as the intermediary link to fishes." Odum goes on to review a number of studies that highlight the importance of aquatic insect larvae and benthic fauna (ollgochaetes, chironomid larvae, *Corbicula*) as food sources for the omnivorous fishes of freshwater marshes and creeks. In Odum's theoretical scheme, zooplankton are important only to the extent that they provide food for larval fish, while phytoplankton provide food for zooplankton.

Aside from the fact that the plankton community appears to be less important trophically than the benthic community, the plankton community--whether phytoplankton or zooplankton--is problematic in terms of sampling and statistical analysis. Both groups show large annual, seasonal, and diel variations in spatial and temporal abundance (Wetzel, 1975). Sampling programs that are sufficiently robust from a statistical perspective to show differences in community structure between regions and times are very expensive and time consuming. Even intensive and elegantly designed sampling programs may not identify real differences because these apparent differences are confounded by normal population cycles, increased/decreased predation, intra- and interspecific competitive interaction, micro- and macroclimatological factors (e.g., regional and local rainfall patterns affecting runoff and nutrient inflows), and calamities such as floods and droughts. Plankton populations, and in particular, plankton populations in small bodies of water, are far more subject to the vagaries of weather than are benthic macroinvertebrates or fish.

3.2 CONTROL SITES

Control sites are critical in long-term biomonitoring because they help identify "natural" changes in biological communities, i.e., those caused by local or regional change in variables like rainfall/nutrient loading or cataclysmic events like hurricanes. Control sites for this Biomonitoring Plan were selected

with input from local authorities and experts (e.g., Indian Head NSWC, USGS, USFWS and Maryland Department of the Environment) on the water quality and biota of the Indian Head-Mattawoman Creek drainage area. The two control sites that will be used for this project are: one at a large beaver dam in Stump Neck Annex on a tributary to Chicamuxen Creek and one in Mattawoman Creek where it is crossed by Route 225.

3.3 SAMPLING PROTOCOLS

The Biomonitoring Plan will consist of the following types of sampling:

- Water quality
- Periphyton
- Macroinvertebrate
- Fish
- Amphibians

Specific protocols that will be used to implement each of the above sampling types, the objectives of the sampling, and the data to be obtained are described in the following sections.

3.3.1 Water Quality Sampling

Temperature, dissolved oxygen (DO), conductivity, and pH measurements will be taken at surface (1-foot depth), a mid-depth, and near-bottom. Grab samples of water for hardness, and total organic carbon (TOC) will be taken at the surface. Field personnel will follow Halliburton NUS Standard Operating Procedures for measurement of water temperature, DO, conductivity, and pH. Standard methods for the measurement of hardness and TOC will be followed (APHA, 1985). The depth of the pond, less than 1 meter in most areas, may preclude sampling at depth in some instances.

Water quality measurements associated with the biological monitoring program have been chosen to satisfy two objectives:

- Collection of basic water quality data (i.e., water temperature, dissolved oxygen, conductivity) needed to support the interpretation of biological data.

- Collection of water quality data (i.e., hardness, pH, and TOC) required to interpret toxicity information and assess bioavailability of contaminants.

Data to be obtained: Water temperature, DO, conductivity, hardness, pH, and TOC at each sampling station

3.3.2 Periphyton Sampling

Periphyton will be sampled with floating artificial substrate samplers or periphytometers (APHA, 1985). Each floating periphytometer will contain at least 10 glass slides. Three slides will be analyzed for ash-free dry weight; three will be analyzed for chlorophyll-a; three will be examined for species composition and abundance. One slide from each round of sampling will be placed in a suitable preservative and retained for verification of information (e.g., identification of species). Identification of periphyton will be to the species level if possible, otherwise to lowest practicable taxon.

Data to be obtained:
- Mean (± SE) ash-free dry wt/cm^2
- Mean (± SE) chlorophyll-a concentration/cm^2
- Number of cells and relative abundance of taxa on each slide
- Diversity Indices

Periphyton cell counts per unit area of substrate will be calculated. This will permit calculations of periphyton densities in the various regions of the tidal pond as well as standard numerical indices of species heterogeneity or "species diversity," e.g., Simpson's Index (D_S) and Shannon's Index (H') (Brower et al., 1977). Ludwig and Reynolds (1988) review the standard methods of quantifying species diversity and suggest circumstances that favor the various approaches.

3.3.3 Macroinvertebrate Sampling

Macroinvertebrates will be sampled quantitatively with either an Ekman dredge or a petite-Ponar dredge (whichever is most appropriate to the range of substrate types encountered). .

These samples will be transported to a cooperating laboratory (USFWS Ecological Services Office in Annapolis or a qualified subcontractor) and processed by an experienced macroinvertebrate taxonomist. Organisms will be identified to the lowest practicable taxon (to the subfamily or tribe level for chironomide, to the species level for ephemeroptera, trichoptera, plecoptera, megaloptera, odonata, and other larval aquatic insects) and counted. Measures of density, species richness, and species diversity (Brower et al., 1977; Ludwig and Reynolds, 1988) will be calculated. Differences between areas and years will be examined graphically and with descriptive statistics (i.e., mean, standard error) and using appropriate standard measures of species richness, evenness and diversity.

If the data lends itself to statistical analysis, statistical methods will be used to evaluate the macroinvertebrate data. Should preliminary data indicate that parametric methods are appropriate, standard statistical tests (e.g., Student's T-tests) will be used to compare differences in abundance between habitats. Given the patchy distribution observed in the July biosurvey, it may be necessary to employ a non-parametric approach, e.g., Kruskall-Wallis. Use of classical parametric methods, such as T-tests, loses information by pooling regions, ignores the multivariate nature of the data, and may well be invalid if the assumptions of the parametric test (e.g., normality) are not met. Also, the use of T-Tests and similar tests will by chance alone produce a number of seemingly significant results.

Data to be Obtained:

- Taxa lists for each habitat/stratum (i.e., cattail marsh and two control sites)
- Mean densities (+ SE) from each habitat
- Relative abundance (percent) of each taxa
- Relative abundance (percent) of functional feeding groups
- Measures of evenness
- Measures of diversity

3.3.4 Fish Sampling

Fish will be collected semiannually, in April and October, for mercury tissue analysis from the Site 8 pond and two Control Sites. Hoopnets/Traps nets, gill nets, or fish traps, gill nets, baited minnow traps, and electrofishing may be used to collect fish. Methods that appear to be most effective (and least damaging to fish that are captured) should be employed. No quantitative abundance measures will be performed. Electrofishing will be conducted only to the extent necessary to capture sifficient fish for mercury analysis.

All fish collected will be identified to species, measured (total length in millimeters), weighed (to nearest 1.0 gram), and examined cursorily for gross pathology (e.g., lesions, ectoparasites, fungal/bacterial infections). The preceding data along with sample transect/station, date, time of day, and weather conditions will be recorded on field data sheets.

Fish with conspicuous lesions or bacterial/fungal infections will not be used. Should the Navy feel it is necessary, post-mortem examination of diseased fish will be conducted by a qualified fish disease specialist. Specimens of each species will be retained in a reference collection.
Measurements of fish length will permit a limited evaluation of population size structure, and by inference, age structure. Length-weight relationships will also permit calculation of condition factors,

should this information be required by regulatory agencies to quantify changes in average condition of fish over time.

Data to be Obtained: Species list for each habitat type/stratum
Species Length-weight relationships

3.3.5 Amphibian Sampling

Amphibians (frogs) will be collected in the spring of 1993 and 1994 for mercury analysis.

4.0 SITE-SPECIFIC SAMPLING AND ANALYSIS PLAN

4.1 SAMPLING SCHEDULE

This Biomonitoring Plan will be implemented in two phases Phase 1 and Phase 2. The overall schedule for implementation of the Biomonitoring Plan is shown in Table 4-1. Phase 1 sampling, which took place in Fall (October 1992) and Winter (January 1993) was intended to identify the extent of mercury contamination in biota, as well as baseline ecological conditions of the stream, marsh, and pond at Site 8. As shown in Table 4-1, Phase 2 sampling is scheduled to begin April 1993. Phase 2 sampling is based on the results of the Phase 1.

4.2 WATER QUALITY SAMPLING

Water temperature, dissolved oxygen (D.O.), pH, conductivity, hardness, and Total Organic Carbon (TOC) will be measured quarterly at six stations. At Site 8, the four stations to be sampled quarterly are T1C, T4C, T8 (conditions permitting), and T10 (conditions permitting). If conditions do not permit sampling at these locations, alternative locations may selected. Water temperature, DO, pH, and conductivity will also be measured in conjunction with periphyton, macrobenthos, and fish sampling. Grab samples will be taken for shipment to the approved laboratory for TOC and Hardness analysis. Halliburton NUS Standard Operating Procedures for measurement of water temperature, DO, and pH will be followed. Standard methods for the measurement of salinity, hardness, and TOC will be followed (APHA, 1985).

4.3 PERIPHYTON SAMPLING

Periphyton will be sampled quarterly with floating artificial substrate samplers or periphytometers (APHA, 1985). Each floating periphytometer will contain at least 10 glass slides. The periphytometers will be left in place for 14 days. After 14 days, the slides will be removed and transported to the laboratory for analysis. Three slides will be analyzed for ash-free dry weight; three will be analyzed for chlorophyll-a; three will be examined for species composition and abundance. One slide from each round of sampling will be placed in a suitable preservative and retained for verification of information (e.g., identification of species). Identification of periphyton will be to the lowest practicable taxon, and to the species level if possible.

TABLE 4-1

SAMPLING SCHEDULE FOR BIOMONITORING PLAN

Sample Type	Phase 1		Phase 2								Phase 3		
	Oct 92	Jan 93	Apr 93	Jul 93	Oct 93	Jan 94	Apr 94	Jul 94	Oct 94	Jan 94	Apr 95	Jul 95	Oct 95
Fish Collection for Bioassays (nets, traps, etc.)(1)	•		•		•		•		•				Biomonitoring program will be re-evaluated after the completion of the January 1995 round of biomonitoring.
Amphibians/Seine(1)			•				•						
Turtles (counts only)(2)			•				•						
Benthic macroinvertebrates/ Ponar(3)	•	•	•	•	•	•	•	•	•	•			
Periphyton/artificial substrates(3)	•	•	•	•	•	•	•	•	•	•			
Water quality(1): Temperature, DO, pH, Conductivity, Hardness, TOC	•	•	•	•	•	•	•	•	•	•			
Fish for bioassay(1)	•	•	•		•		•		•				
Frogs for bioassay(1)			•				•						

(1) Site 8, Beaver Pond control site, and Mattawoman Creek control site. Electrofishing is to be employed only if other measures fail to obtain sufficient results for samples required.
(2) Site 8 only.
(3) Sampling will be performed at Site 8 and two control sites in Spril 1993. This sampling may be detected at control sites depending on April 1993 results.

Periphytometers will be placed in four regions of the pond; uplake, which will correspond with Transect T6; mid-lake, which will correspond with Transect T4; down-lake, which will correspond with Transect T1; and T10 which is located on the opposite side of Atkins Road Extension. The APHA (1985) recommends that, at a minimum, two sampling stations be employed. A periphytometer will be placed at both control sites.

4.4 MACROINVERTEBRATE SAMPLING

Macroinvertebrates will be sampled quantitatively at five transects (T1, T3, T5, T7, and T10) semi-annually (Figure 4-1) with either an Ekman dredge or a petite Ponar dredge (whichever is most appropriate to the range of substrate types encountered). Duplicate samples will be taken during each sampling round. The macrobenthos that are retained by a standard number 30 (0.6 mm) sieve will be retained for identification and enumeration. Detailed sampling procedures for macrobenthos are described in Lind (1979). Sampling for macroinvertebrates will also be conducted at both control sites and duplicate samples will be taken during each sampling event.

Quantitative macroinvertebrate sampling stations were chosen to take advantage of previously designated sediment sampling locations (AFSP, 1992). This dual usage should result in cost savings and enhanced information collection because information will be used twice. Thus, semiannual macroinvertebrate sampling will be conducted at many of the AFSP sediment sampling locations. This should result in more information being collected because the two studies will be complementary rather than independent. Moreover, using the same sampling locations should facilitate exchange of information on site conditions (access, water temperatures, water level fluctuations). As noted before, in Section 3.0, a reference (or control) sampling location will be identified prior to the first round of sampling.

Benthos samples will be transported to a cooperating laboratory (USFWS Ecological Services Office in Annapolis or a qualified subcontractor) and processed by an experienced macroinvertebrate taxonomist. Organisms will be identified to the lower practicable taxon (species level, if possible) and counted. Measures of density, species richness, and species diversity (see Brower et al., 1977) will be calculated.

4.5 FISH FOR TISSUE RESIDUE ANALYSIS

Fish will be collected for mercury analysis using hoop/trap nets, slat traps and/or gill nets, and baited minnow traps. Nielsen and Johnson (1983) and Bagenal (1978) discuss the relative merits of these collection techniques in considerable detail. Electrofishing will only be conducted if required to capture

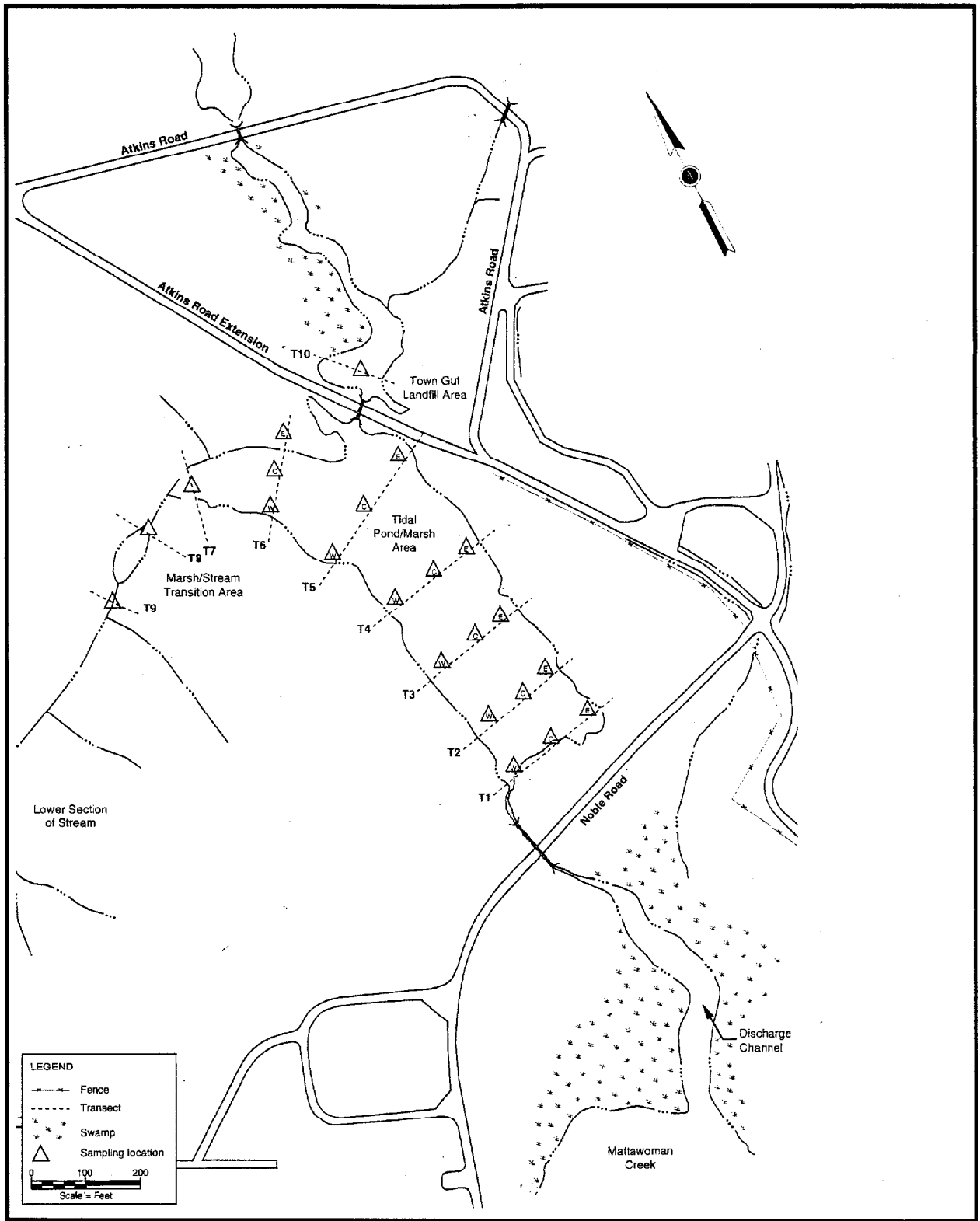

FIGURE 4-1

SITE PLAN OF POND/MARSH AREA
INDIAN HEAD DIVISION
NAVAL SURFACE WARFARE CENTER

HALLIBURTON NUS
Environmental Corporation

sufficient fish for mercury analysis, but all locations of the pond should be attempted before electrofishing is employed.

A minimum of 20 grams each of tissue will be obtained from whole-body samples of brown bullhead, *Gambusia*, and large-mouth bass. If possible, these samples would represent more than 5 largemouth bass (>200 mm TL), more than 10 brown bullhead (>100 mm TL), and more than 10 *Gambusia* (>50 mm TL). If enough largemouth bass cannot be collected, bluegill will be used as a surrogate. If enough Gambusia cannot be collected, *Fundulus* will be used as a surrogate. In subsequent years, should additional analyses be necessary, several fish of each species totaling 20 grams of tissue will be collected and analyzed for mercury residue.

Each of these fish species will provide useful information to evaluate food web biomagnification of mercury because each has a different feeding strategy/behavior and occupies a different trophic level. Small *Gambusia* are eaten by sunfish (e.g., bluegill and large-mouth bass) as well as larger *Gambusia* (see Meffe, 1987, for a discussion of cannibalistic behavior in *Gambusia*). *Gambusia* of all size are eaten by large-mouth bass and wading birds, such as the great blue heron, which is common in the study area. Brown bullhead are for the most part bottom feeders, ingesting a variety of insect larvae, fish eggs, molluscs, and plants (Pfieger, 1975; Lee, 1980), and should be indicators of mercury contamination in the sediments and macrobenthos. Large-mouth bass, which are top-of-the-food-chain predators, are known to bioaccumulate toxicants, including mercury. Also, each species has a different life span, with *Gambusia* typically living 0 to 2 years, brown bullhead 0 to 5 years, and large-mouth bass 0 to 10 years (Carlander, 1969; Pflieger, 1975; Lee, 1980). Older fish typically accumulate higher levels of contaminants, particularly mercury, than younger fish because of longer exposure times (Sorensen, 1991). These three species' different feeding strategies and positions in the food chain should provide insight into the trophic dynamics of mercury in the Indian Head NSWC pond ecosystem.

EPA (1991) contains detailed guidance on analytical procedures for measuring residual mercury in fish tissue, along with sampling recommendations. These analytical methods, which are expected to become industry standards, will be employed.

4.6 AMPHIBIANS FOR TISSUE RESIDUE ANALYSIS

Amphibia (frogs) will also be collected in the spring for mercury analysis. Collecting strategies and techniques are described in APHA (1985) and Jones (1986).

A random sample of frogs will be collected from Site 8. If possible, three or more frogs will be captured-probably with a minnow seline-from each location and composited for mercury analysis. At least 20 grams (wet weight) of tissue are to be collected from Site 8.

4.7 REPORTING

Table 4-1 shows the schedule for Phase 1 (completed) and Phase 2 biomonitoring activities. A Summary Report will be provided to the Navy approximately 6 weeks after completing the analysis of data collected in April. This report will (1) briefly describe results of the April sampling, (2) explain any changes in sampling protocols or deviations from the Biomonitoring Plan, and (3) discuss any practical or logistical problems encountered in the field. The timing and format of subsequent reports will be determined by the Navy and Halliburton NUS at a later date. At a minimum, a summary report describing the results of Phase 1 biomonitoring will be prepared.

5.0 PROJECT MANAGEMENT PLAN

Halliburton NUS will perform this project with support from the Navy. This section of the Biomonitoring Plan describes the project organization, Navy contacts and support, and a project contingency plan.

5.1 PROJECT ORGANIZATION

The proposed project organization is shown on Figure 5-1. As shown on that figure, Halliburton NUS anticipates utilizing a subcontractor to perform the field work for the October 1992 sampling round. However, subsequent sampling will be performed by either a subcontractor or the United States Fish and Wildlife Service (USFWS) in accordance with an interagency agreement between the Navy and USFWS.

Mr. Anthony P. Klimek, P.E. will be the project manager for CTO 99 and will be the primary point of contact. He will manage the day-to-day aspects of this project and will be responsible for cost and schedule control as well as technical performance. Mr. Klimek is a registered professional engineer in the state of Maryland and has more than 11 years of experience on civil and environmental engineering projects. He is also the Project Manager for the other ongoing work at Site 8 and will provide continuity between the tasks.

Field work oversight and preparation of the project reports will be performed by Mr. Philip Moore, Project Biologist. He will provide technical assistance and continuity through the development of the Biomonitoring Plan, field work, and preparation of progress, summary, and final reports.

Dr. Kathleen E. Trapp will provide technical support in the areas of toxicology and ecological risk assessment. Dr. Trapp has more than 8 years of experience as a consulting toxicologist.

5.2 NAVY SUPPORT

Mr. Paul Berkman will be the CHESDIV Remedial Project Manager (RPM). He will be the primary Navy point of contact for the project. All project activities, including reporting and field activities, will be coordinated through Mr. Berkman. Any changes in scope will be approved through Mr. Berkman prior to implementation.

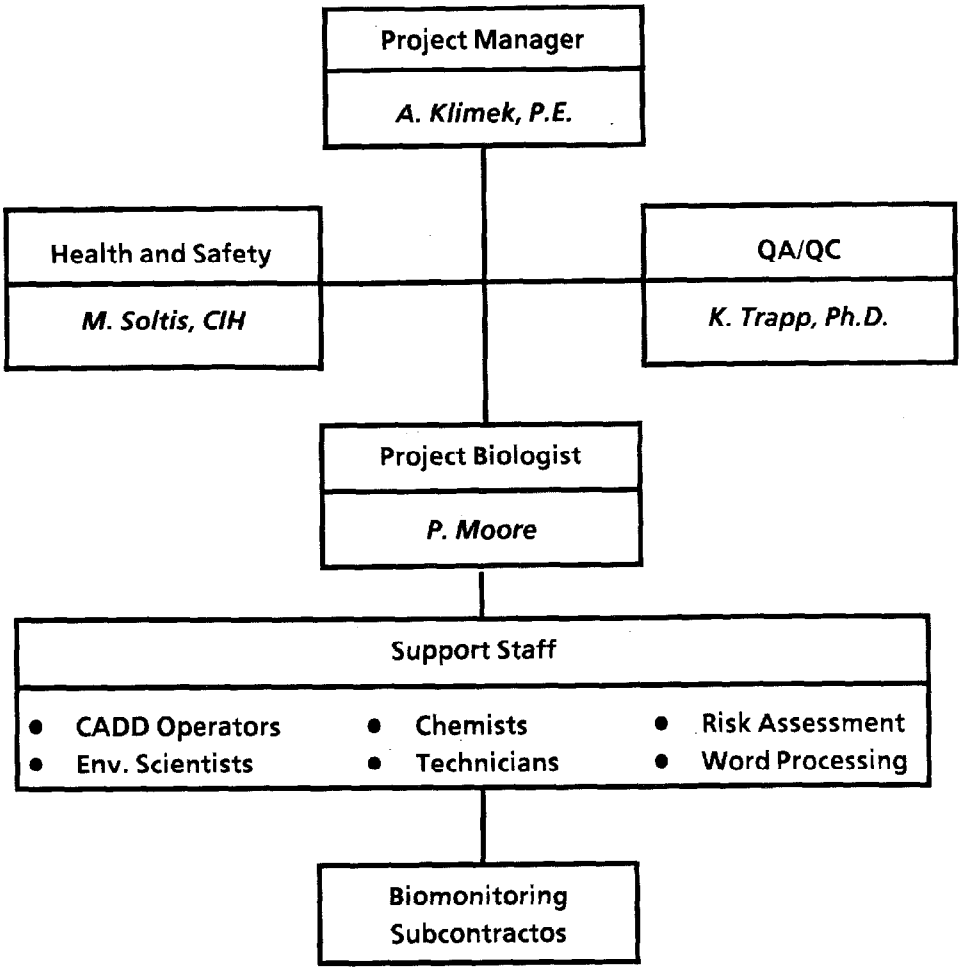

FIGURE 5-1

PROJECT ORGANIZATION CHART

HALLIBURTON NUS
Environmental Corporation

Mr. Berkman may be contacted at the following address:

Mr. Paul Berkman, Code 1812
Chesapeake Division
Naval Facilities Engineering Command
Washington Naval Yard, Building 212
Washington, DC 20374-2121
(202) 433-3760

Mr. Shawn Jorgensen will be the primary point of contact at NSWC. All field work will be coordinated through Mr. Jorgensen; he will notify appropriate NSWC personnel (security, etc.) and make arrangements for equipment (boat and support equipment) that will be provided by the Navy. Mr. Jorgensen may be contacted at the following address:

Mr. Shawn Jorgensen, Code 0965
Indian Head Division
Naval Surface Warfare Center
Building D28
Indian Head, Maryland 20640-5035
(301) 743-6745

Throughout this project, Navy will provide the following support:

- Arrange with the USFWS to provide field sampling personnel and equipment (Halliburton NUS will coordinate and oversee actual work).

- Make available existing engineering plans, drawings, diagrams, aerial photographs, digitized map files, etc., to facilitate evaluation of the site.

- Make available all historical data, background geological and hydrogeological information, and previous investigation documents.

In addition, NSWC personnel will arrange to provide the following:

- A supply (e.g., garden hose or faucet) of potable water for equipment cleaning, etc. Halliburton NUS will fill 5-gallon containers and transport the water to Site 8.

- A temporary office area, conference room, or other location, equipped with a telephone for local and long distance telephone calls.

- A row boat, three life preservers, and other associated equipment to obtain samples from the water-covered areas to be sampled.

5.3 CONTINGENCY PLAN

In the event major problems are encountered during field activities, the Halliburton NUS Project Manager will be notified immediately, followed by the NSWC Point of Contact and the CHESDIV RPM. Halliburton NUS will then develop an alternate course of action and discuss it with the Navy. All alternate courses of action that impact the project schedule and budget will be approved through the NSWC Point of Contact and the CHESDIV RPM before being enacted.

REFERENCES

ABB Environmental Services (ABB-ES), 1992a. Biomonitoring Work Plan: Site 8 - Nitroglycerin Plant Office (Final Document).

ABB Environmental Services (ABB-ES), 1992b. Engineering Evaluation and Cost Analysis Report: Site 8 - Nitroglycerin Plant Office.

American Public Health Association (APHA), 1985. Standard Methods for the Examination of Water and Wastewater (Sixteenth Edition). Am. Pub. Health Assn., Washington, D.C.

Bagenal, T., 1978. Method for Assessment of Fish Production in Fresh Waters (Third Edition). Blackwell Scientific Publications, Oxford, United Kingdom.

Brower, J. E., J. H. Zar, and C. N. VonEnde, 1990. Field and Laboratory Methods for General Ecology (Third Edition). Wm. C. Brown Publishers, Dubuque, Iowa.

Carlander, K. D., 1969. Handbook of Freshwater Fishery Biology. The Iowa State University Press, Ames, Iowa.

Eisler, R., 1987. Mercury Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review. U.S. Fish and Wildlife Service, Biological Report 85(1.10).

Halliburton NUS Corporation, 1992. Draft Abbreviated Field Sampling Plan: Site 8 - Nitroglycerin Plant Office, Indian Head, Maryland.

Hynes, H. B. N., 1970. The Ecology of Running Waters. Liverpool University Press, Liverpool, United Kingdom.

Jordan, E. C., 1987. NIRP Feasibility Study and Remedial Design. Task 2 - Supplemental Site Characterization Report, Naval Ordnance Station, Indian Head, Maryland.

Jones, K. B., 1986. "Amphibians and Reptiles." *In* Inventory and Monitoring of Wildlife Habitat. U.S. Department of the Interior, Bureau of Land Management, Denver, Colorado.

Lee, D. S., 1980. Atlas of North American Freshwater Fishes. North Carolina State Museum of Natural History, Raleigh, North Carolina.

Lind, O. T., 1979. Handbook of Common Methods in Limnology. C. V. Mosby Company, St. Louis, Missouri.

Maryland Department of Natural Resources, 1981. Environmental Atlas of the Potomac Estuary. Maryland Dept. of Natural Resources, Annapolis, Maryland.

Ludwig, J. A. and J. F. Reynolds, 1988. Statistical Ecology. John Wiley & Sons, New York.

Meffe, G. K. and M. L. Crump, 1987. Possible growth and reproductive benefits of cannibalism in the mosquitofish. The American Naturalist 129 (2): 203-212.

Nielsen, L. A. and D. L. Johnson (Eds), 1983. Fisheries Techniques. American Fisheries Society, Bethesda, Maryland.

Nriagu, J. O. (Ed.), 1979. The Biogeochemistry of Mercury in the Environment. Elsevier/North Holland Biomedical Press, Amsterdam, The Netherlands.

Odum, W. E., T. J. Smith, J. K. Hoover, and C. C. Molvor, 1984. The Ecology of Tidal Freshwater Marshes of the United States East Coast. U. S. Fish Wild. Serv. FWS/OBS-83/17.

Pennak, R. W., 1978. Fresh-Water Invertebrates of the United States (Second Edition). John Wiley & Sons, New York.

Pfileger, W. L., 1975. The Fishes of Missouri. Missouri Department of Conservation, Jefferson City, Missouri.

Phillips, G. R., P. A. Medvick, D. R. Skaar, and D. E. Knight, 1987. Factors Affecting the Mobilization, Transport, and Bioavailability of Mercury in Reservoirs of the Upper Missouri River Basin (Fish and Wildlife Technical Report 10). United States Department of the Interior Fish and Wildlife Service, Washington, D. C.

Reynolds, J. B., 1983. "Electrofishing." *In* L. A. Nielsen and D. L. Johnson (Eds) Fisheries Techniques. American Fisheries Society, Bethesda, Maryland.

Schindler, D. W., 1987. Detecting Ecosytem Responses to Anthropogenic Stress. Canadian Journal of Fisheries and Aquatic Sciences 44: 6-25.

Scott, S. L. (Ed), 1987. Field Guide to the Birds of North America (Second Edition). The National Geographic Society, Washington, D. C.

Sorensen, E. M. B, 1991. Metal Poisoning in Fish. CRC Press, Boca Raton, Florida.

United States Environmental Protection Agency (USEPA), 1983. Protocol for Bioassessment of Hazardous Waste Sites (EPA-600/2-83-054). USEPA, Office of Research and Development, Corvallis, Oregon.

USEPA, 1985. Ambient Water Quality Criteria for Mercury--1984 (EPA-440/5-84-026).

USEPA, 1989. Ecological Assessment of Hazardous Waste Sites: A Field and Laboratory Reference (EPA-600/3-89-013). USEPA, Environmental Research Laboratory.

USEPA, 1991. Assessment and Control of Bioconcentratable Contaminants in Surface Waters (Draft Report) USEPA, Office of Water, Washington, D.C.

United States Fish and Wildlife Service (USFWS), 1991. Mattawoman Creek/Naval Ordnance Station Mercury Monitoring Study Progress Report for 1990 (Pub. No. AFO-C91-05).

Webster, W. D., J. F. Pamell, and W. C. Biggs, 1985. Mammals of the Carolinas, Virginia, and Maryland. The University of North Carolina Press, Chapel Hill.

Wetzel, R. G, 1975. Limnology. W. B. Saunders Company, Philadelphia.

APPENDIX A

PRELIMINARY BIOSURVEY

United States Department of the Interior

FISH AND WILDLIFE SERVICE
DIVISION OF ECOLOGICAL SERVICES
1825 VIRGINIA STREET
ANNAPOLIS, MARYLAND 21401

August 11, 1992

Mr. Phil Moore
HALLIBURTON-NUS Environmental Corporation
900 Trail Ridge Road
Aiken, S.C.

Dear Mr. Moore:

This letter presents results of a preliminary biosurvey conducted by the Chesapeake Bay Field Office (CBFO) at an Indian Head Naval Ordnance Station wetland. A small tidal pond associated with a wetland exists at Site 8 - Nitroglycerin Plant Office (Site 8). CBFO surveyed fish and invertebrates at Site 8 to assist the Department of Defense in design of an emergency removal action that reduces or eliminates mercury contamination from an unnamed tributary of Mattawoman Creek.

Field sampling was conducted on July 27 and 28, 1992, in the tidal pond/wetland system in pilot study to identify biota that may serve as biomonitoring candidates during the mercury removal process. Recently, a dam at the tidal pond was breached. The new lower water level allowed terrestrial grasses to colonize the wetland surface. However the sediments are still unconsolidated and difficult to sample. Littoral areas were not sampled because the bottom was to soft. There is a pool at the outflow of the pond that is three to four feet in depth. The remainder of the pond is shallow (< 50 cm) with patchy areas of water lily and algae growing on the bottom. These areas were sampled with ponars.

Macroinvertebrates

Bottom sediments were sampled using a stainless steel petite ponar and sieved. A sample consisted of two ponar grabs. The pond was sampled in five locations (Figure 1). Benthic samples were preserved with 70 % ETOH and transported to Annapolis for processing. Limited numbers of pollution tolerant invertebrates were present. The most abundant groups were in decreasing order: chironomids (448.9/m), oligochaetes (127.4/m), pelecypods (84.4/m), nematodes (58.6/m), gastropods (27.6/m),water spider (3.4/m), Gerris (3.4/m), and odonata (1.4/m).

Minnow traps were baited with bread and set overnight for a period of twenty hours. Two crayfish were captured from one trap set near the southeast inflow. Although staff observed three species of adult

dragonflies in abundance over the entire study area, only one was sampled by ponar. This ponar sample was taken adjacent to a small group of lilies in the southeast area of the pond.

Fish

Fish were sampled with six minnow traps set overnight and baited with bread. Minnow traps were set in the deeper area near the dam, in several locations with adequate water depth throughout the pond, and at the inflow at the southeast end of the pond. This technique produced Fundulus, Gambusia, and bluegill sunfish. Electroshocking resulted in capture of bluegill sunfish, brown bullhead, largemouth bass, Gambusia, and Fundulus. Young of year bass, bluegill, Gambusia, and Fundulus were observed as well as adults of all species. Species abundance was as follows:

Fundulus	Most Abundant
Gambusia	
Brown bullhead	
Bluegill sunfish	
Largemouth bass	Least Abundant

Seining was not possible because of the soft bottom along the shoreline. Water depth proved to be too shallow for gill or hoop nets.

Other Vertebrates

Toad tadpoles were abundant in the pond in all stages of development. We observed egg masses of an unknown amphibian species. Many painted turtles were also observed. At least one muskrat is present in the pond.

Terrestrial vertebrates that use the habitats around the pond include woodchuck, deer, indigo bunting, kingfisher, cardinal, green heron, hawk, blue jay, and great blue heron.

The U.S. Fish and Wildlife Service appreciates the opportunity to provide the assistance to HALLIBURTON-NUS and Indian Head Naval Surface Warfare Center. If you have any questions concerning preliminary biosurvey, please contact me at (410) 269-5448.

Robert E. Foley

Robert E. Foley

Attachment

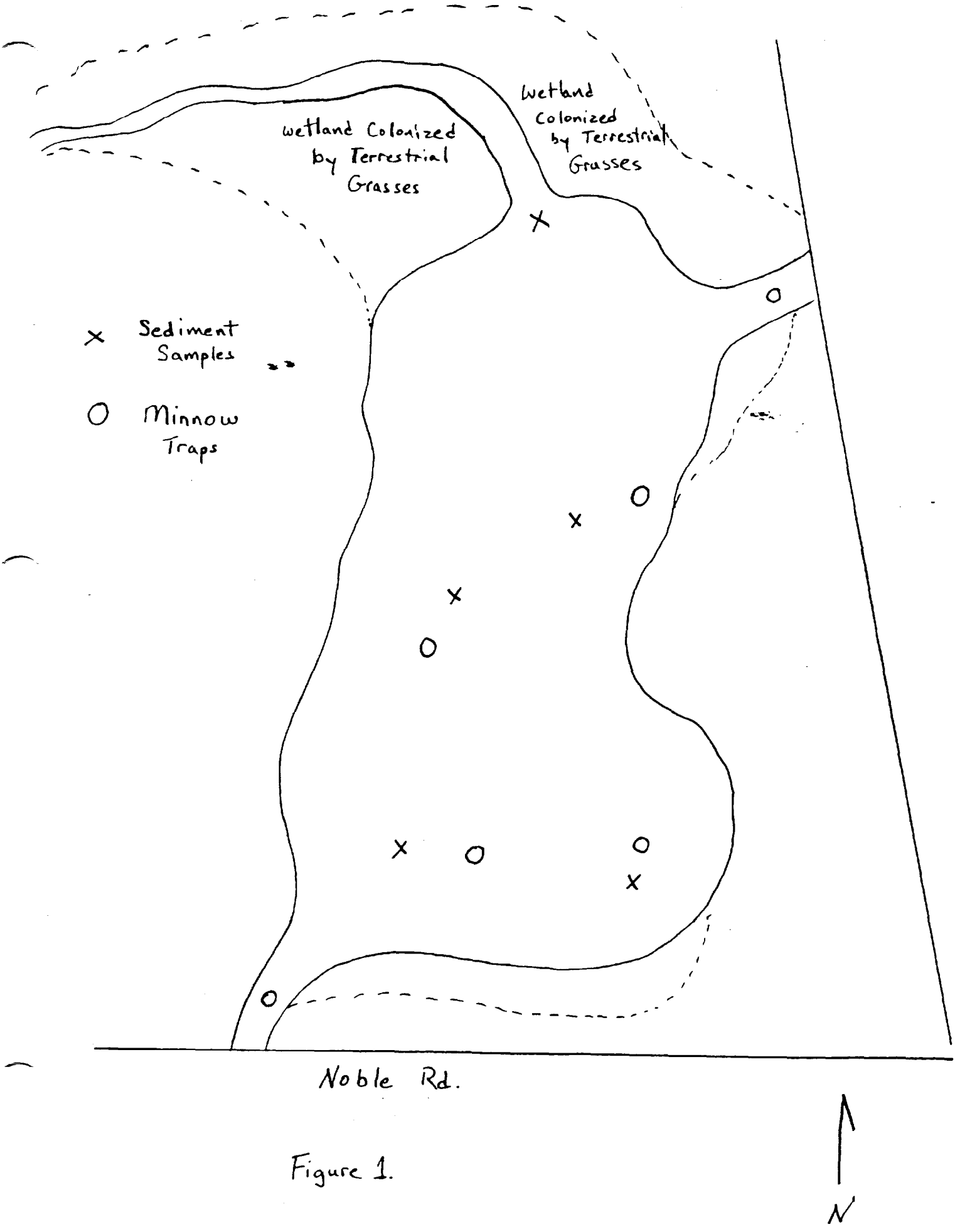
wetland Colonized by Terrestrial Grasses
Wetland Colonized by Terrestrial Grasses
X Sediment Samples
O Minnow Traps
Noble Rd.
N

Figure 1.