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REPORT ON OCTOBER 1992 BIOMONITORING FOR SITE 8 - NITROGLYCERIN PLANT OFFICE INDIAN HEAD DIVISION, NAVAL SURFACE WARFARE CENTER INDIAN HEAD, MARYLAND

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

Submitted to:
Chesapeake Division
Environmental Branch, Code 18
Naval Facilities Engineering Command
Building 212, Washington Navy Yard
Washington, D.C. 20374-2121

Submitted by:
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Contract Number N62472-90-D-1298
Contract Task Order 0064

JANUARY 1993

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 (Halliburton NUS), 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 (IHDIVNAVSURFWARCEN or NSWC) in Indian Head, Maryland. NSWC is in the Chesapeake Division (CHESDIV) of the Naval Facilities Engineering Command. 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 and begin implementation of a Biomonitoring Program to assess the extent of mercury contamination in the biota of the Installation Restoration Site 8 marsh and tidal pond as well as evaluate the potential ecological impacts of any interim removal action.

Halliburton NUS developed a site specific Biomonitoring Program for Site 8. This program was presented in a Biomonitoring Plan (Halliburton NUS, 1992b) for the site. The plan outlined procedures to perform biomonitoring at Site 8 on a quarterly basis through two distinct phases - Phase I and Phase II. The plan was developed so that it could be modified (particularly during Phase I) in order to achieve the overall objective of the Biomonitoring Program. During Phase I, sample collection and analytical techniques would be refined based on actual site conditions. After the techniques are refined in Phase I, Phase II would begin. Phase I was to be performed through three months - (October 1992, January 1993 and April 1993) of biomonitoring. Phase II would begin in July 1993 and would continue until it was determined to be no longer necessary.

This report presents the results of the October 1992 round of biomonitoring; the biomonitoring was implemented in accordance with the approved Biomonitoring Plan (Halliburton NUS, 1992b). Because this first round of biomonitoring was part of Phase I, information obtained will be used both to assess Site 8 and to refine the Biomonitoring Program in subsequent Phase I and II rounds.

1.1 BACKGROUND

For approximately 20 years, mercury was inadvertently released in small amounts from sink and floor drains in Building 766 of the Site 8 - Nitroglycerin Plant Office. The Building 766 sink and floor drains discharged into a storm drain system that discharged into a small stream that flows south and east for

approximately 1/4 mile, enters a cattail marsh and tidally-influenced pond (tidal pond), 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). The actual quantity of mercury that was released is unknown; however, it was previously estimated that between 200 and 500 pounds of mercury were released to the environment from Site 8 (ABB-ES, 1992a).

In August 1992, Halliburton NUS Corporation began sampling and analysis work to investigate the extent of mercury contamination in the soils, sediment, and surface water of Site 8 in accordance with an approved Abbreviated Field Sampling Plan (Halliburton NUS, 1992a). The results of that sampling and analysis indicate that sediments in the Upper Section of Stream (near Building 766) are contaminated with mercury concentrations greater than 25 mg/kg. Mercury concentrations ranged from non-detect to 671 mg/kg. Sediments in the tidal pond/marsh area had mercury concentrations ranging from non-detect to 13.8 mg/kg. Mercury was not detected in sediments from other areas at the site or detected at substantially lower concentrations and/or not widely distributed.

The Biomonitoring Program developed by Halliburton NUS was designed to be implemented in the tidal pond/marsh area of Site 8 only. The tidal pond/marsh area is the most downstream area of Site 8, sediments from the more contaminated areas of the site (stream) accumulate in the tidal pond/marsh, and the biota in the tidal pond/marsh area are more conducive for biomonitoring.

1.2 SITE DESCRIPTION

The study site (Site 8 tidal pond/marsh) is on the main area of the NSWC. Site 8 discharges into Mattawoman Creek via a 6-foot-diameter culvert running under Noble Road. A beaver pond on the Stump Neck Annex of NSWC, approximately 3 miles southeast of the study site and 1/2 mile northwest of Alexandria Church, was chosen as the control site. The location of Site 8 and the control site are shown on Figure 1-1. The beaver pond control site is located on an unnamed tributary of the Chicamuxen Creek, with drainage to the south of Mattawoman Creek. Both streams are tributaries of the Potomac River. This beaver pond was chosen as a control site because it offers security (access to the area is restricted and controlled by NSWC) and reasonably approximates the study site in terms of water chemistry, water level, topography, and resident plants and animals. Because the beaver pond control site is approximately 2 miles upstream from Chicamuxen Creek and approximately 3 miles upstream from the Potomac River, it has not been impacted by mercury contamination from Site 8; any pollutants (e.g., mercury) in its water, sediments, and biota are presumed to be from atmospheric or geologic sources rather than the Site 8 source.

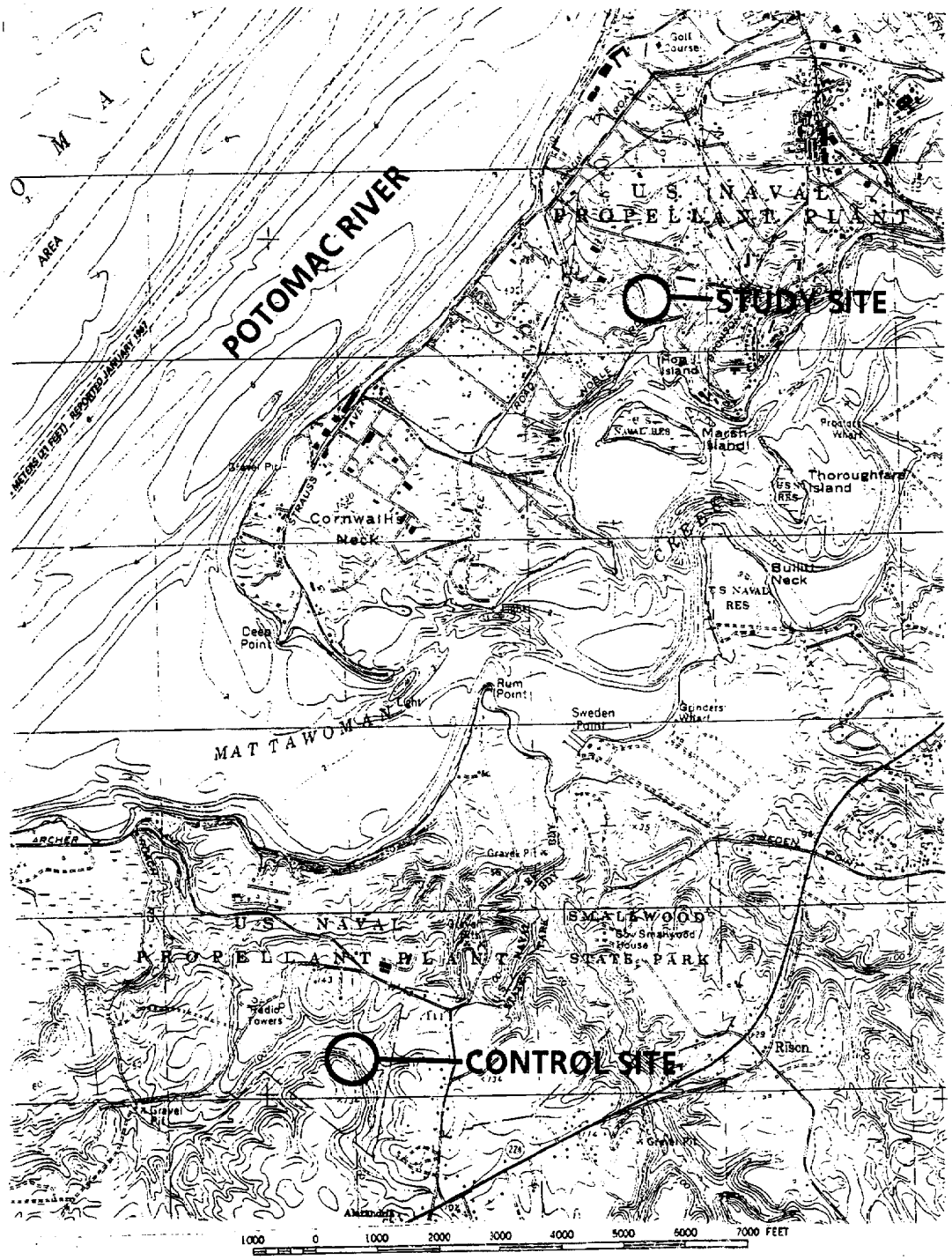


FIGURE 1-1
STUDY AND CONTROL LOCATION MAP
BIOMONITORING PROGRAM
INSTALLATION RESTORATION PROGRAM
SITE 8 - NITROGLYCERIN PLANT OFFICE

HALLIBURTON NUS
Environmental Corporation

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

Until recently (summer of 1992) the normal depth of the tidal pond/marsh was approximately 4 to 5 feet deep and was maintained by a beaver dam near the upstream end of the pipe, which outlets from the tidal pond/marsh. The beaver dam was removed in the summer of 1992 and normal pool was lowered approximately 4 feet. During the October 1992 phase of biomonitoring the water level in the study site was generally one to two feet deep. A weir to regulate flow from the study site and restore normal pool to its previous level is proposed to be installed on the upstream end of the culvert.

1.3 OBJECTIVE

The overall objective of the Biomonitoring Program is to assess the impact that mercury contamination at Site 8 has affected the biota at the Site 8 tidal pond/marsh and to evaluate potential environmental impacts of any interim removal action. The objective of the October 1992 round of biomonitoring was to collect initial biota data on Site 8, begin establishment of baseline conditions, and provide information to refine and improve subsequent phases of biomonitoring.

2.0 SAMPLING LOCATIONS AND METHODS

Field sampling for the October 1992 round of biomonitoring was conducted on October 29 and 30, 1992. Actual field sampling was performed by Coastal Environmental, Inc., a subcontractor to Halliburton NUS.

As previously described, because the weir (to replace the beaver dam) was not installed, the actual depth of the study site was approximately 1 to 2 feet deep. Field sampling was performed at seven transects through the main area of the tidal pond/marsh (Transect 1 through 7) and at a location on the north side of Atkins Road Extension (Transect 10). The sampling locations are shown on Figure 2-1. During the October 1992 phase of biomonitoring, Transects 1 through 5 were located on an open water (pool) area of the tidal pond/marsh. Transects 6 and 7 were located in the upgradient stream. Transect 10, which under normal circumstances is a marsh with standing water just upstream of the tidal pond, was, at the time of the October sampling, a small stream flowing into the tidal pond.

As part of the October 1992 round of biomonitoring the following sampling and analytical procedures were performed and/or sampled.

- Water Quality
- Periphyton
- Benthic Macroinvertebrate
- Fish

2.1 WATER QUALITY MEASUREMENTS

Water temperature, dissolved oxygen (DO), pH, and conductivity measurements were taken in the field with a Hydrolab Surveyor II at a mid-depth only because water was <1.0 meter deep at all transects. Conductivity, rather than salinity, was monitored because preliminary field measurements indicated that the tidal pond was freshwater, with salinities <1.0 part per thousand (ppt) at all transects. Grab samples of water for hardness and total organic carbon (TOC) were taken at the surface and shipped to Halliburton NUS' Pittsburgh laboratory for analysis.

2.2 PERIPHYTON SAMPLING

Periphyton was sampled with an artificial substrate device similar to that described in Standard Methods for Analysis of Water and Wastewater (APHA, 1985). This device employs glass slides in a frame supported by styrofoam floats. Two sets of periphyton samplers, each containing 8 slides (a total of 16 slides), were placed at each sampling location. After 14 days the samplers were retrieved and transported to the laboratory for analysis.

Three randomly-selected slides from each array were analyzed for ash-free dry weight, three were analyzed for chlorophyll-a, and three were examined for species composition and abundance. One slide from each periphyton sampler was preserved and archived, in the event that additional analysis or verification of periphyton identification is required. Any remaining slides collected at a given sampling location were discarded.

2.3 BENTHIC MACROINVERTEBRATE SAMPLING

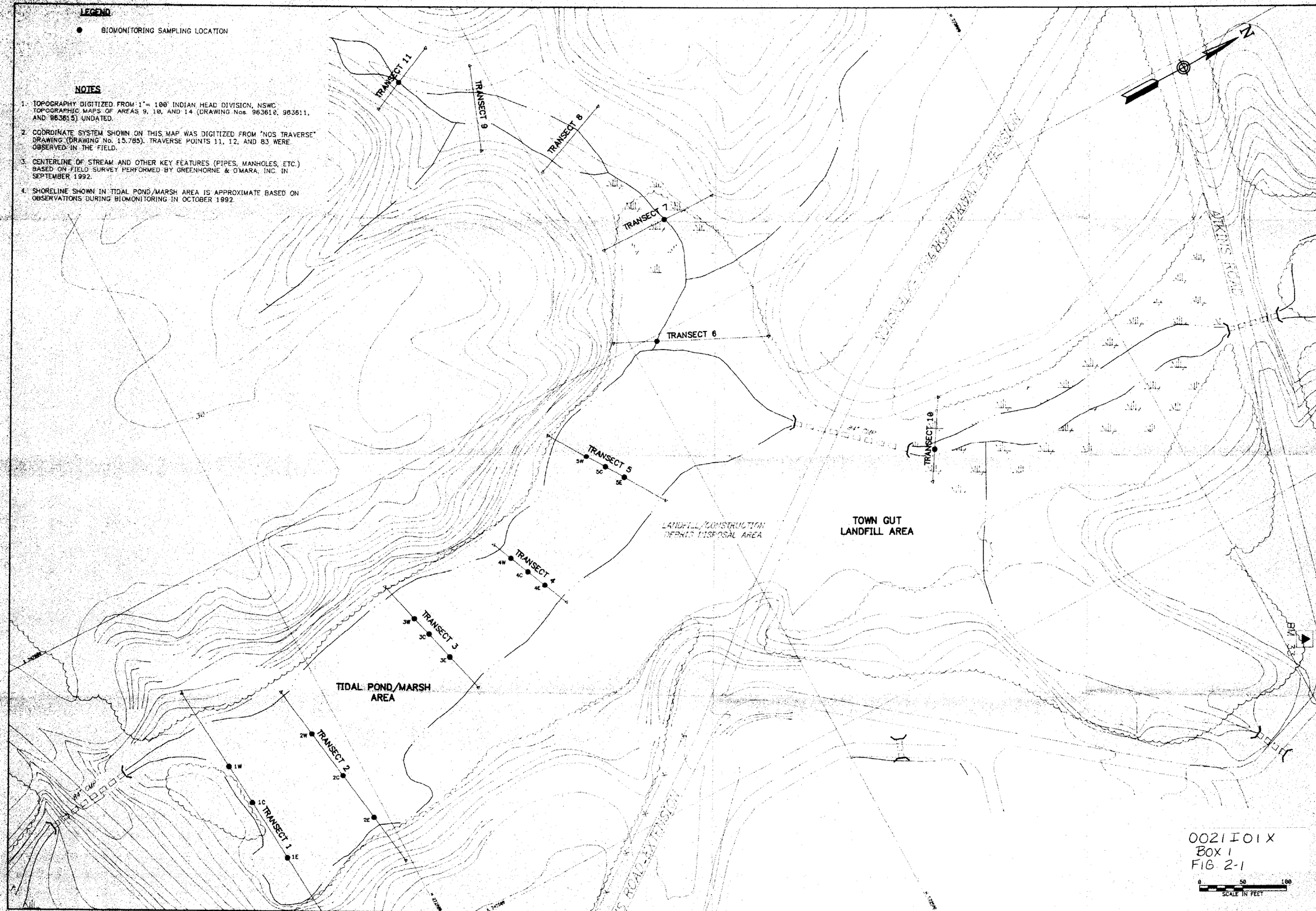
Benthic macroinvertebrates were sampled with a Petite Ponar grab sampler. Samples were sieved in the field, preserved, and transported to the laboratory for identification and enumeration. Standard methods described in APHA (1985) and Lind (1979) for collecting and counting benthic macroinvertebrates were employed.

2.4 FISH SAMPLING

2.4.1 Fish Survey

A fish survey was conducted at the study site with a backpack electrofishing unit. The total time that current was actually applied to the water was recorded at each station. Because the fish community of the tidal pond was dominated numerically by fish from two species--*Gambusia affinis* and *Fundulus heteroclitus*--representative specimens from these two groups were measured and weighed. All fish were identified in the field and returned to the water unharmed, except for specimens retained for mercury residue analysis.

Unsuccessful attempts were made to collect fish at the control site with a backpack electrofisher and a bag seine. The lack of successful electrofishing may have been due to the water's low conductivity (approximately 75 micromhos/cm) or to the inability of the sampling crew to approach fish in this small body of water without being detected. The effectiveness of the bag seine was limited by the soft bottom and the abundance of aquatic vegetation.



DEPARTMENT OF THE NAVY
WASHINGTON NAVY YARD
NAVAL FACILITIES ENGINEERING COMMAND
WASHINGTON, DC

CHESAPEAKE DIVISION

INDIAN HEAD DIVISION, NAVAL SURFACE WARFARE CENTER
SITE 8 – NITROGLYCERIN PLANT OFFICE
OCTOBER 1992 – BIOMONITORING SAMPLING LOCATIONS

ISSUED: JANUARY 22, 1993
NORTHDIV FOR COMMANDER, NAVFAC

REV. DESCRIPTION PREP BY DATE APPRVD

DSGN: DR: CH ENG:
SUPV:
SUBMITTED BY: (FIRM MEMBER) (TITLE) (DATE)
CHECKED: CM: PM: NO: NO: DR:
OFFICER IN CHARGE
APPROVED: DATE

SEAL AREA

SAT TO DATE
CODE I.D. NO. 86001
SCALE: AS SHOWN
SPEC. NO. 04 – NA
CONSTRN. CONTR. NO. NA
NAVFAC DRAWING NO. NA
SHEET 1 OF 1
SIZE: D
DIS. SH. NO. FIGURE 2-1

2.4.2 Fish Sampling for Mercury Residues

Additional fish sampling for analysis of mercury in tissues was conducted using a combination of electrofishing, seining, and minnow traps. Minnow traps were set at the study site and control site, left overnight, and retrieved the next day. Target species were largemouth bass (*Micropterus salmoides*), brown bullhead (*Ameiurus nebulosus*), and the mosquitofish (*Gambusia affinis*), which were selected because they represent three distinct trophic (feeding) levels: top-of-the-food-chain predator, bottom-feeding omnivore, and surface-feeding insectivore (Halliburton NUS, 1992b). Because sampling efforts produced no largemouth bass, bluegill (*Lepomis macrochirus*) were collected from the study site and analyzed as a surrogate.

As noted previously, no fish were captured at the control site. In an effort to collect some additional data for purposes of comparison, fish were collected from Transect 10, a tributary stream upstream of the tidal pond. Only two species, *Gambusia* and bluegill, were collected in sufficient quantities from Transect 10 to permit tissue analysis for mercury. Fish were placed on ice and shipped to Gascoyne Laboratories, Incorporated, for analysis of mercury residues in tissues.

3.0 BIOMONITORING RESULTS AND DISCUSSION

3.1 WATER QUALITY

Water quality data are presented in Table 3-1. As shown in Table 3-1 water temperatures in the study site area ranged from 12.4 to 14.7°C. Temperatures increased with decreasing depth, with Transect 1 (deeper water at the foot of the dam) showing the lowest temperature and Transects 7 and 10, both located upstream in shallow, slow-flowing water, having the highest temperatures, 14.3 and 14.7°C. Water temperatures were lower at the control site. Dissolved oxygen (DO) levels ranged from 10.4 mg/L at Transect 10 to 5.3 mg/L at Transect 1, and were adequate to support a variety of aquatic life at all transects. DO levels were consistently lower at the two control stations, however, measuring 4.0 mg/L at both control stations. Measurements of pH ranged from 6.6 to 7.1 at the study site (Transects 1, 2, 4, and 7), and were slightly lower (5.7 to 5.9) at the control site.

TABLE 3-1

(OCTOBER 29, 1992)
WATER QUALITY DATA

Station	Time (approximate)	DO (mg/L)	Temperature (°C)	pH	Conductivity (µmhos)
T-1	10:00-11:00	5.3	12.4	6.6	372.0
T-2	10:00-11:00	5.4	12.6	6.6	398.0
T-4	10:00-11:00	9.4	13.2	6.7	344.0
T-7	12:00-13:00	7.0	14.3	6.9	406.0
T-10	12:00-13:00	10.4	14.7	7.1	304.0
Control A	17:00	4.0	11.7	5.9	74.0
Control B	17:00	4.0	11.7	5.7	73.0

3.2 PERIPHYTON

The periphyton (attached algae) of the control site were dominated by two phyla, the Baccillariophyta (diatoms) and the Chlorophyta (green algae) (see Tables in Attachment A). These two groups made up more than 95 percent by number and weight of the attached algae collected. Diatoms are ubiquitous in a wide variety of freshwater and marine habitats, and are often associated

with the littoral zones of lakes and ponds as well as the bottoms of streams (Whitford and Schumacher, 1973).

Within this diverse diatom group, the control site contained diatom genera associated with clean waters (e.g., *Cocconeis* and *Navicula*) as well as diatoms often used as bioindicators of stress or pollution in aquatic ecosystems (e.g., *Gomphonema* and *Nitzschia*) (APHA, 1985). *Eunotia*, the genus of diatom most common in control site samples, is abundant in stained, acidic waters, such as those of the control site. The pH of the beaver pond control site, which was approximately 5.8 during the October monitoring, was the most acidic of all transects tested.

Of the three green algae genera present in control site samples, *Chlorococcum* was most abundant, while *Ulothrix*, a colonial form, made up most of the biomass. Small numbers of the golden-brown algae *Ophiocytium* were also collected at the control site. This small-celled form, which is generally associated with the phytoplankton rather than periphyton (Wetzel, 1975), made up less than 5 percent of the periphyton collected from the control site and only 2 percent of the total biomass.

Green algae, numerically dominant (53.5% of total collected) in samples from Transect 1, made up approximately 84% of samples by weight. Diatoms were next in abundance and biomass. A small number of *Ophiocytium* were also present in samples from Transect 1.

Transect 3 collections were also dominated by diatoms and green algae, both in density and weight. Diatoms evidenced highest densities, while green algae made up more than 70% of the periphyton samples by weight. Densities and biomass measures of diatoms and green algae from Transect 3 were markedly higher (10 to 15 times) than those of the control site or Transect 1. Samples from Transect 3 also contained small numbers of two phyla, *Euglenophyta* and *Cyanophyta*, not seen at the control site or Transect 1. *Cyanophyta*, or blue-green "algae," are generally regarded as indicators of eutrophication or pollution. Density, biomass, and types of periphyton at Transect 3 are indicative of a much more productive body of water than the control site.

Transect 4, like Transect 3, was characterized by high densities and high measures of biomass. Diatoms were the most abundant group (66 percent), while green algae comprised the bulk of the biomass (72 percent). Transect 4 also contained small numbers of *Euglenophyta* and *Cyanophyta*.

3.3 BENTHIC MACROINVERTEBRATES

The Site 8 tidal pond is typical of tidally-influenced freshwater ponds in the Potomac River estuary, with rooted aquatic vegetation and a soft bottom containing large amounts of organic detritus

(Maryland DNR, 1981). Table 3-2 lists densities of benthic macroinvertebrates collected at the various transects.

A total of 16 macroinvertebrate taxa was collected from the pond proper (Transects 1-3), with *oligochaetes* most abundant (36.5% to 80.0% of total). A total of 10 taxa was collected from the pond-cattail marsh transition zone (Transects 4 and 5), again with *Oligochaeta* most prevalent. A total of 3 taxa was collected from Transects 6 and 7, which represent the stream-cattail marsh transition zone.

Highest densities of macrobenthos were found in the transition zone between the pond proper and the cattail marsh (Transects 4 and 5), which had 3,102 and 5,129 organisms per square meter, respectively. The highest densities of macrobenthos were at Transect 5, a relatively shallow, narrow area at the head of the pond, just below the confluence of the two tributary streams.

Diversity, on the other hand, was highest at Transects 2, 3, and 4, which contained 9, 13, and 10 taxa, respectively. Transect 1, in the deeper water at the base of the dam, contained only five taxa, the bulk of which were *Oligochaeta* and the amphipod *Gammarus*. Transects 6 and 7 (in a stream-like environment) also were low in diversity, containing a total of three macroinvertebrate taxa, the majority of which were *Oligochaetes* and the pulmonate snail *Physella*. Perhaps more significantly, Transects 2, 3, and 4 contained relatively few pollution-tolerant forms (e.g., *Oligochaeta*), and more groups that are indicative of good water quality, such as the odonates (dragonfly larvae) *Gomphus* and *Calopteryx* and an unspecified trichopteran (caddisfly).

Pennak (1978) notes that dragonfly larvae are "rare" in polluted waters. Similarly, caddisflies are associated with shallow (generally lotic) freshwater habitats where there is an adequate supply of oxygen. This dependence on relatively high oxygen levels stems from the fact that respiration in caddisfly larvae is "independent of the (water) surface and atmospheric oxygen" (Wiggins, 1984).

The megalopteran (alderfly larvae) *Sialis*, a sediment-dwelling predator that feeds on insect larvae, annelids, and crustaceans, was collected at Transect 3 only. Roback (1974) identifies *Sialis* as one of the few pollution-tolerant genera of *Megaloptera*. However, this is based on the genus' ability to withstand extremes of pH and high concentrations of several ions (e.g., sulfate and chloride), not a tolerance of low oxygen levels. According to the same reference, *Sialis* requires DO concentrations of at least 5 mg/L.

The beaver pond control site showed a depauperate macroinvertebrate community, low in density and diversity. The amphipod *Gammarus* was the dominant organism, making up 85% of the

TABLE 3-2

BENTHIC MACROINVERTEBRATE SAMPLING
DENSITY (NUMBER/M2) AND RELATIVE ABUNDANCE (%) OF ORGANISMS COLLECTED FROM TRANSECTS
INDIAN HEAD DIVISION, NAVAL SURFACE WARFARE CENTER
INDIAN HEAD, MARYLAND

	Transect 1	Transect 2	Transect 3	Transect 4	Transect 5	Transect 6
Hymanella sp.	32 (1.5%)	--	--	211 (6.8%)	--	--
Nematoda	--	--	51 (6.1%)	306 (9.9%)	--	38 (4.3%)
Oligochaeta	1097 (50.4%)	472 (80.0%)	306 (36.5%)	1053 (34.0%)	4860 (94.8%)	804 (91.4%)
Polychaeta	--	19 (3.2%)	6 (0.8%)	230 (7.4%)	--	--
Asellus sp.	--	6 (1.1%)	--	--	--	--
Gammarus sp.	791 (36.4)	13 (2.1%)	70 (8.4%)	134 (4.3%)	--	--
Gomphus	--	6 (1.1%)	9 (1.1%)	58 (1.9%)	--	--
Calopeteryx sp.	128 (5.9%)	6 (1.1%)	140 (16.7%)	19 (0.6%)	--	--
Sialis sp.	--	--	6(0.8%)	--	--	--
Trichoptera	--	--	6 (0.8%)	--	--	--
Hemiptera	--	--	--	--	--	--
Diptera (adult)	--	6 (1.1%)	--	--	--	--
Diptera (larvae)	--	--	6 (0.8%)	--	--	--
Culex sp.	--	13 (2.1%)	--	--	--	--
Chironomidae	128 (5.9%)	48 (8.2%)	128 (15.2%)	880 (28.4%)	115 (2.2%)	--
Pysella sp.	--	--	38 (4.5%)	77 (2.5%)	115 (2.2%)	38 (4.3%)
Unionidae	--	--	6 (0.8%)	--	--	--
Sphaerium sp.	--	--	64 (7.6%)	134 (4.3%)	39 (0.8%)	--
TOTALS	**2176**	**589**	**836**	**3102**	**5129**	**880**

TABLE 3-2
BENTHIC MACROINVERTEBRATE SAMPLING
DENSITY (NUMBER/M2) AND RELATIVE ABUNDANCE (%) OF ORGANISMS COLLECTED FROM TRANSECTS
INDIAN HEAD DIVISION, NAVAL SURFACE WARFARE CENTER
INDIAN HEAD, MARYLAND
PAGE TWO

	Transect 7	Transect 10	Transect 11	Control A	Control B
Hymanella sp.	--	76 (1.8%)	--	--	--
Nematoda	--	--	--	76 (9.9%)	--
Oligochaeta	172 (37.5%)	4132 (98.2%)	76 (100.0%)	--	--
Polychaeta	--	--	--	--	--
Asellus sp.	--	--	--	--	--
Gammarus sp.	--	--	--	536 (70.2%)	38 (100.0%)
Gomphus	--	--	--	--	--
Calopeteryx sp.	--	--	--	--	--
Sialis sp.	--	--	--	--	--
Trichoptera	--	--	--	--	--
Hemiptera	--	--	--	76 (9.9%)	--
Diptera (adult)	--	--	--	--	--
Diptera (larvae	--	--		76 (9.9%)	--
Culex sp.	--	--	--	--	--
Chironomidae	--	--	--	--	--
Pysella sp.	287 (62.5%)	--	-	--	--
Unionidae	--	--	--	--	--
Sphaerium sp.	--	--	--	--	--
TOTALS	**459**	**4208**	**76**	**764**	**38**

macroinvertebrates collected. Small numbers of nematodes, dipteran larvae, and hemipterans were also present. The presence of hemipterans, or "true bugs" in the control site samples is not surprising because this narrow beaver pond is surrounded by shrubby vegetation and trees. Most hemipterans are terrestrial, and those collected presumably fell from nearby vegetation or were washed into the pond by rains.

3.4 FISH DIVERSITY

Low water levels at the Site 8 study site and low conductivity at the control site hindered fish collecting in October 1992. Four fish species were captured during the population surveys at the Site 8 pond: *Lepomis gibbosus* (pumpkinseed), *Ameiurus nebulosus* (brown bullhead), *Fundulus heteroclitus* (mummichog), and *Gambusia affinis* (mosquitofish). No fish were collected from the control site. At least two more species--largemouth bass (*Micropterus salmoides*) and bluegill (*Lepomis machrochirus*)--have been collected in the past at Site 8 (letter from Robert E. Foley, U.S. Fish and Wildlife Service to Philip Moore, Halliburton NUS Corporation, dated August 11, 1992). Even if these two additional species had been collected during the October biomonitoring effort, the fish community could only be described as low in species diversity.

The water level of the tidal pond was lowered in 1992 when a beaver dam in its lower end was breached. A weir was to have been installed just upstream of the Noble Road dam prior to the October biomonitoring, but circumstances prevented its installation. As a result, water levels were lower than anticipated at the study site, making sampling of fish and invertebrates extremely difficult. The surface area of the pond was reduced by approximately one-half, and areas previously accessible by boat were no longer accessible. Once the weir has been installed, in the Spring of 1993, the water level in the pond is expected to rise approximately 3 feet, which will inundate much of the exposed pond bed.

Installation of the weir will prevent fish (and invertebrates) from moving into the Site 8 pond from Mattawoman Creek. All recruitment of biota will be from upstream, or from the pond itself. It is unclear whether this will result in marked changes in invertebrate communities, but it appears likely that the fish community will change over time, with a fishery developing that is more typical of a freshwater stream/pond than an estuary.

In the absence of recruitment from downstream, at least one species--the mummichog, *Fundulus heteroclitus*--is expected to decrease in relative abundance. A review of published life history accounts of this species suggests that the mummichog is able to reproduce and maintain population levels in freshwater impoundments under certain circumstances, but is more likely to flourish in

brackish tidal waters (Scott and Crossman, 1973; Lee et al., 1980). It is unknown what effect the installation of the weir and the isolation of the pond will have on Gambusia, bluegill, and brown bullhead. Bluegill and brown bullhead are freshwater species. *Gambusia affinis* is an adaptable euryhaline species that fares equally well in fresh or brackish water, lakes, ponds, backwaters of rivers, and drainage ditches (Lee et al., 1980).

3.5 ANALYSIS OF MERCURY IN FISH TISSUE

As previously noted, fish samples were shipped on ice to Gascoyne Laboratories, Inc. EPA Method 7471 (detection limit = 0.01 mg/kg) was used to determine the concentration of total inorganic mercury present in each sample. Analyses were performed on homogenized whole body samples, rather than on fillets. The number and total weight of fish comprising each sample and the concentration of total mercury present in each sample are summarized in Table 3-3.

TABLE 3-3

MERCURY FISH TISSUE ANALYTICAL RESULTS

Fish Species	Site 8			T-10		
	No. Fish Analyzed	Total Weight (grams)	Total Hg (mg/kg)	No. Fish Analyzed	Total Weight (grams)	Total Hg (mg/kg)
Brown Bullhead	3	14.6	0.04	0	0.0	0.00
Gambusia	16	14.2	0.06	20	17.7	0.04
Bluegill	11	53.6	0.02	3	14.6	0.02

No particular trends were evident from these limited data. No significant difference was demonstrated when tissue concentrations of mercury measured in a given species were compared between sites (e.g., mercury present in bluegill samples collected from Transect 10 vs. Site 8). The data also failed to demonstrate a marked difference in the concentration of mercury measured in different fish species collected at a particular sampling station (i.e., Site 8). Because mercury exhibits a tendency to biomagnify (increases in concentration at higher levels of a food chain), detection of higher concentrations of mercury in bluegill (a mid-food-chain organism) than in bullheads or *Gambusia* would have been anticipated. This type of a pattern was not observed.

The tissue concentrations of mercury measured in the samples of bluegill collected in October 1992 are similar to concentrations reported by the USFWS for this area between 1987 and 1991 (USFWS, 1991). As noted in these reports, the levels of mercury reported for bluegill collected from Indian Head are similar to those reported for bluegill collected from other locations in Maryland and throughout the United States; comparable data were not available for bullheads or *Gambusia*. The bluegill data (1987-1992) suggest that the levels of mercury available to these organisms have remained static over the last 6 years and that mercury tissue levels in bluegill have remained within the range reported for this species from other locations throughout the state.

Eisler (1987) suggested that fish tissue levels of 0.1 mg/kg mercury (wet weight) be used as a guideline for the protection of sensitive piscivorous birds and recommended that 1.1 mg Hg/kg serve as a guidance level for the dietary intake of piscivorous mammals. The concentration of mercury present in samples of fish collected from both Site 8 and Transect 10 were well below these suggested guidance levels, indicating that piscivorous terrestrial species that feed on these fish are not at risk.

4.0 CONCLUSTIONS AND RECOMMENDATIONS

4.1 CONCLUSIONS

These preliminary findings suggest that the Site 8 marsh-tidal pond system has relatively-simple community structure. The periphyton community was dominated by diatoms and green algae in October 1992; however, the periphyton community is expected to show marked seasonal changes. The benthic macroinvertebrate community is composed largely of herbivores that feed on attached algae and detritivores (such as oligochaetes) that feed on organic detritus. The two most abundant fish species (*Fundulus heteroclit* and *Gambusia affinis*) in the Site 8 tidal pond are omnivores that feed on plant matter, larval and adult insects, and small fish. Fish species diversity is low, as is typical of tidal streams and ponds in the mid-Atlantic.

Concentrations of mercury in fish tissue from Site 8 (0.02 to 0.06 mg/kg) revealed no clear differences between species or areas. Mercury levels in fish samples were below those suggested as a guideline for protection of sensitive piscivorous birds (0.1 mg/kg) and piscivorous mammals (1.1 mg/kg), indicating that fish-eating terrestrial species that feed on Site 8 fish are not at risk.

None of these data should be regarded as conclusive. Future biomonitoring will reveal more about community structure and will yield more definitive information about levels of mercury in Site 8 biota.

4.2 RECOMMENDATIONS

Despite a number of practical and logistical problems caused by low water levels, the October 1992 round of biomonitoring was useful in that it provided data to begin establishment of baseline conditions at the study site. In addition, based on the results of the October 1992 biomonitoring, a number of refinements will be implemented in subsequent rounds of biomonitoring. These refinements include, but are not limited to: (1) reducing the number of replicate benthos samples taken at the study site, (2) increasing the level of resolution to which certain benthic macroinvertebrate groups are identified, (3) re-evaluating fish sampling methods employed in order to capture a wider variety of fish species, (4) omitting quantitative studies of fish abundance (catch-per-unit-effort) and diversity, and (5) identifying deficiencies with the control site.

Numerous researchers have commented on the tendency of benthic macroinvertebrates to be patchily, rather than uniformly distributed (Cummins, 1975; Wetzel, 1975). Given this patchiness and the large number of samples that would be required to discern statistically significant differences between sampling events (based on the variability observed in this preliminary study), in future rounds of biomonitoring the number of benthos samples will be reduced, and that these data will be assessed qualitatively and graphically rather than quantitatively.

The number of replicate benthic macroinvertebrate samples (3 per transect--results reported here are combined) may be revised. In the future it may be wise to reduce the number of samples and increase the resolution. It is recommended that duplicate, rather than triplicate samples, be taken at each transect. It is also recommended that taxa such as *Trichoptera* and *Unionidae* be classified at least to the genus level, and, when practicable, to species. This should provide more information about the true diversity of the systems and, more importantly, allow a more detailed examination of pollution-tolerant and pollution-intolerant genera and species. As is, it is difficult to draw any conclusions about the relative pollution tolerance of the groups that are represented. Identification to the species level is essential for evaluations of the pollution sensitivity of many benthic organisms.

Given the ecology of the species present and the size and configuration of the two bodies of water, monitoring abundance of fish populations in the Site 8 pond and the control pond is not recommended. The fish communities are dominated by two species, *Gambusia affinis* and *Fundulus heteroclitus*, both of which are small, schooling species. As a result, fish sampling may produce several hundred fish in a very short time (if a large school is encountered) or no fish over a longer time period. Moreover, factors totally unrelated to NSWC operations, such as rainfall, may well determine electrofishing success. For these reasons it is suggested that fish be collected for mercury analyses only, and that additional effort go into collecting adequate numbers of fish from the three targeted groups (i.e., largemouth bass, brown bullhead, and *Gambusia*). If field teams are unable to capture several largemouth bass in the January 1993 and April 1993 sampling rounds, it may be necessary to replace this test species with bluegill, a species that is apparently more abundant than largemouth bass in the Site 8 pond.

The fish and invertebrate communities in the control site are markedly less diverse than the study site, containing only three groups of aquatic macroinvertebrates (i.e., amphipods, nematodes, and dipterans) and small numbers of fish. This probably stems from the fact that the Stump Neck Annex beaver pond is in transition from a stream ecosystem to a pond ecosystem, is in large measure a closed system, and has not been colonized by organisms from upstream and downstream to the degree that the study site has. If another site within the Indian Head complex has more diverse invertebrate and fish communities, it should be considered as the control site. However, if a more appropriate control

site is not available within the Indian Head complex, the Stump Neck Annex control site used in the preliminary round will be used and its limitations duly noted.

The first round of sampling suggests that at least one water quality parameter, salinity, may be omitted in future quarterly biomonitoring. Despite the fact that several sources (e.g., ABB-ES, 1992a) reported that the Site 8 tidal pond was oligohaline (approximately 1 ppt salinity), all indications are that this system is a tidally-influenced freshwater system. This was suggested by a definitive reference (Maryland DNR, 1981) and was confirmed by field measurements of salinity during the October 1992 biomonitoring. It is conceivable that under extraordinary circumstances (e.g., extreme drought coupled with extreme high tides, hurricanes) the Indian Head tidal pond might show low levels of salinity. In future sampling it should only be necessary to measure salinity at a representative location at each site before each day's sampling and to note these data in the field logs. Once confirmed, there should be no reason to measure salinity at every station.

Similarly, Total Organic Carbon (TOC) and hardness, measured at Transects 1, 2, 4, 7, and 10 as well as the control site during the October round of sampling, need not be as intensively investigated. TOC ranged from 3.0 mg/L to 4.0 mg/L at the four transects in the Site 8 pond and marsh. Hardness (as $CaCO_3$) ranged from 44 mg/L to 65 mg/L at these same four transects. There was very little variation in the samples, except for Transect 10, located upstream of the tidal pond, which had a higher TOC value (16.0 mg/L) than the four transects in the marsh and pond proper. It should be sufficient to take duplicate water samples for TOC and hardness from uplake and downlake locations in the tidal pond and from the control site. All of the measured values were unremarkable, indicative of soft water with low to intermediate TOC levels (Lind, 1979; Drever, 1982).

It is anticipated that the water level in the Site 8 tidal pond will still be low during the January 1993 biomonitoring. Despite the difficulty of working in very shallow water, an effort will be made to collect all the biological samples called for in the Biomonitoring Plan. Although the Biomonitoring Plan does not call for fish collecting in January, an effort will also be made to collect fish in the Site 8 pond and control site. It is hoped that normal water levels will be restored by April 1993 (the next sampling period), that the entire pond can be sampled effectively, and that a more complete and representative picture of the tidal pond ecosystem and its plant and animal communities will emerge.

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ATTACHMENT A

PERIPHYTON SAMPLING RESULTS

TABLE A-1

CONTROL SITE A
PERIPHYTON SAMPLING RESULTS
SITE 8 - NITROGLYCERIN PLANT OFFICE
INDIAN HEAD DIVISION, NAVAL SURFACE WARFARE CENTER
INDIAN HEAD, MARYLAND

Taxon	Density (No./cm^2)	Relative Abundance (%)	mg/m^2	Relative Weight (%)
BACILLARIOPHYTA				
Cocconeis	14		0.14	
Cymbella	14		0.21	
Eunotia	224		5.60	
Frustulia	28		0.84	
Gomphonema	56		0.86	
Navicula	56		0.56	
Nitzschia	98		0.78	
Pinnularia	42		4.20	
Synedra	56		0.44	
CHLOROPHYTA				
Chlorococcum	28		0.02	
Oocystis	28		4.70	
Ulothrix	140		5.60	
CHRYSOPHYTA				
Ophiocytium	70		0.84	
TOTALS				
TOTALS	**854**		**24.82**	
BACILLARIOPHYTA	**588**	**68.8**	**13.65**	**55.0**
CHLOROPHYTA	**196**	**23.0**	**10.33**	**41.6**
CHRYSOPHYTA	**70**	**8.2**	**0.84**	**3.4**

TABLE A-2

CONTROL SITE B
PERIPHYTON SAMPLING RESULTS
SITE 8 - NITROGLYCERIN PLANT OFFICE
INDIAN HEAD DIVISION, NAVAL SURFACE WARFARE CENTER
INDIAN HEAD, MARYLAND

Taxon	Density (No./cm^2)	Relative Abundance (%)	mg/m^2	Relative Weight (%)
BACILLARIOPHYTA				
Eunotia	180		2.16	
Frustulia	24		0.72	
Gomphonema	84		1.10	
Navicula	108		1.08	
Nitzschia	96		0.76	
Pinnularia	12		1.20	
Synedra	24		1.92	
CHLOROPHYTA				
Chlorococcum	180		0.18	
Oedogonium	168		1.68	
Oocystis	48		8.06	
Stigeoclonium	156		0.78	
Ulothrix	264		10.56	
CHRYSOPHYTA				
Ophiocytium	36		0.43	
TOTALS				
TOTALS	**1,380**		**30.64**	
BACILLARIOPHYTA	**528**	**38.3**	**8.95**	**29.2**
CHLOROPHYTA	**816**	**59.1**	**21.26**	**69.4**
CHRYSOPHYTA	**36**	**2.6**	**0.43**	**1.4**

TABLE A-3

CONTROL SITE C
PERIPHYTON SAMPLING RESULTS
SITE 8 - NITROGLYCERIN PLANT OFFICE
INDIAN HEAD DIVISION, NAVAL SURFACE WARFARE CENTER
INDIAN HEAD, MARYLAND

Taxon	Density (No./cm^2)	Relative Abundance (%)	mg/m^2	Relative Weight (%)
BACILLARIOPHYTA				
Eunotia	144		1.92	
Frustulia	16		0.48	
Gomphonema	64		0.64	
Navicula	48		0.48	
Nitzschia	240		2.35	
Pinnularia	48		4.80	
Synedra	16		0.12	
CHLOROPHYTA				
Chlorococcum	416		0.41	
Oedogonium	96		0.96	
Oocystis	16		2.68	
Ulothrix	176		7.04	
CHRYSOPHYTA				
Ophiocytium	32		0.38	
TOTALS				
TOTALS	**1,312**		**22.28**	
BACILLARIOPHYTA	**576**	**43.9**	**10.80**	**48.5**
CHLOROPHYTA	**704**	**53.7**	**11.10**	**49.8**
CHRYSOPHYTA	**32**	**2.4**	**0.38**	**1.7**

TABLE A-4

TRANSECT LOCATION 1W
PERIPHYTON SAMPLING RESULTS
SITE 8 - NITROGLYCERIN PLANT OFFICE
INDIAN HEAD DIVISION, NAVAL SURFACE WARFARE CENTER
INDIAN HEAD, MARYLAND

Taxon	Density (No./cm^2)	Relative Abundance (%)	mg/m^2	Relative Weight (%)
BACILLARIOPHYTA				
Cyclotella	20		0.08	
Eunotia	600		6.00	
Frustulia	20		0.60	
Gomphonema	160		1.60	
Navicula	200		2.00	
Nitzschia	580		4.64	
Synedra	60		4.80	
Other Diatoms	20		10.00	
CHLOROPHYTA				
Chlorococcum	360		0.36	
Cladophora	160		32.00	
Oedogonium	2,680		260.00	
CHRYSOPHYTA				
Ophiocytium	20		0.24	
TOTALS				
TOTALS	**4,880**		**322.32**	
BACILLARIOPHYTA	**1,660**	**34.0**	**29.72**	**9.2**
CHLOROPHYTA	**3,200**	**65.6**	**292.36**	**90.7**
CHRYSOPHYTA	**20**	**<1.0**	**0.24**	**<1.0**

TABLE A-5

TRANSECT LOCATION 1C
PERIPHYTON SAMPLING RESULTS
SITE 8 - NITROGLYCERIN PLANT OFFICE
INDIAN HEAD DIVISION, NAVAL SURFACE WARFARE CENTER
INDIAN HEAD, MARYLAND

Taxon	Density (No./cm^2)	Relative Abundance (%)	mg/m^2	Relative Weight (%)
BACILLARIOPHYTA				
Cocconeis	24		0.24	
Cyclotella	24		0.09	
Eunotia	456		4.56	
Frustulia	24		0.72	
Gomphonema	408		4.08	
Melosira	96		0.28	
Navicula	552		7.44	
Nitzschia	912		7.29	
Pinnularia	24		2.40	
Synedra	72		5.76	
Other Diatoms	48		24.00	
CHLOROPHYTA				
Cladophora	216		43.20	
Oedogonium	1,272		128.88	
Ulothrix	288		11.52	
CHRYSOPHYTA				
Ophiocytium	24		0.28	
TOTALS				
TOTALS	**4,440**		**240.76**	
BACILLARIOPHYTA	**2,640**	**59.5**	**56.88**	**23.6**
CHLOROPHYTA	**1,776**	**40.0**	**183.60**	**76.3**
CHRYSOPHYTA	**24**	**<1.0**	**0.28**	**<1.0**

TABLE A-6

TRANSECT LOCATION 1E
PERIPHYTON SAMPLING RESULTS
SITE 8 - NITROGLYCERIN PLANT OFFICE
INDIAN HEAD DIVISION, NAVAL SURFACE WARFARE CENTER
INDIAN HEAD, MARYLAND

Taxon	Density (No./cm^2)	Relative Abundance (%)	mg/m^2	Relative Weight (%)
BACILLARIOPHYTA				
Cocconeis	32		0.32	
Gomphonema	160		2.30	
Navicula	192		1.92	
Nitzschia	608		4.86	
Synedra	80		6.40	
Other Diatoms	16		8.00	
CHLOROPHYTA				
Cladophora	96		19.20	
Oedogonium	1,264		114.72	
CYANOPHYTA				
Chroococcus	32		0.12	
TOTALS				
TOTALS	**2,480**		**157.85**	
BACILLARIOPHYTA	**1,088**	**43.9**	**23.80**	**15.1**
CHLOROPHYTA	**1,360**	**54.8**	**133.92**	**84.8**
CYANOPHYTA	**32**	**<1.0**	**0.12**	**<1.0**

TABLE A-7

TRANSECT LOCATION 3W
PERIPHYTON SAMPLING RESULTS
SITE 8 - NITROGLYCERIN PLANT OFFICE
INDIAN HEAD DIVISION, NAVAL SURFACE WARFARE CENTER
INDIAN HEAD, MARYLAND

Taxon	Density (No./cm^2)	Relative Abundance (%)	mg/m^2	Relative Weight (%)
BACILLARIOPHYTA				
Cocconeis	320		3.20	
Cyclotella	320		1.28	
Cymbella	160		2.40	
Eunotia	1,920		19.20	
Frustulia	320		9.60	
Gomphonema	10,000		101.76	
Gyrosigma	160		11.20	
Melosira	880		6.00	
Navicula	8,880		104.80	
Nitzschia	14,880		149.28	
Pinnularia	960		96.00	
Synedra	960		76.80	
CHLOROPHYTA				
Closterium	40		40.00	
Oedogonium	15,680		1,221.60	
CHRYSOPHYTA				
Ophiocytium	720		8.64	
EUGLENOPHYTA				
Trachelomonas	160		8.48	
TOTALS				
TOTALS	**56,360**		**1,860.24**	
BACILLARIOPHYTA	**39,760**	**70.5**	**581.52**	**31.3**
CHLOROPHYTA	**15,720**	**27.9**	**1,261.60**	**67.8**
CHRYSOPHYTA	**720**	**1.3**	**8.64**	**<1.0**
EUGLENOPHYTA	**160**	**<1.0**	**8.48**	**<1.0**

TABLE A-8

TRANSECT LOCATION 3C
PERIPHYTON SAMPLING RESULTS
SITE 8 - NITROGLYCERIN PLANT OFFICE
INDIAN HEAD DIVISION, NAVAL SURFACE WARFARE CENTER
INDIAN HEAD, MARYLAND

Taxon	Density (No./cm^2)	Relative Abundance (%)	mg/m^2	Relative Weight (%)
BACILLARIOPHYTA				
Cyclotella	160		4.00	
Cymbella	80		1.20	
Eunotia	2,560		25.60	
Frustulia	320		9.60	
Gomphonema	9,760		101.12	
Melosira	160		3.84	
Navicula	10,080		107.20	
Nitzschia	16,960		161.80	
Pinnularia	960		96.00	
Surirella	160		6.40	
Synedra	960		76.80	
Other Diatoms	320		160.00	
CHLOROPHYTA				
Oedogonium	26,240		2,409.60	
Scenedesmus	320		4.80	
CHRYSOPHYTA				
Ophiocytium	160		1.92	
TOTALS				
TOTALS	**69,200**		**3,169.68**	
BACILLARIOPHYTA	**42,480**	**61.4**	**753.36**	**23.8**
CHLOROPHYTA	**26,560**	**38.4**	**2,414.40**	**76.1**
CHRYSOPHYTA	**160**	**<1.0**	**1.92**	**<1.0**

TABLE A-9

TRANSECT LOCATION 3E
PERIPHYTON SAMPLING RESULTS
SITE 8 - NITROGLYCERIN PLANT OFFICE
INDIAN HEAD DIVISION, NAVAL SURFACE WARFARE CENTER
INDIAN HEAD, MARYLAND

Taxon	Density (No./cm^2)	Relative Abundance (%)	mg/m^2	Relative Weight (%)
BACILLARIOPHYTA				
Cyclotella	120		3.00	
Cymbella	60		0.90	
Eunotia	2,280		22.80	
Frustulia	240		7.20	
Gomphonema	10,800		108.00	
Gyrosigma	60		4.20	
Melosira	120		2.88	
Navicula	12,840		128.40	
Nitzschia	15,240		144.60	
Pinnularia	960		96.00	
Synedra	480		38.40	
Other Diatoms	120		60.00	
CHLOROPHYTA				
Oedogonium	17,400		1,507.20	
CHRYSOPHYTA				
Ophiocytium	240		2.88	
CYANOPHYTA				
Chroococcus	360		1.44	
TOTALS				
TOTALS	**61,320**		**2,127.90**	
BACILLARIOPHYTA	**43,320**	**70.6**	**616.38**	**29.0**
CHLOROPHYTA	**17,400**	**28.4**	**1,507.20**	**70.8**
CHRYSOPHYTA	**240**	**<1.0**	**2.88**	**<1.0**
CYANOPHYTA	**360**	**<1.0**	**1.44**	**<1.0**

TABLE A-10

TRANSECT LOCATION 4W
PERIPHYTON SAMPLING RESULTS
SITE 8 - NITROGLYCERIN PLANT OFFICE
INDIAN HEAD DIVISION, NAVAL SURFACE WARFARE CENTER
INDIAN HEAD, MARYLAND

Taxon	Density (No./cm^2)	Relative Abundance (%)	mg/m^2	Relative Weight (%)
BACILLARIOPHYTA				
Cyclotella	60		3.00	
Eunotia	2,160		21.60	
Frustulia	120		3.60	
Gomphonema	8,880		88.80	
Melosira	120		2.88	
Navicula	13,320		138.00	
Nitzschia	11,760		100.56	
Pinnularia	240		24.00	
Surirella	60		2.40	
Synedra	840		67.20	
Other Diatoms	120		60.00	
CHLOROPHYTA				
Oedogonium	17,520		1,495.20	
Scenedesmus	480		0.48	
CHRYSOPHYTA				
Ophiocytium	120		0.36	
EUGLENOPHYTA				
Trachelomonas	120		6.36	
TOTALS				
TOTALS	**55,920**		**2,014.44**	
BACILLARIOPHYTA	**37,680**	**67.4**	**512.04**	**25.4**
CHLOROPHYTA	**18,000**	**32.2**	**1,495.68**	**74.2**
CHRYSOPHYTA	**120**	**<1.0**	**0.36**	**<1.0**
EUGLENOPHYTA	**120**	**<1.0**	**6.36**	**<1.0**

TABLE A-11

TRANSECTS LOCATION 4C
PERIPHYTON SAMPLING RESULTS
SITE 8 - NITROGLYCERIN PLANT OFFICE
INDIAN HEAD DIVISION, NAVAL SURFACE WARFARE CENTER
INDIAN HEAD, MARYLAND

Taxon	Density (No./cm^2)	Relative Abundance (%)	mg/m^2	Relative Weight (%)
BACILLARIOPHYTA				
Cymbella	60		0.90	
Eunotia	1,440		14.40	
Frustulia	120		3.60	
Gomphonema	6,120		61.20	
Melosira	60		1.44	
Navicula	9,600		124.80	
Nitzschia	12,120		116.40	
Pinnularia	360		96.00	
Synedra	480		38.40	
CHLOROPHYTA				
Closterium	60		60.00	
Oedogonium	21,000		1,464.00	
Oocystis	240		40.32	
TOTALS				
TOTALS	**51,660**		**2,021.46**	
BACILLARIOPHYTA	**30,360**	**58.8**	**457.14**	**22.6**
CHLOROPHYTA	**21,300**	**41.2**	**1,564.32**	**77.4**

TABLE A-12

TRANSECT LOCATION 4E
PERIPHYTON SAMPLING RESULTS
SITE 8 - NITROGLYCERIN PLANT OFFICE
INDIAN HEAD DIVISION, NAVAL SURFACE WARFARE CENTER
INDIAN HEAD, MARYLAND

Taxon	Density (No./cm^2)	Relative Abundance (%)	mg/m^2	Relative Weight (%)
BACILLARIOPHYTA				
Cyclotella	240		6.00	
Cymbella	240		3.60	
Eunotia	1,920		19.20	
Frustulia	120		3.60	
Gomphonema	5,280		52.80	
Melosira	120		2.88	
Navicula	5,160		61.20	
Nitzschia	16,440		160.68	
Pinnularia	360		36.00	
Synedra	960		76.80	
Other Diatoms	120		60.00	
CHLOROPHYTA				
Chlorococcum	1,080		1.08	
Closterium	60		60.00	
Oedogonium	9,960		812.40	
Oocystis	120		20.16	
CHRYSOPHYTA				
Ophiocytium	120		0.36	
CYANOPHYTA				
Chroococcus	720		2.88	
EUGLENOPHYTA				
Trachelomonas	60		0.60	
TOTALS				
TOTALS	**43,080**		**1,380.24**	
BACILLARIOPHYTA	**30,960**	**71.9**	**482.76**	**35.0**
CHLOROPHYTA	**11,220**	**26.0**	**893.64**	**64.7**
CHRYSOPHYTA	**120**	**<1.0**	**0.36**	**<1.0**
CYANOPHYTA	**720**	**1.7**	**2.88**	**<1.0**
EUGLENOPHYTA	**60**	**<1.0**	**0.60**	**<1.0**

APPENDIX B

CALCULATION SHEETS

RISK ASSESSMENT CALCULATIONS

HALLIBURTON NUS Environmental Corporation and Subsidiaries — **STANDARD CALCULATION SHEET**

CLIENT: NAVY CLEAN	FILE NO.:	BY: L. A. SINAGOGA	PAGE 1 OF 1
SUBJECT: Derivation of Action Level for Industrial Use/ Trespass Scenario		CHECKED BY: MS	DATE: 10/27/92

Objective: Calculate Action Level for Hg assuming occasional contact w/ sediments by Base personnel or individual trespassing across the site. the accidental ingestion and dermal contact routes of exposure are evaluated. RfD_o for Hg and Methyl Hg is 3×10^{-4}

Action Level for Accidental Ingestion:

$$C(mg/Kg) = \frac{RfD_o(mg/Kg/d) \times BW \times ED \times 365 days/yr}{IR \times EF \times ED \times 10^{-6} Kg/mg}$$

where:

BW = Body weight = 70Kg
ED = Duration = 30yrs
IR = Ingestion rate = 50mg/d
EF = Exposure frequency = 50days/yr

$$\text{Action Level}(mg/Kg) = \frac{3 \times 10^{-4}(mg/Kg/d) \times 70Kg \times 30yrs \times 365 days/yr}{50mg/day \times 50d/yr \times 30yrs \times 10^{-6} Kg/mg}$$

$$= \underline{3066 mg/Kg}$$ ✓

Action Level for Dermal Contact:

$$C(mg/Kg) = \frac{3 \times 10^{-4}(mg/Kg/d) \times BW \times ED \times 365 d/yr}{SCR \times EF \times ED \times ABS \times 10^{-6} Kg/mg}$$

where: BW, ED, EF – previously defined
SCR = Soil Contact rate = 500mg/d (Region I value)
ABS = Absorption Factor
Mercury – 1%
Methylmercury 77%
} Region I values.

$$\text{Action level (Hg)} = \frac{3 \times 10^{-4}(mg/Kg/d) \times 70Kg \times 30yrs \times 365 d/yr \times 0.15}{500mg/d \times 50d/yr \times 30yrs \times 10^{-6} Kg/mg \times 0.01}$$ ← RfD adjustment for gastro-intestinal absorption

$$= \underline{4599}$$ ✓

$$\text{Action Level (Methyl Hg)} = \frac{3 \times 10^{-4}(mg/Kg/d) \times 70Kg \times 30yrs \times 365 d/yr}{500mg/d \times 50d/yr \times 30yrs \times 10^{-6} \times 0.77}$$

$$= \underline{398 mg/Kg}$$ ✓

QUANTITY CALCULATIONS

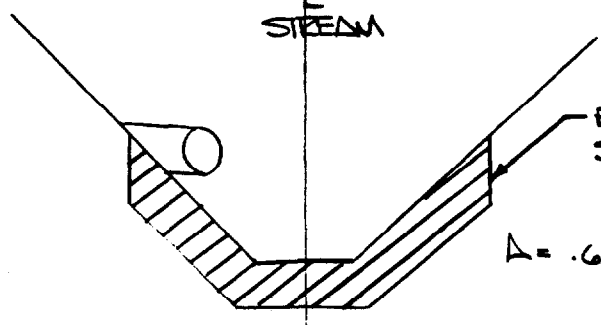
HALLIBURTON NUS Environmental Corporation and Subsidiaries — **STANDARD CALCULATION SHEET**

CLIENT: NAVY CLEAN	FILE NO.: 5508	BY: S. RUFFING	PAGE 1 OF 7
SUBJECT: EXCAVATION QTY'S / ASSUMPTIONS		CHECKED BY: T.J. Riley	DATE: 11/4/92

X-SECTIONS OF STREAM:

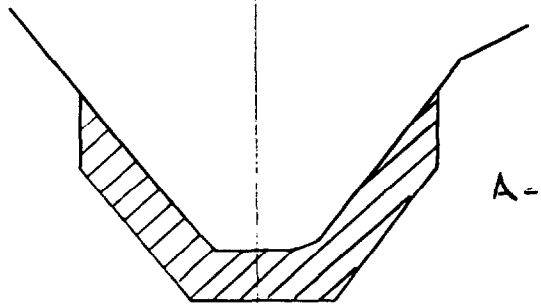
- USE AVERAGE END AREA METHOD TO CALCULATE VOLUME

1" : 8'



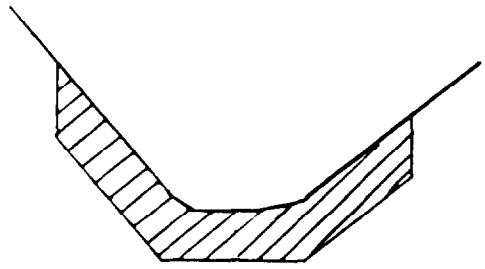
A = .60 in² x 64 = 38.4 SF

OUTLET OF 36" PIPE
(BEGINNING OF UPPER SECTION OF STREAM)



A = .70 in² x 64 = 44.8 SF

50' DOWNSTREAM

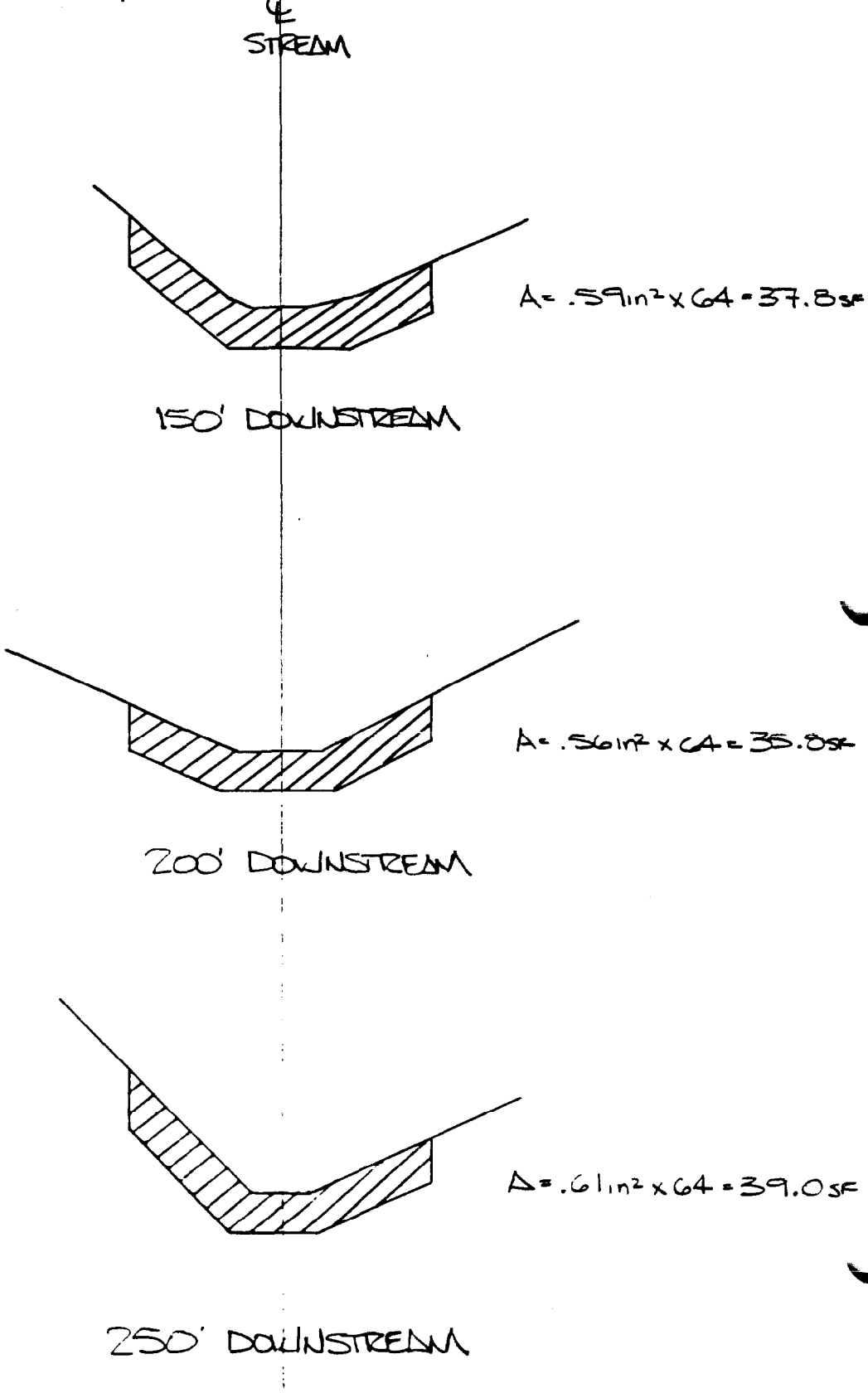


A = .62 in² x 64 = 39.7 SF

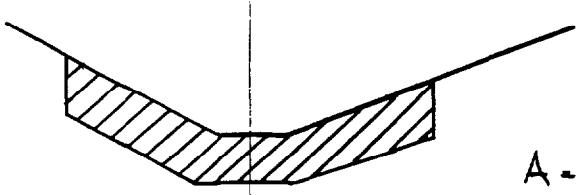
100' DOWNSTREAM

HALLIBURTON NUS Environmental Corporation and Subsidiaries	STANDARD CALCULATION SHEET

CLIENT: NAVY CLEAN	FILE NO.: 5508	BY: S. RUFFING	PAGE 2 OF 7
SUBJECT: EXCAVATION QTYS | ASSUMPTIONS		CHECKED BY: T.J. Riley	DATE: 11/4/92



HALLIBURTON NUS Environmental Corporation and Subsidiaries			STANDARD CALCULATION SHEET
CLIENT: NAVY CLEAN	FILE NO.: 5508	BY: S. RUFFING	PAGE 3 OF 7
SUBJECT: EXCAVATION QTYS / ASSUMPTIONS		CHECKED BY: T.J. Riley	DATE: 11/4/92



A = .56 in² x 64 = 35.8 SF

300' DOWNSTREAM
(END OF UPPER SECTION OF STREAM)

ASSUMPTIONS:

1. REMOVAL OF SEDIMENTS/SOILS WITH MERCURY CONCENTRATIONS EXCEEDING 10 mg/kg.
2. BASED ON MERCURY CONCENTRATIONS FOUND AT LATERAL X-SECTIONS A WIDTH OF EXCAVATION OF 15 FEET (7.5' NORTH AND 7.5' SOUTH OF STREAM CENTERLINE) WILL BE USED.
3. DEPTH OF EXCAVATION IS 2 FEET.
4. LENGTH OF EXCAVATION IS 300 FEET.
5. AFTER EXCAVATION
   - MATERIAL REMOVED SHALL BE STABILIZED WITH CEMENT AND PLACED IN AN AREA DESIGNATED BY THE NAVY.
   - AFTER EXCAVATION A LAYER OF GEOTEXTILE AND RIPRAP (2 FEET THICK) SHALL BE PLACED TO MINIMIZE EROSION.

HALLIBURTON NUS Environmental Corporation and Subsidiaries	STANDARD CALCULATION SHEET

CLIENT: NAVY CLEAN	FILE NO.: 5508	BY: S. RURSING	PAGE 4 OF 7
SUBJECT: EXCAVATION QTYS / ASSUMPTIONS		CHECKED BY: T.J. Riley	DATE: 11/4/92

USE AVG END METHOD TO CALCULATE VOLUME:

STATION	AREA	AVG AREA	DIST	CF	CY
① OUTLET OF PIPE	38.4 SF				
		41.6 SF	50 LF	2080 CF	77 CY
② 50' DOWNSTREAM	44.8 SF				
		42.25 SF	50 LF	2112.5 CF	78 CY
③ 100' DOWNSTREAM	39.7 SF				
		38.75 SF	50 LF	1937.5 CF	72 CY
④ 150' DOWNSTREAM	37.8 SF				
		36.8 SF	50 LF	1840.0 CF	68 CY
⑤ 200' DOWNSTREAM	35.8 SF				
		37.4 SF	50 LF	1870 CF	69 CY
⑥ 250' DOWNSTREAM	39.0 SF				
		37.4 SF	50 LF	1870 CF	69 CY
⑦ 300' DOWNSTREAM	35.8 SF				

TOTAL VOL: 11710 CF 433 CY

VOLUME OF EXCAVATION = 433 CY

HALLIBURTON NUS Environmental Corporation and Subsidiaries — **STANDARD CALCULATION SHEET**

CLIENT: NAVY CLEAN	FILE NO.: 5508	BY: S. RUFFING	PAGE 5 OF 7
SUBJECT: EXCAVATION QTYS / ASSUMPTIONS		CHECKED BY: T. J. Riley	DATE: 11/4/92

QTY OF RIPRAP & GEOTEXTILE FABRIC

SURFACE AREA TO COVER

STATION	LF @ X-SECTION	AVG LF	DIST	SF	SY
OUTLET OF 36" PIPE	19 LF				
		20 LF	50 LF	1000 SF	111 SY
50' DOWNSTREAM	21 LF				
		20.25 LF	50 LF	1012.5 SF	113 SY
100' DOWNSTREAM	19.5 LF				
		18 LF	50 LF	900 SF	100 SY
150' DOWNSTREAM	16.5 LF				
		16.25 LF	50 LF	812.5 SF	90 SY
200' DOWNSTREAM	16 LF				
		17.5 LF	50 LF	875 SF	97 SY
250' DOWNSTREAM	19 LF				
		17.75 LF	50 LF	887.5 SF	99 SY
300' DOWNSTREAM	16.5 LF				

TOTAL SURFACE AREA: 5487.5 SF 610 SY

VOLUME OF RIPRAP @ 2' THICK COVERING 610 SY = 407 CY

GEOTEXTILE FABRIC UNDER RIPRAP LAYER = 610 SY

HALLIBURTON NUS Environmental Corporation and Subsidiaries — **STANDARD CALCULATION SHEET**

CLIENT:	FILE NO.:	BY:	PAGE 6 OF 7
NAVY CLEAN	5508	S. RUFFING	
SUBJECT: EXCAVATION QTYS / ASSUMPTIONS		CHECKED BY: T.J. Riley	DATE: 11/4/92

QUANTITY OF CEMENT REQUIRED FOR STABILIZATION:

ASSUMPTIONS:

1. AVERAGE WATER CONTENT OF SEDIMENTS IS 30%.
2. WATER / CEMENT RATIO IS 1.25.

QTY OF SEDIMENTS IS 433 cy

QTY OF WATER IN SEDIMENTS = 433 x .30 = 129.9 cy

BASED ON WATER/CEMENT RATIO OF 1.25

THE QTY OF CEMENT = $129.9 \times \frac{1}{1.25} = 103.92$ cy

THEREFORE USE 104 cy OF CEMENT TO STABILIZE 433 cy OF SEDIMENT.

POUNDS OF CEMENT:

104 cy x 27 = 2808 cf

CEMENT DENSITY : 94 lb/cf

2808 cf x 94 = 263952 lb. OF CEMENT

HALLIBURTON NUS Environmental Corporation and Subsidiaries

STANDARD CALCULATION SHEET

CLIENT: NAVY GLEAN	FILE NO.: 5508	BY: S. RUFFING	PAGE 7 OF 7
SUBJECT: EXCAVATION QTYS / ASSUMPTIONS		CHECKED BY: T.J. Riley	DATE: 11/4/92

QUANTITY OF STONE FOR ACCESS ROAD

4" THICK x 12' WIDE x 150' LONG
LAYER OF GRAVEL

.33 x 12 x 150 = 594 CF

594 CF / 27 = 22 CY

SURFACE AREA = 12 x 150 = 1800 SF
1800/9 = 200 SY @ 4" THICK

COST ESTIMATES

HALLIBURTON NUS Environmental Corporation and Subsidiaries

STANDARD CALCULATION SHEET

CLIENT:	FILE NO.:	BY:	PAGE 1 OF 1
NAVY CLEAN	5508	S. RUFFING	
SUBJECT: ALTERNATIVE 1		CHECKED BY: T. Jordy	DATE: 11/4/92

NO FURTHER ACTION:

THIS ALTERNATIVE INCLUDES NO ADDITIONAL WORK, THEREFORE, COST IS $0.00

NAVAL SURFACE WARFARE CENTER
Indian Head, Maryland
No Action
Alternate No. 2
Post Remedial Monitoring
(O&MNSWC2)

Annual Costs

ITEM	ITEM $ QUARTERLY BIOMONITORING	ITEM $ SEMI-ANNUAL BIOMONITORING	NOTES
1. Biomonitoring	112000.00		Biomonitoring Consisting of Sampling, Analysis and Reporting Years 1 and 2
2. Biomonitoring		56000.00	Biomonitoring Consisting of Sampling, Analysis and Reporting Years 3 thru 7
TOTAL ANNUAL COST	112000.00		Post Remedial monitoring will be performed quarterly for years 1 and 2
TOTAL ANNUAL COST		56000.00	Post Remedial monitoring will be performed quarterly for years 3 thru 7

NAVAL SURFACE WARFARE CENTER
Indian Head, Maryland
No Action
Alternate No. 2
(PWANSWC2)
428

PRESENT WORTH ANALYSIS

COST/YEAR COST OCCURS ($000'S)

COST COMPONENT	0	1	2	3	4	5	6	7	8	9	10	11
1. CAPITAL COST	0											
2. O & M COSTS		112										
3. ANNUAL COSTS	0	112	112	56	56	56	56	56	0	0	0	0
4. ANNUAL DISCOUNT RATE=5%	1	.952	.907	.864	.823	.784	.746	.711	.677	.645	.614	.585
PRESENT WORTH =	0	107	102	48	46	44	42	40	0	0	0	0

	12	13	14	15	16	17	18	19	20	21	22	23
O & M COSTS	0	0	0	0	0	0	0	0	0	0	0	0
ANNUAL DISCOUNT RATE=5%	.557	.53	.505	.481	.458	.436	.416	.396	.377	.359	.342	.326
PRESENT WORTH =	0	0	0	0	0	0	0	0	0	0	0	0

	24	25	26	27	28	29	30	TOTAL PRESENT WORTH (000'S)
O & M COSTS	0	0	0	0	0	0	0	
ANNUAL DISCOUNT RATE=5%	.31	.295	.281	.268	.255	.243	.231	
PRESENT WORTH =	0	0	0	0	0	0	0	428

NAVAL SURFACE WARFARE CENTER
Indian Head, Maryland
Riprap Stream
Alternate No. 3
Post Remedial Monitoring
(O&MNSWC3)

Annual Costs

ITEM	ITEM $ QUARTERLY BIOMONITORING	ITEM $ SEMI-ANNUAL BIOMONITORING	NOTES
1. Biomonitoring	112000.00		Biomonitoring Consisting of Sampling, Analysis and Reporting Years 1 and 2
2. Biomonitoring		56000.00	Biomonitoring Consisting of Sampling, Analysis and Reporting Years 3 and 4
TOTAL ANNUAL COST	112000.00		Post Remedial monitoring will be performed quarterly for years 1 and 2
TOTAL ANNUAL COST		56000.00	Post Remedial monitoring will be performed quarterly for years 3 and 4

NAVAL SURFACE WARFARE CENTER
Indian Head, Maryland
Riprap Stream
Alternate No. 3
(NSWC3)
1/20/93

Item	Qty	Unit	Unit Cost Sub.	Unit Cost Mat.	Unit Cost Labor	Unit Cost Equip.	Total Cost Sub.	Total Cost Mat.	Total Cost Labor	Total Cost Equip.	Total Direct Cost	Comments
MOBILIZATION/DEMOBILIZATION												
1) Office Trailer (1)	1	MO	500.00				500				500	
2) Equipment Mobilization		LS	10000.00				10000				10000	
3) Equipment Demobilization		LS	7500.00				7500				7500	
DECONTAMINATION FACILITIES												
1) Decontamination Services	1	MO	1000.00				1000				1000	
2) Decon Water	500	GAL	.20				100				100	
3) Personnel Decon Pad												
a) Concrete Pad - 4"	2	CY		70.00	125.00	5.00		140	250	10	400	
b) Curb	40	LF		3.07	1.99	.05		123	80	2	204	
4) Clean Water Storage Tank	1			1000.00	200.00			1000	200		1200	1000 Gallon
ACCESS ROAD												
1) Access Road	200	SY		6.00	.90	.90		1200	180	180	1560	
STREAM DIVERSION												
1) Stream Diversion	400	LF		1.00	2.00	3.00		400	800	1200	2400	
PIPE CLEANING												
1) Pipe Cleaning		LS		100.00	300.00	100.00		100	300	100	500	
STREAM REMEDIATION												
1) Regrade Stream		LS			600.00	1000.00			600	1000	1600	
2) Geotextile	610	SY		1.50	.50			915	305		1220	
3) Riprap	410	SY		11.00	6.00	8.00		4510	2460	3280	10250	
4) Site Restoration	150	SY		1.50	1.50	1.70		225	225	255	705	
							19100	8613	5400	6027	39139	
Burden @ 30% of Labor Cost									1620		1620	
Labor @ 15% of Labor Cost									810		810	
Material @ 10% of Material Cost								861			861	
SubContract @ 10% of Sub. Cost							1910				1910	
Total Direct Cost							21010	9474	7829	6027	44341	
Indirects @ 75% of Total Direct Labor Cost									5872		5872	
Profit @ 10% of Total Direct Cost											4434	
											54647	
Health & Safety Monitoring @ 20%											10929	
Total Field Cost											65576	
Contingency @ 20% of Total Field Cost											13115	
TOTAL CONSTRUCTION COST											78691	USE $80,000
Engineering Costs Consisting Of Permitting, Design Engineering, Health and Safety Plan, Sampling And Analysis, Report Preparation											175000	
											253691	

SAY 255,000

NAVAL SURFACE WARFARE CENTER
Indian Head, Maryland
Riprap Stream
Alternate No. 3
(PWANSWC3)
556

PRESENT WORTH ANALYSIS

COST/YEAR COST OCCURS ($000'S)

COST COMPONENT	0	1	2	3	4	5	6	7	8	9	10	11
1. CAPITAL COST	253.7											
2. O & M COSTS		112										
3. ANNUAL COSTS	253.7	112	112	56	56	0	0	0	0	0	0	0
4. ANNUAL DISCOUNT RATE=5%	1	.952	.907	.864	.823	.784	.746	.711	.677	.645	.614	.585
PRESENT WORTH =	254	107	102	48	46	0	0	0	0	0	0	0

	12	13	14	15	16	17	18	19	20	21	22	23
O & M COSTS	0	0	0	0	0	0	0	0	0	0	0	0
ANNUAL DISCOUNT RATE=5%	.557	.53	.505	.481	.458	.436	.416	.396	.377	.359	.342	.326
PRESENT WORTH =	0	0	0	0	0	0	0	0	0	0	0	0

	24	25	26	27	28	29	30	TOTAL PRESENT WORTH (000'S)
O & M COSTS	0	0	0	0	0	0	0	
ANNUAL DISCOUNT RATE=5%	.31	.295	.281	.268	.255	.243	.231	
PRESENT WORTH =	0	0	0	0	0	0	0	556

NAVAL SURFACE WARFARE CENTER
Indian Head, Maryland
Excavation And Stabilization
Alternate No. 4
Post Remedial Monitoring
(O&MNSWC4)

Annual Costs

ITEM	ITEM $ QUARTERLY BIOMONITORING	NOTES
1. Biomonitoring	112000.00	Biomonitoring Consisting of Sampling, Analysis and Reporting Years 1 and 2
TOTAL ANNUAL COST	112000.00	Post Remedial monitoring will be performed quarterly for years 1 and 2

NAVAL SURFACE WARFARE CENTER
Indian Head, Maryland
Excavation And Stabilization
Alternate No. 4
(PWANSWC4)
563

PRESENT WORTH ANALYSIS

COST/YEAR COST OCCURS ($000'S)

COST COMPONENT	0	1	2	3	4	5	6	7	8	9	10	11
1. CAPITAL COST	355.2											
2. O & M COSTS		112										
3. ANNUAL COSTS	355.2	112	112	0	0	0	0	0	0	0	0	0
4. ANNUAL DISCOUNT RATE=5%	1	.952	.907	.864	.823	.784	.746	.711	.677	.645	.614	.585
PRESENT WORTH =	355	107	102	0	0	0	0	0	0	0	0	0

	12	13	14	15	16	17	18	19	20	21	22	23
O & M COSTS	0	0	0	0	0	0	0	0	0	0	0	0
ANNUAL DISCOUNT RATE=5%	.557	.53	.505	.481	.458	.436	.416	.396	.377	.359	.342	.326
PRESENT WORTH =	0	0	0	0	0	0	0	0	0	0	0	0

	24	25	26	27	28	29	30	TOTAL PRESENT WORTH (000'S)
O & M COSTS	0	0	0	0	0	0	0	
ANNUAL DISCOUNT RATE=5%	.31	.295	.281	.268	.255	.243	.231	
PRESENT WORTH =	0	0	0	0	0	0	0	563

NAVAL SURFACE WARFARE CENTER
Indian Head, Maryland
Excavation And Stabilization
Alternate No. 4
(NSWC4)
1/20/93

Item	Qty	Unit	Unit Cost Sub.	Unit Cost Mat.	Unit Cost Labor	Unit Cost Equip.	Total Cost Sub.	Total Cost Mat.	Total Cost Labor	Total Cost Equip.	Total Direct Cost	Comments
MOBILIZATION/DEMOBILIZATION												
1) Office Trailer (1)	2	MO	500.00				1000				1000	
2) Equipment Mobilization		LS	12500.00				12500				12500	
3) Equipment Demobilization		LS	9000.00				9000				9000	
DECONTAMINATION FACILITIES												
1) Decontamination Services	2	MO	1000.00				2000				2000	
2) Decon Water	500	GAL	.20				100				100	
3) Personnel Decon Pad												
a) Concrete Pad - 4"	2	CY		70.00	125.00	5.00		140	250	10	400	
b) Curb	40	LF		3.07	1.99	.05		123	80	2	204	
4) Clean Water Storage Tank	1			1000.00	200.00			1000	200		1200	1000 Gallon
ACCESS ROAD												
1) Access Road	200	SY		6.00	.90	.90		1200	180	180	1560	
CLEARING												
1) Clear And Grub	.5	AC			920.00	1100.00			460	550	1010	
STREAM DIVERSION												
1) Stream Diversion	400	LF		1.00	2.00	3.00		400	800	1200	2400	
PIPE CLEANING												
1) Pipe Cleaning		LS		100.00	300.00	100.00		100	300	100	500	
STREAM REMEDIATION												
1) Excavation	433	CY			8.00	11.00			3464	4763	8227	
2) Stabilization	433	CY	60.00				25980				25980	
3) Hauling Stabilized Soil	433	CY			.59	1.46			255	632	888	
4) Geotextile	610	SY		1.50	.50			915	305		1220	
5) Riprap	410	SY		11.00	6.00	8.00		4510	2460	3280	10250	
6) Site Restoration	150	SY		1.50	1.50	1.70		225	225	255	705	
							50580	8613	8979	10972	79144	
Burden @ 30% of Labor Cost									2694		2694	
Labor @ 15% of Labor Cost									1347		1347	
Material @ 10% of Material Cost								861			861	
SubContract @ 10% of Sub. Cost							5058				5058	
Total Direct Cost							55638	9474	13020	10972	89104	
Indirects @ 75% of Total Direct Labor Cost									9765		9765	
Profit @ 10% of Total Direct Cost											8910	
											107779	
Health & Safety Monitoring @ 20%											21556	
Total Field Cost											129335	
Contingency @ 20% of Total Field Cost											25867	
TOTAL CONSTRUCTION COST											155202	SAY $155,000
Engineering Costs Consisting Of Permitting, Design Engineering, Health and Safety Plan, Sampling And Analysis, Report Preparation											200000	
											355202	USE $355,000

NAVAL SURFACE WARFARE CENTER
Indian Head, Maryland
Excavation And Offsite Disposal
Alternate No. 5
Post Remedial Monitoring
(O&MNSWC5)

Annual Costs

ITEM	ITEM $ QUARTERLY BIOMONITORING	NOTES
1. Biomonitoring	112000.00	Biomonitoring Consisting of Sampling, Analysis and Reporting Years 1 and 2
TOTAL ANNUAL COST	112000.00	Post Remedial monitoring will be performed quarterly for years 1 and 2

NAVAL SURFACE WARFARE CENTER
Indian Head, Maryland
Excavation And Offsite Disposal
Alternate No. 5
(NSWC5)
1/20/93

Item	Qty	Unit	Unit Cost Sub.	Unit Cost Mat.	Unit Cost Labor	Unit Cost Equip.	Total Cost Sub.	Total Cost Mat.	Total Cost Labor	Total Cost Equip.	Total Direct Cost	Comments
MOBILIZATION/DEMOBILIZATION												
1) Office Trailer (1)	2	MO	500.00				1000				1000	
2) Equipment Mobilization		LS	12500.00				12500				12500	
3) Equipment Demobilization		LS	9000.00				9000				9000	
DECONTAMINATION FACILITIES												
1) Decontamination Services	2	MO	1000.00				2000				2000	
2) Decon Water	500	GAL	.20				100				100	
3) Personnel Decon Pad												
a) Concrete Pad - 4"	2	CY		70.00	125.00	5.00		140	250	10	400	
b) Curb	40	LF		3.07	1.99	.05		123	80	2	204	
4) Clean Water Storage Tank	1			1000.00	200.00			1000	200		1200	1000 Gallon
ACCESS ROAD												
1) Access Road	200	SY		6.00	.90	.90		1200	180	180	1560	
STREAM DIVERSION												
1) Stream Diversion	400	LF		1.00	2.00	3.00		400	800	1200	2400	
PIPE CLEANING												
1) Pipe Cleaning		LS		100.00	300.00	100.00		100	300	100	500	
STREAM REMEDIATION												
1) Excavation	433	CY			8.00	11.00			3464	4763	8227	
2) Hauling And Disposal	433	CY	110.00				47630				47630	
3) Geotextile	610	SY		1.50	.50			915	305		1220	
4) Riprap	410	SY		11.00	6.00	8.00		4510	2460	3280	10250	
5) Site Restoration	150	SY		1.50	1.50	1.70		225	225	255	705	
							72230	8613	8264	9790	98896	
Burden @ 30% of Labor Cost									2479		2479	
Labor @ 15% of Labor Cost									1240		1240	
Material @ 10% of Material Cost								861			861	
SubContract @ 10% of Sub. Cost							7223				7223	
Total Direct Cost							79453	9474	11982	9790	110699	
Indirects @ 75% of Total Direct Labor Cost									8987		8987	
Profit @ 10% of Total Direct Cost											11070	
											130756	
Health & Safety Monitoring @ 20%											26151	
Total Field Cost											156907	
Contingency @ 20% of Total Field Cost											31381	
TOTAL CONSTRUCTION COST											188288	SAY $190,000
Engineering Costs Consisting Of Permitting, Design Engineering, Health and Safety Plan, Sampling And Analysis, Report Preparation											200000	
											388288	$390,000

NAVAL SURFACE WARFARE CENTER
Indian Head, Maryland
Excavation And Offsite Disposal
Alternate No. 5
(PWANSWC5)
597

PRESENT WORTH ANALYSIS

COST/YEAR COST OCCURS ($000'S)

COST COMPONENT	0	1	2	3	4	5	6	7	8	9	10	11
1. CAPITAL COST	388.3											
2. O & M COSTS		112										
3. ANNUAL COSTS	388.3	112	112	0	0	0	0	0	0	0	0	0
4. ANNUAL DISCOUNT RATE=5%	1	.952	.907	.864	.823	.784	.746	.711	.677	.645	.614	.585
PRESENT WORTH =	388	107	102	0	0	0	0	0	0	0	0	0

	12	13	14	15	16	17	18	19	20	21	22	23
O & M COSTS	0	0	0	0	0	0	0	0	0	0	0	0
ANNUAL DISCOUNT RATE=5%	.557	.53	.505	.481	.458	.436	.416	.396	.377	.359	.342	.326
PRESENT WORTH =	0	0	0	0	0	0	0	0	0	0	0	0

	24	25	26	27	28	29	30	TOTAL PRESENT WORTH (000'S)
O & M COSTS	0	0	0	0	0	0	0	
ANNUAL DISCOUNT RATE=5%	.31	.295	.281	.268	.255	.243	.231	
PRESENT WORTH =	0	0	0	0	0	0	0	597

APPENDIX C

EXHIBITS

Exhibit C-1	Site 8 - Nitroglycerin Plant Office - Site Plan
Exhibit C-2	Site 8 - Nitroglycerin Plant Office - Contaminant Occurrence and Distribution in Upper Section of Stream
Exhibit C-3	Site 8 - Nitroglycerin Plant Office - Sediment/Soil Sampling Locations and Areas of Elevated Mercury Concentrations

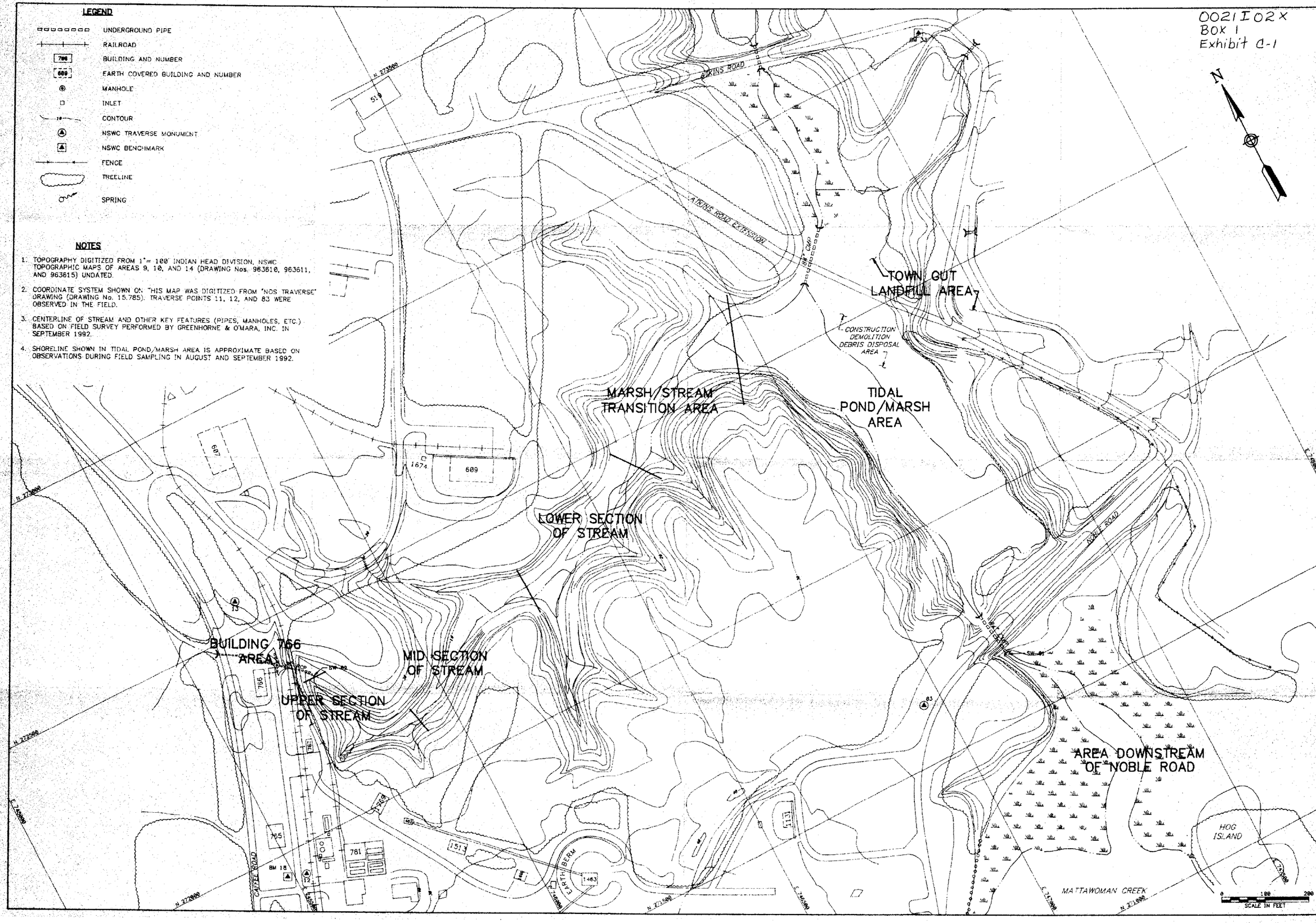
0021I02X
Box 1
Exhibit C-1

LEGEND

- UNDERGROUND PIPE
- RAILROAD
- BUILDING AND NUMBER
- EARTH COVERED BUILDING AND NUMBER
- MANHOLE
- INLET
- CONTOUR
- NSWC TRAVERSE MONUMENT
- NSWC BENCHMARK
- FENCE
- TREELINE
- SPRING

NOTES

1. TOPOGRAPHY DIGITIZED FROM 1"= 100' INDIAN HEAD DIVISION, NSWC TOPOGRAPHIC MAPS OF AREAS 9, 10, AND 14 (DRAWING Nos. 963610, 963611, AND 963615) UNDATED.
2. COORDINATE SYSTEM SHOWN ON THIS MAP WAS DIGITIZED FROM "NOS TRAVERSE" DRAWING (DRAWING No. 15.785). TRAVERSE POINTS 11, 12, AND 83 WERE OBSERVED IN THE FIELD.
3. CENTERLINE OF STREAM AND OTHER KEY FEATURES (PIPES, MANHOLES, ETC.) BASED ON FIELD SURVEY PERFORMED BY GREENHORNE & O'MARA, INC. IN SEPTEMBER 1992.
4. SHORELINE SHOWN IN TIDAL POND/MARSH AREA IS APPROXIMATE BASED ON OBSERVATIONS DURING FIELD SAMPLING IN AUGUST AND SEPTEMBER 1992.



REV.	DESCRIPTION	PREP BY	DATE	APPRVD

PREP BY DATE APPRVD

DESIGN: DR: CHK:
SUPV: CH. ENG.
SUBMITTED BY: (FIRM MEMBER) (TITLE) (DATE)
CHECKED BY: NO. NO. NO.
FOR: DATE: DATE:
OFFICER IN CHARGE
APPROVED

DEPARTMENT OF THE NAVY
WASHINGTON NAVY YARD
NAVAL FACILITIES ENGINEERING COMMAND
WASHINGTON, DC

CHESAPEAKE DIVISION

INDIAN HEAD DIVISION, NAVAL SURFACE WARFARE CENTER
SITE 8 – NITROGLYCERIN PLANT OFFICE
SITE PLAN

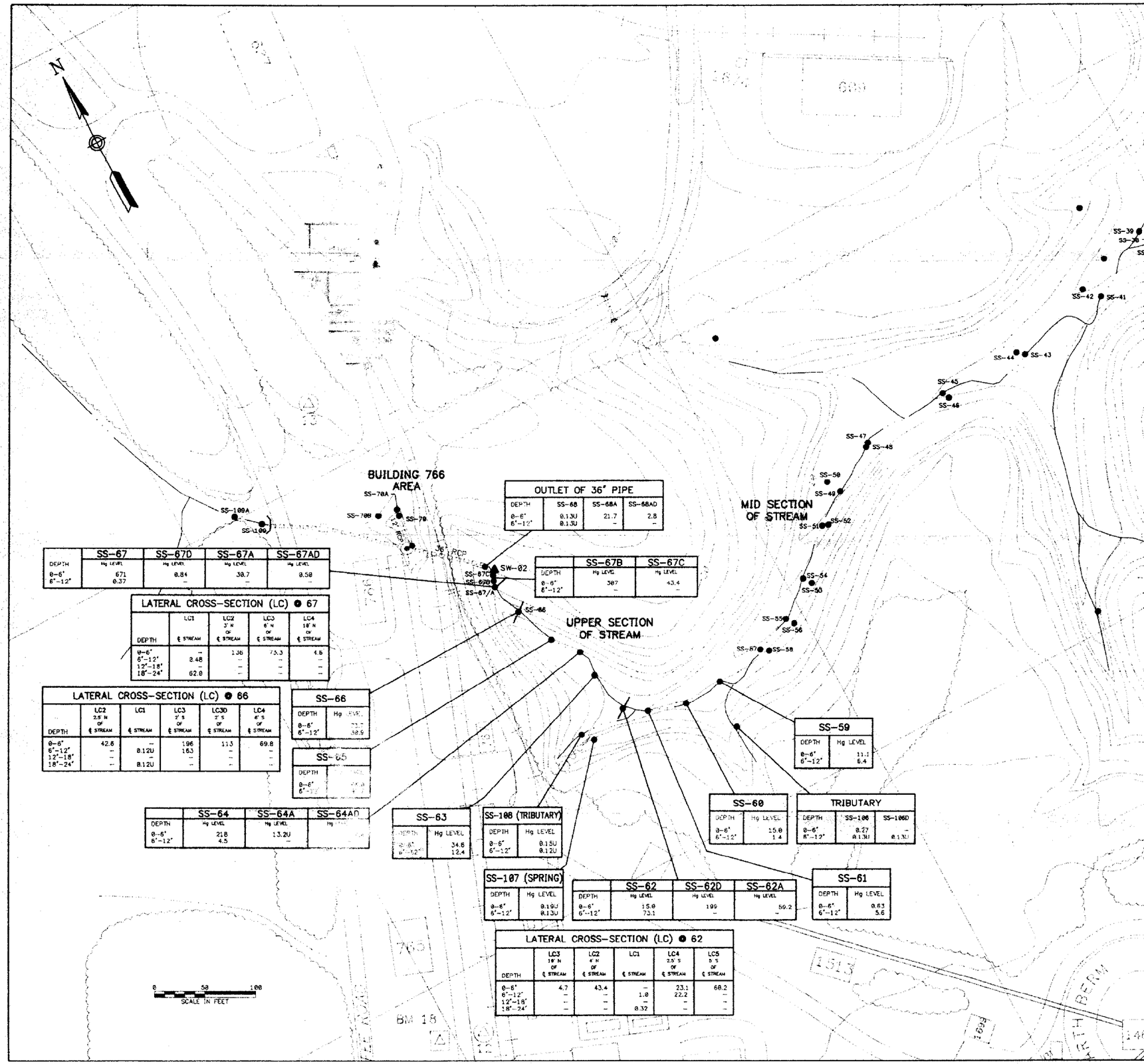
ISSUED: JANUARY 22, 1993

NORFOLK FOR COMMANDER, NAVFAC

SEAL AREA

SAT TO	DATE
CODE I.D. NO.	80001
SCALE :	AS SHOWN
SPEC. NO. 84 –	NA
CONSTRN. CONTR. NO.	NA
NAVFAC DRAWING NO.	NA
SHEET 1 OF 1	
SIZE: D	DIS. SH. NO. EXHIBIT C-1

0021I03X
Box 1
Exhibit C-2



OUTLET OF 36" PIPE			
DEPTH	SS-68	SS-68A	SS-68AD
0-6"	0.13U	21.7	2.8
6"-12"	0.13U	–	–

	SS-67	SS-67D	SS-67A	SS-67AD
DEPTH	Hg LEVEL	Hg LEVEL	Hg LEVEL	Hg LEVEL
0-6"	671	0.84	30.7	0.58
6"-12"	0.37	–	–	–

	SS-67B	SS-67C
DEPTH	Hg LEVEL	Hg LEVEL
0-6"	307	43.4
6"-12"	–	–

LATERAL CROSS-SECTION (LC) @ 67				
	LC1	LC2 3' N OF ℄ STREAM	LC3 6' N OF ℄ STREAM	LC4 18' N OF ℄ STREAM
DEPTH	℄ STREAM			
0-6"	–	1.36	75.3	4.6
6"-12"	0.48	–	–	–
12"-18"	–	–	–	–
18"-24"	62.0	–	–	–

LATERAL CROSS-SECTION (LC) @ 66					
	LC2 2.5' N OF ℄ STREAM	LC1 ℄ STREAM	LC3 2' S OF ℄ STREAM	LC3D 2' S OF ℄ STREAM	LC4 6' S OF ℄ STREAM
DEPTH					
0-6"	42.6	–	196	113	69.8
6"-12"	–	0.12U	163	–	–
12"-18"	–	–	–	–	–
18"-24"	–	0.12U	–	–	–

SS-66	
DEPTH	Hg LEVEL
0-6"	[illegible]
6"-12"	38.9

SS-65	
DEPTH	[illegible]
0-6"	[illegible]
6"-12"	[illegible]

	SS-64	SS-64A	SS-64AD
DEPTH	Hg LEVEL	Hg LEVEL	Hg LEVEL
0-6"	218	13.2U	[illegible]
6"-12"	4.5	–	[illegible]

SS-63	
DEPTH	Hg LEVEL
0-6"	34.6
6"-12"	12.4

SS-108 (TRIBUTARY)	
DEPTH	Hg LEVEL
0-6"	0.15U
6"-12"	0.12U

SS-107 (SPRING)	
DEPTH	Hg LEVEL
0-6"	0.19U
6"-12"	0.13U

	SS-62	SS-62D	SS-62A
DEPTH	Hg LEVEL	Hg LEVEL	Hg LEVEL
0-6"	15.0	199	59.2
6"-12"	73.1	–	–

LATERAL CROSS-SECTION (LC) @ 62					
	LC3 19' N OF ℄ STREAM	LC2 4' N OF ℄ STREAM	LC1 ℄ STREAM	LC4 2.5' S OF ℄ STREAM	LC5 5' S OF ℄ STREAM
DEPTH					
0-6"	4.7	43.4	–	23.1	68.2
6"-12"	–	–	1.0	22.2	–
12"-18"	–	–	–	–	–
18"-24"	–	–	0.32	–	–

SS-59	
DEPTH	Hg LEVEL
0-6"	11.1
6"-12"	6.4

SS-60	
DEPTH	Hg LEVEL
0-6"	15.0
6"-12"	1.4

TRIBUTARY		
DEPTH	SS-108	SS-108D
0-6"	0.27	–
6"-12"	0.13U	0.13U

SS-61	
DEPTH	Hg LEVEL
0-6"	0.63
6"-12"	5.6

LEGEND

- UNDERGROUND PIPE
- RAILROAD
- 766 BUILDING AND NUMBER
- 609 EARTH COVERED BUILDING AND NUMBER
- MANHOLE
- INLET
- CONTOUR
- NSWC TRAVERSE MONUMENT
- NSWC BENCHMARK
- FENCE
- TREELINE
- SEDIMENT/SOIL SAMPLING LOCATION
- SURFACE WATER SAMPLING LOCATION
- SPRING

NOTES

1. TOPOGRAPHY DIGITIZED FROM 1"= 100' INDIAN HEAD DIVISION, NSWC TOPOGRAPHIC MAPS OF AREAS 9, 10, AND 14 (DRAWING Nos. 963610, 963611, AND 96 3615) UPDATED.
2. COORDINATE SYSTEM SHOWN ON THIS MAP WAS DIGITIZED FROM "NOS TRAVERSE" DRAWING (DRAWING No. 15.785). TRAVERSE POINTS 11, 12, AND 83 WERE OBSERVED IN THE FIELD.
3. CENTERLINE OF STREAM AND OTHER KEY FEATURES (PIPES, MANHOLES, ETC.) BASED ON FIELD SURVEY PERFORMED BY GREENHORNE & O'MARA, INC. IN SEPTEMBER 1992.
4. FIVE BACKGROUND SEDIMENT/SOIL SAMPLES WERE COLLECTED AT SITE 8. THREE SAMPLES WERE COLLECTED UPSTREAM OF SITE 8 IN MATTAWOMAN CREEK. THE REMAINING TWO SAMPLES WERE COLLECTED FROM A STREAM CHANNEL LOCATED AT THE NORTHWESTERN CORNER OF THE BASE, APPROXIMATELY ONE MILE FROM SITE 8.
5. ALL MERCURY CONCENTRATIONS ARE SHOWN IN mg/kg. DUPLICATE SAMPLES ARE IDENTIFIED WITH A "D" SUFFIX.
6. DATA VALIDATION QUALIFIERS ARE AS FOLLOWS:

– NO SAMPLE TAKEN

U – VALUE IS NONDETECT AS REPORTED BY THE LABORATORY.

K(m) – POSITIVE RESULTS ARE ESTIMATED AND BIASED HIGH DUE TO HIGH MATRIX SPIKE RECOVERY.

J(m) – VALUE IS ESTIMATED DUE TO MATRIX SPIKE NONCOMPLIANCES. BIAS CANNOT BE DETERMINED.

UJ(m) – NONDETECT IS ESTIMATED DUE TO MATRIX SPIKE NONCOMPLIANCE. BIAS CANNOT BE DETERMINED.

UJ(d) – NONDETECTED IS ESTIMATED DUE TO LABORATORY DUPLICATE IMPRECISION. BIAS CANNOT BE DETERMINED.

J(d) – VALUE IS ESTIMATED DUE TO LABORATORY DUPLICATE IMPRECISION. BIAS CANNOT BE DETERMINED.

PREP BY DATE APPRVD

REV. DESCRIPTION

DEPARTMENT OF THE NAVY
WASHINGTON NAVY YARD
NAVAL FACILITIES ENGINEERING COMMAND
WASHINGTON, DC

CHESAPEAKE DIVISION

INDIAN HEAD DIVISION, NAVAL SURFACE WARFARE CENTER
SITE 8 – NITROGLYCERIN PLANT OFFICE CONTAMINANT OCCURRENCE AND DISTRIBUTION IN UPPER SECTION OF STREAM

ISSUED: JANUARY 22, 1993

NORTHDIV FOR COMMANDER, NAVFAC

SEAL AREA

SAT TO	DATE
CODE I.D. NO.	80091
SCALE :	AS SHOWN
SPEC. NO. 84 –	NA
CONSTRN. CONTR. NO.	NA
NAVFAC DRAWING NO.	NA
SHEET 1 OF 1	
SIZE: D	DTS. SH. NO. EXHIBIT C-2