FINAL REPORT

on

ANALYSIS OF BASELINE SEAWATER AND SEDIMENT SAMPLES FROM THE 106-MILE DEEPWATER MUNICIPAL SLUDGE SITE

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1.0 INTRODUCTION

The U.S. Environmental Protection Agency (EPA), under the Marine Protection, Research, and Sanctuaries Act of 1972 (MPRSA, PL 92-532), is responsible for regulating the disposal of sewage sludges in the oceans. Part of the strategy for regulating sludge disposal includes the preparation and implementation of an effective monitoring program for the 106-Mile Deepwater Municipal Sewage Sludge Site (106-Mile Site) (Battelle, 1987e). The 106-Mile Site is located approximately 120 nautical miles (nmi) southeast of Ambrose Light, New York, and beyond the edge of the continental shelf in water depths ranging from 2250 to 2750 m (Figure 1).

EPA has published ocean dumping regulations designed to protect the marine environment from unreasonable degradation resulting from ocean dumping activities. Site monitoring is a tool provided by the regulations for protecting the marine environment. The overall objective of the 106-Mile Site monitoring program is to ensure that the regulations are met by

- Assessing whether ocean dumping conditions for permits and requirements for site management are being met, and
- Assessing whether dumping of sludges adversely impacts resources or other aspects of the marine environment.

Data collected under the monitoring program will be used in making decisions about continued designation of the site, status of ocean dumping permits, and continuation or alteration of the monitoring program.

The 106-Mile Site monitoring program is being implemented according to a tiered approach (Zeller and Wastler, 1987). The conceptual basis of the approach is that data collected in each of a hierarchy of tiers are required as the foundation for the design and extent of monitoring activities in the next tier. Such an approach also ensures that only information needed for making decisions will be collected. The 106-Mile Site monitoring program includes four tiers:

Tier 1--Sludge Characteristics and Disposal Operations

Tier 2--Nearfield Fate and Short-Term Effects

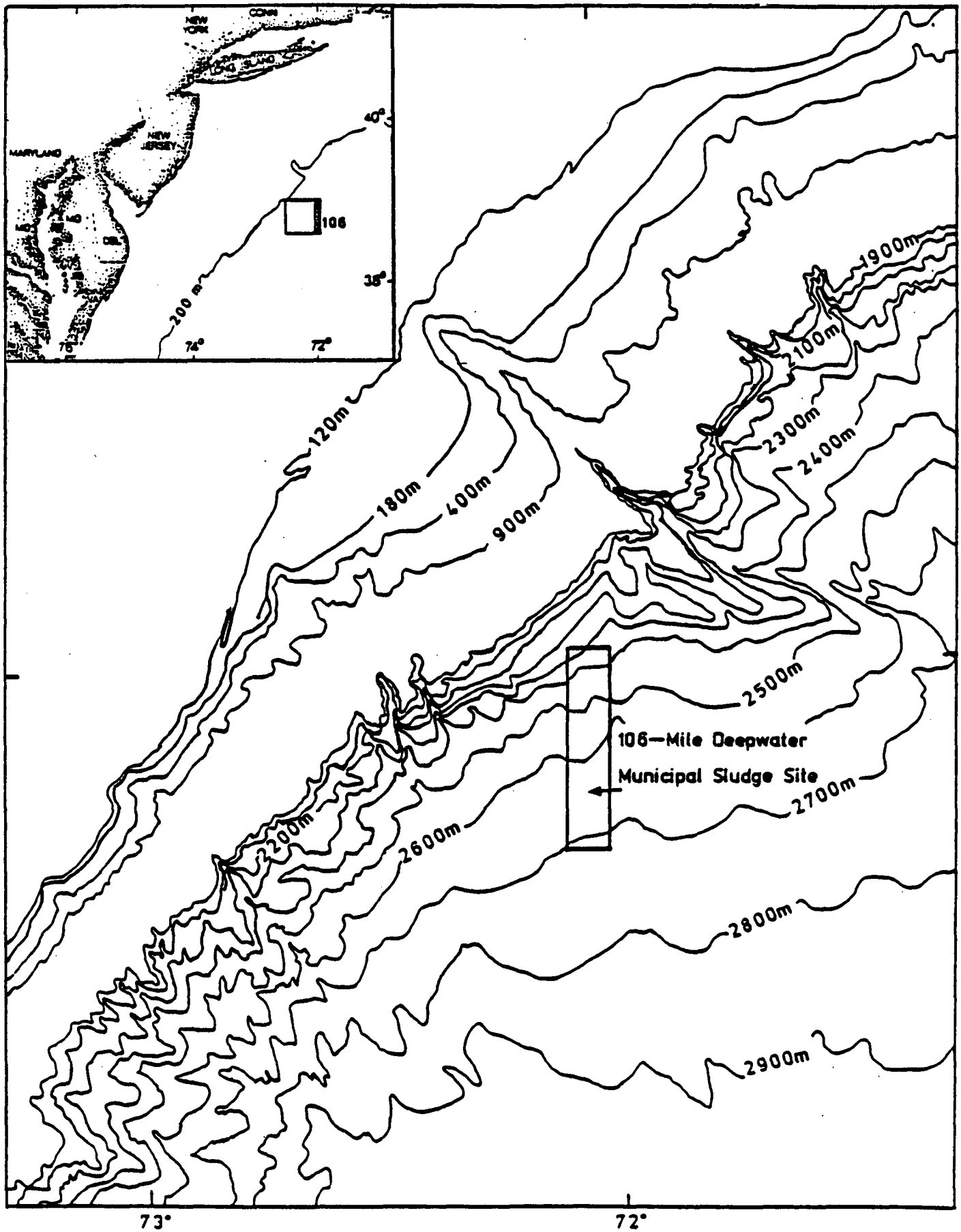

FIGURE 1. LOCATION OF THE 106-MILE SITE

Tier 3--Farfield Fate

Tier 4--Long-Term Effects

Using this approach, a series of parameters (Table 1) may be monitored in the water column or sediment in Tiers 2 and 4. Monitoring results will be compared to baseline conditions to determine whether ocean dumping of sludges is adversely impacting the marine environment.

Some of these parameters were measured for the environmental impact statement filed for the designation of the 106-Mile Site (EPA, 1980). However, environmental changes may have occurred and sampling and analytical methods have been improved since this earlier study. Therefore, additional baseline studies have been conducted by EPA.

As a first step toward obtaining additional baseline information, the environmental studies performed in the vicinity of the 106-Mile Site since site designation were reviewed. Five surveys during which baseline samples were collected and archived for analysis were identified. Those surveys were part of the following programs and studies:

- Studies funded by EPA: Baseline studies of the 106-Mile Site in 1984, 1985, and 1986.
- Studies funded by the Department of the Interior, Minerals Management Service (MMS): Study of Biological Processes on the U.S. Mid-Atlantic Slope and Rise.

A set of the archived samples was selected for analysis. Selection criteria were based on the proximity of the station to the 106-Mile Site, quality of the sample, methods of collection, and comparability to other samples collected at the 106-Mile Site.

This document presents the results of those analyses. In addition, it summarizes previously reported data from the five selected surveys at the 106-Mile Site. Section 2 describes the 106-Mile Site and the location of the sampling stations for each survey. Section 3 outlines the field and laboratory methods used to collect and analyze all survey samples. Section 4 describes the procedures followed to ensure the accuracy and precision of the data. The results of the quality assurance analyses are presented and discussed in Section 4. In Section 5, the analytical results are presented. The results are discussed and interpreted within the framework of the 106-Mile Site monitoring plan in Section 6.

TABLE 1. PARAMETERS ANALYZED IN BASELINE SAMPLES FOR THE 106-MILE SITE MONITORING PROGRAM

Water Samples

1. Trace metals: Ag, Cd, Cr, Cu, Fe, Hg, Pb, Zn

2. Priority pollutant PAH: acenaphthene, acenaphthylene, anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo-(g,h,i)perylene,benzo(k)fluoranthene,chrysene, dibenzo(a,h)anthracene, fluoranthene, fluorene, indeno(1,2,3-cd)pyrene, naphthalene, phenanthrene, pyrene

3. Priority pollutant organochlorine compounds: aldrin, β-BHC, -BHC, -BHC, chlordane, 4,4'-DDT, 4,4'-DDE, 4,4'-DDD, dieldrin, endosulfan I, endosulfan II, endosulfan sulfate, endrin, endrin aldehyde, heptachlor, heptachlor epoxide, toxaphene, PCB (total)

4. Other organics: phthalate, coprostanol

5. Clostridium perfringens

6. Water quality parameters: Total suspended solids, adenosine triphosphate, dissolved oxygen, pH, salinity, and temperature

Sediment Samples

1. Trace metals: Ag, Cd, Cr, Cu, Fe, Hg, Pb, Zn

2. Priority pollutant PAH: acenaphthene, acenaphthylene, anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo-(g,h,i)perylene, benzo(k)fluoranthene, chrysene, dibenzo(a,h)-anthracene, fluoranthene, fluorene, indeno(1,2,3-cd)pyrene, naphthalene, phenanthrene, pyrene

3. Priority pollutant organochlorine compounds: PCB isomers, aldrin, dieldrin, chlordane 4,4'-DDT, heptachlor, toxaphene

4. Other organics: phthalate, total organic carbon

5. Benthic infauna

6. Sediment grain size

7. Clostridium perfringens

2.0 STUDY AREA

2.1 SITE DESCRIPTION

The area designated by EPA for disposal of sewage sludge is located near the 2500-m isobath approximately 120 nmi southeast of Ambrose Light, New York, and 115 nmi east of Atlantic City, New Jersey. The site is approximately 100 square nmi in area and is bounded by latitudes 38°40'N to 39°00'N and longitudes 72°00'W to 72°05'W (Figure 1).

The 106-Mile Site is a designated U.S. deepwater dumpsite for the ocean disposal of sewage sludge. EPA designated this site because of a demonstrated need for ocean disposal of sludge, and because the site meets all specified requirements of the MPRSA of 1972 for site designation. The site is not located in an area of significant commercial or recreational fish or shellfish harvesting. The currents in the vicinity of the site, the deep permanent pycnocline, and the great distance of the site from shore assure that impacts associated with ocean dumping will be minimal.

2.2 STATION LOCATIONS

The locations of all of the stations occupied during the five surveys are given in Table 2. Water and sediment samples were collected on the OSV Anderson August 1984 Survey (Figure 2). The three surveys in 1985 (Figure 3, OSV Anderson August 1985, RV Oceanus August 1985, and RV Gyre November 1985) focused on the collection of sediment samples. However, water was also collected for microbial analysis at two stations on the OSV Anderson August 1985 Survey. The OSV Anderson February 1986 Survey collected sediment samples at Station A1 (Figure 4). All of the stations on this survey were sampled for surface (10-m) water. Samples from below the thermocline were collected at Stations A5 and A6.

TABLE 2. LOCATION OF STATIONS OCCUPIED

Ship/Survey Date	Station ID	Position Latitude/Longitude
RV Oceanus August 2 to 12, 1985		
	A	38°40'N 71°59'W
	B	38°20'N 72°14'W
	C	38°00'N 72°29'W
RV Gyre November 9 to 19, 1985		
	6	39°05'N 72°03'W
	12	38°29'N 72°42'W
	F	38°51'N 72°16'W
	G	38°55'N 72°02'W
OSV Anderson August 1984		
	1	38°19'N 73°29'W
	2	38°40'N 73°00'W
	3	38°50'N 72°22'W
	4	39°00'N 72°29'W
	5	38°39'N 72°40'W
	6	38°24'N 72°54'W
	10	39°13'N 71°48'W
	11	38°59'N 71°59'W
	12	39°15'N 72°29'W
	13	39°14'N 72°45'W
	14	39°30'N 72°50'W
	15	39°50'N 73°05'W
	16	38°10'N 73°51'W
	17	38°28'N 73°14'W
OSV Anderson August 18 to 30, 1985		
	D2	38°22'N 74°15'W
	D3	38°23'N 73°52'W
	D7	38°57'N 72°18'W
	D10	39°35'N 72°43'W
	D11	39°15'N 72°29'W
	D12	39°14'N 72°45'W
	D14	38°59'N 72°57'W
OSV Anderson February 5 to 24, 1986		
	A1	39°15'N 72°54'W
	A2	38°58'N 72°28'W
	A3	39°01'N 71°39'W
	A4	38°30'N 71°48'W
	A5	38°36'N 72°34'W
	A6	38°46'N 72°05'W

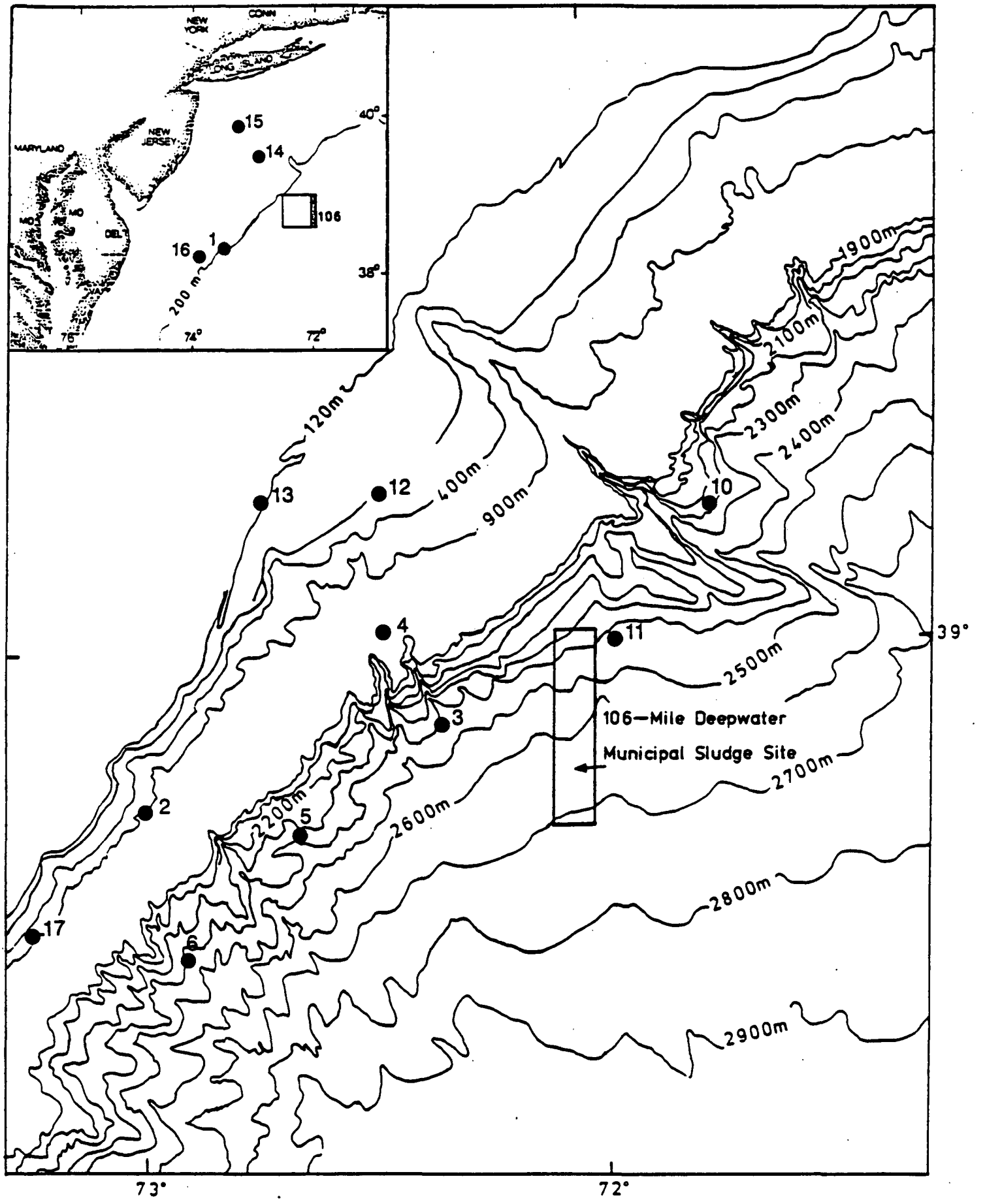

FIGURE 2. STATION LOCATIONS FOR THE 1984 SURVEY AT THE 106-MILE SITE

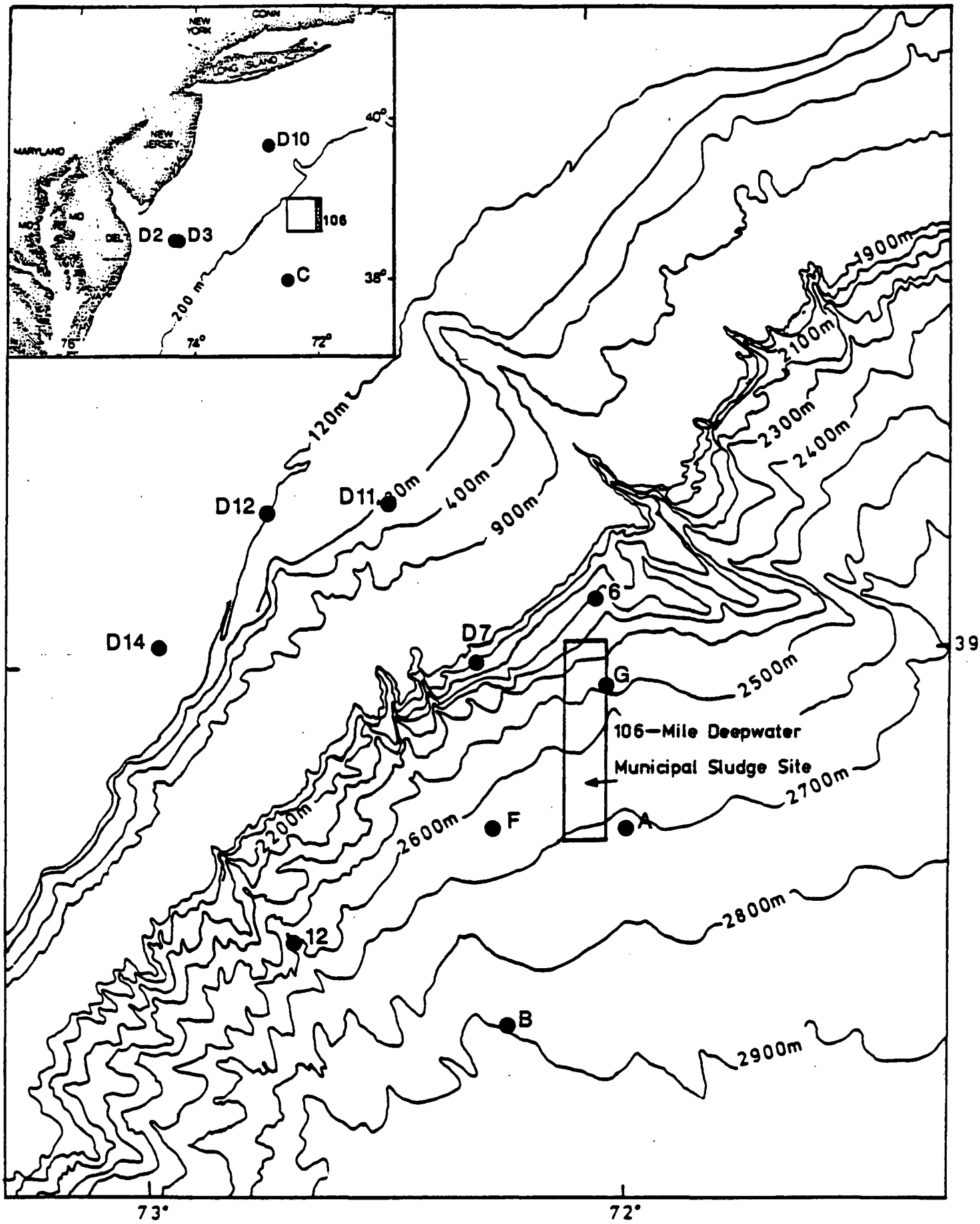

FIGURE 3. STATION LOCATIONS FOR THE 1985 SURVEYS AT THE 106-MILE SITE

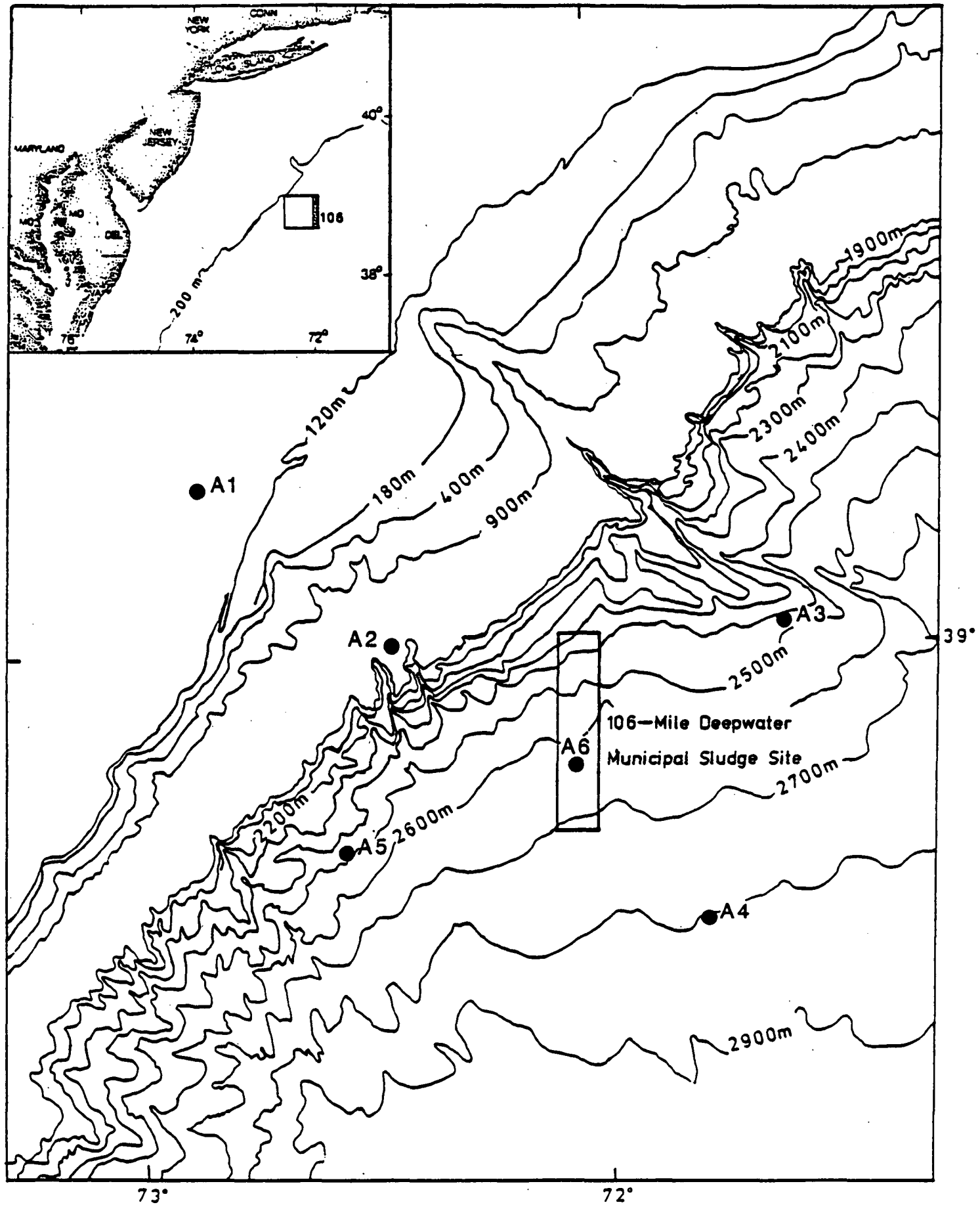

FIGURE 4. STATION LOCATIONS FOR THE 1986 SURVEY AT THE 106-MILE SITE

3.0 METHODS

The analyses of baseline samples included metals and organic compound determinations on seawater filtrate, seawater particulate, and sediment samples. Seawater particulate samples were also analyzed for adenosine triphosphate (ATP) and total suspended solids (TSS). Sediment samples were analyzed for infauna, sediment grain-size distribution, and Clostridium perfringens spore content. Laboratory analyses were completed according to standard methods for the 106-Mile Site monitoring program (Battelle, 1987b). Details of methods for sample collection and water quality analyses can be found in a survey report (JRB, 1985) and a field Quality Assurance (QA) Plan (Battelle, 1987c). Similar methods were used during all surveys.

3.1 SAMPLE COLLECTION

3.1.1 Water

3.1.1.1 WATER QUALITY AND TRACE METALS

Seawater samples for trace metal analysis were collected in an acid-cleaned, Teflon-lined, 30-L GO-FLO sample bottle. The hydrowire was made of non-contaminating Kevlar. A second unlined GO-FLO bottle was used to collect water for analysis of the water quality parameters and microbiology. For surface (10-m) samples, each bottle was lowered separately. For each replicate of subthermocline samples, the water quality bottle was attached to the hydrowire 10 m above the trace metal bottle.

3.1.1.2 ORGANIC COMPOUNDS

Surface water for trace organic analysis was pumped to the ship through 1-in. O.D. stainless steel tubing which was clamped to the ship's trawl cable. Using a stainless steel centrifugal pump, water was pumped through an in-line glass fiber filter and into a 1000-L extraction vessel.

Subthermocline samples were collected by repeated lowerings of 90-L Kel-F-lined sampling bottles (Bodman bottle). Upon retrieval, water from each bottle was pumped through the in-line filter to the 1000-L extraction vessel.

3.1.2 Sediments

Sediment samples were collected using two sampling devices. Samples were collected aboard the OSV Anderson with a 0.1-m^2 Smith-MacIntyre grab. Sediment sampling aboard the RV Oceanus and RV Gyre (MMS surveys) was performed with a Mark III box corer. On all surveys, only the top 2 cm of sediment was collected for chemical, microbiological, or grain-size analysis. On the MMS surveys, additional subsamples were taken for infaunal analysis.

3.2 SHIPBOARD ANALYSIS OF WATER QUALITY PARAMETERS

The procedures summarized below for the analysis of water samples for water quality parameters were performed on board the OSV Anderson during the 1986 survey.

3.2.1 Salinity

Salinity determinations were made on board the OSV Anderson with the Beckman Model RS-7L induction salinometer. Standard seawater (Copenhagen water) was used to calibrate the instrument at the start of the survey and was also used as a control sample with each set of samples analyzed.

3.2.2 Dissolved Oxygen

Dissolved oxygen (DO) in seawater was measured on board the OSV Anderson with the YSI Model 57 dissolved oxygen meter. DO seawater samples were taken from the GO-FLO sample bottles before other samples. Analysis was conducted within 15 min of sample collection. Oxygen-saturated, deionized water and seawater were used as controls.

3.2.3 pH

Seawater pH was determined with the Beckman Model 4500 pH meter. Instrument performance was checked and the pH meter calibrated at the start of the survey and before each set of samples.

3.2.4 Turbidity

The seawater turbidity was determined with the Hach Model 2100 turbidometer. The instrument was calibrated before each set of samples using a commercial turbidity standard.

3.2.5 Chlorophyll a and Phaeophytin

Seawater was analyzed for chlorophyll *a* and phaeophytin following standard procedures using a Turner Model 1000 fluorometer. Water samples were filtered through a glass fiber filter, and the cells collected on the filters disintegrated by freezing the filters in acetone. After thawing, the resulting slurry was centrifuged, and the supernatant decanted into a clean culture tube for analysis. By obtaining fluorescence measurements before and after adding acid to each sample extract, both chlorophyll *a* and phaeophytin were determined. Analytical standards were prepared from a commercial chlorophyll *a* stock solution.

3.2.6 Clostridium perfringens

Enumerations of *C. perfringens* in seawater were performed after the method of Cabelli and Pedersen (1982). *C. perfringens* spores were collected by filtering aliquots of seawater (0.1, 1.0, and 10 L) through 0.4-μm polycarbonate filters. Spores in the 10-L aliquots were cultured in reinforced *C. perfringens* medium. After incubation, portions from the bottles showing a positive response were filtered. These filters along with filters collected from the 0.1-L and 1.0-L aliquots were then cultured anaerobically

on modified C. perfringens (m-CP) medium. Confirmation was performed by exposing the incubated plates to ammonium hydroxide vapors, causing C. perfringens colonies to turn to a magenta color. The bacteria were quantified using the Thomas equation (APHA, 1985) to calculate a most probable number value (MPN).

Additional sewage indicator microorganisms (enterococci, coliforms, and antiobiotic-resistant bacteria) were quantified on the 1984 and 1985 OSV Anderson surveys. The collection procedures for those organisms were the same as for C. perfringens. The culturing procedures are described in JRB (1985).

3.3 LABORATORY ANALYSIS OF SEAWATER SAMPLES

3.3.1 Trace Metals Procedures

3.3.1.1 DISSOLVED TRACE METALS PROCEDURES

Silver. Silver was analyzed by the direct injection of the unfiltered seawater sample into a graphite furnace atomic absorption spectrometer (GFAAS). The standard additions method was used to quantify the silver in each sample. This method compares the reading obtained from a sample with no addition, to readings obtained when known amounts of silver are added to the sample.

Cadmium, Copper, Iron, Lead, and Zinc. Both unfiltered and filtered seawater samples were extracted at pH 4 using a 1 percent solution of purified ammonium-1-pyrrolidine dithiocarbamate diethylammonium diethyldithiocarbamate (APDC-DDDC) and 20 mL of freon. The metals were back-extracted into hot nitric acid. Next, the nitric acid solutions were analyzed directly for cadmium, copper, iron, lead, and zinc by GFAAS.

Chromium. The procedure for determining chromium in seawater is a modification of the methods described by Cranston and Murray (1977). Chromium (Cr) was coprecipitated with 0.01 N $Fe(OH)_2$ in aliquots of seawater at pH 8. The precipitate was filtered, then digested with 6 N hydrochloric acid. After dilution with deionized water, the acid digests were analyzed for Cr by GFAAS.

Mercury. Seawater mercury was determined after the method of Fitzgerald and Gill (1979). Mercury (Hg) in seawater samples was reduced with stannous chloride, the water sample purged with nitrogen and the resulting elemental Hg concentrated on a gold-coated quartz trap. The Hg was then desorbed from the trap into a stream of nitrogen and analyzed with a Laboratory Data Control UV Mercury monitor.

3.3.1.2 PARTICULATE TRACE METALS PROCEDURES

Suspended particulate matter samples for trace metals analysis were collected on the OSV Anderson August 1984 Survey. The samples were collected by pressure-filtering seawater through preweighed 0.4-µm polycarbonate membrane filters. The filters were air-dried in the laboratory and then weighed. The membranes were placed in Teflon bombs with concentrated hydrochloric, nitric, and hydrofluoric acids. After digestion at 90°C for 3 h, the samples were diluted with deionized water. The samples were analyzed for silver, iron, lead, and zinc by AAS.

3.3.2 Analysis of Organic Compounds

3.3.2.1 PREPARATION OF SAMPLES

Filtrate Extracts. Seawater samples for trace organic analysis were extracted on board the OSV Anderson in a 1000-L extraction vessel. A 950-L sample was saturated with 8 L of dichloromethane (DCM), whereupon the water was extracted with three successive 4-L aliquots of DCM. After settling, the

DCM layer was removed and the extraction procedure repeated two additional times. Upon receipt in the laboratory, the DCM extracts were combined and concentrated using Kuderna-Danish evaporative techniques. The concentrated extracts were processed through silica-alumina column chromatography and separate fractions were collected containing PAH/pesticide/PCB and coprostanol.

Filters. Filters were extracted in the laboratory with DCM. The filter extracts were concentrated using Kuderna-Danish apparatus. The concentrated extracts were then processed through silica-alumina column chromatography to remove interfering substances and to separate fractions for PAH/pesticide/PCB and coprostanol analyses.

3.3.2.2 ANALYSIS OF SAMPLES

Coprostanol. The polar fraction from the column chromatography procedure was analyzed for coprostanol using gas chromatography. A calibration curve was determined by analyzing standards over a range of concentrations. During analysis, the routine calibration was performed every eight hours.

Pesticides and PCBs. A subsample of the non-polar fraction from the column chromatography procedure was analyzed for pesticides and PCB by capillary WCOT gas chromatography using electron capture detection (GC-ECD). Quantification was performed by adding an internal standard (dibromooctafluorobiphenyl) to each sample. Response factors for each compound relative to the internal standard were determined before the start of analysis.

PAH and Phthalate. A subsample of the non-polar fraction was analyzed for polynuclear aromatic hydrocarbons (PAH) and Bis(2-ethylhexyl)phthalate (BEHP) by capillary WCOT gas chromatography/mass spectroscopy (GC/MS). Compounds were identified by comparing retention times and mass spectra of unknown compounds to those of the known standard compounds. The internal standard, d_{12}-chrysene, was added to each sample before analysis. A calibration curve was established by analyzing calibration

standards of selected known compounds and calculating reponse factors for each compound relative to the internal standard. Concentrations of PAH and BEHP were then determined by the internal standard method of quantification.

3.3.3 Analysis of Total Suspended Solids

Total suspended solids (TSS) samples were collected on board the OSV Anderson by filtering 4 L of seawater through pre-tared 0.45-µm membrane filters. After collection, the filters were stored at -20°C until analysis. In the laboratory, the filters were air-dried for 24 h, weighed on a Mettler analytical balance, and the amount of TSS collected determined by difference.

3.3.4 Analysis of Adenosine Triphosphate

Adenosine triphosphate (ATP) samples were collected on board the OSV Anderson by filtering 4 L of seawater through glass fiber filters. The filters were then extracted with acetone and the extracts frozen until analysis. After thawing, luciferin was added to the extracts and the ATP quantified by liquid scintillation counting of the light emission from the ATP-enzyme complex.

3.4 LABORATORY ANALYSIS OF SEDIMENT SAMPLES

Sediment samples were archived at -20°C until preparation and analysis. The archived sediments were thawed and split into subsamples for the following analytical procedures.

3.4.1 Trace Metals

The sediment subsamples were freeze-dried prior to an aqua-regia digestion for trace metal analysis. After digestion, the samples were weight-diluted with 1 N nitric acid and centrifuged. The supernatant was then

analyzed by Flame AAS for Cu, Fe, Pb, and Zn; GFAAS for Cd, Cr, and Ag; and cold vapor AAS for Hg. Samples were quantified against a calibration curve constructed using known amounts of standards. The calibration was checked against an independent standard every 10 samples.

3.4.2 Organic Compounds and Priority Pollutants

The extraction and analysis of sediment samples for selected organic compounds and priority pollutants were performed according to 301(h) guidelines (Tetra Tech, 1986). A 50-g subsample of the wet sediment was placed in a Soxhlet extractor and extracted with a 2:1 methylene chloride:methanol mixture. Elemental sulfur was removed from the sample extracts by reaction with metallic mercury. Biological macromolecules were removed by gel permeation chromatography (GPC) cleanup. The majority (80 percent) of the extract was further cleaned up by C_{18} reverse-phase chromatography, then concentrated for GC/MS analysis, whereas 20 percent of the extract was further processed through alumina column chromatography before analysis by GC-ECD. PCB and pesticides were detected and quantified by GC-ECD. PAH and base/neutral priority pollutants were quantified by GC/MS. Quantification was by the internal standard method for both GC-ECD and GC/MS analyses.

3.4.3 Total Organic Carbon

Total organic carbon (TOC) was determined using wet combustion methods and a TOC analyzer.

3.4.4 Grain-Size Distribution

Sediment grain-size analysis was performed using the sieve-pipet method. Samples were first washed through a 62-μm sieve to separate the sand and gravel from the silt-clay fraction. The coarse fractions were oven-dried, weighed, and then passed through a 2-mm sieve to collect the gravel fraction. The sand fraction was treated with hydrogen peroxide to remove organic matter,

washed, dried, and weighed. A pipet analysis was performed on the silt-clay fraction.

3.4.5 Benthic Infauna

Each sediment sample, covering a surface area of 0.09 m^2, was sieved on a 0.3-mm screen and then stained with Rose Bengal dye to make the organisms more visible for sorting and identification. The sample was examined under a dissecting microscope and each organism removed from the sediment residue. Organisms were sorted to major taxonomic group. After sorting, the organisms were identified to the lowest possible taxonomic level and quantified. Colonial forms for which the number of individuals could not be determined were identified; these taxa were included in the total number of species reported from each sample, but by definition were not included in the total infaunal densities reported. Pelagic forms that were captured by the box core were also listed, but were not included in the numbers of benthic individuals or species. Undescribed species were recorded in a manner consistent with that used by Battelle in the "Study of Biological Processes on the U.S. Mid-Atlantic Slope and Rise," performed for the Minerals Management Service (MMS) (Maciolek et al., 1986).

3.4.6 Clostridium perfringens

C. perfringens spores were separated from sediment samples by an extraction with sterile deionized water. The aqueous and sediment phases were then separated by centrifugation. The spores in the aqueous phase were then collected on a 0.45-µm membrane filter. After incubation of the filters on modified C. perfringens medium (mCP), presumptively positive C. perfringens colonies were counted and submitted to a series of biochemical tests for confirmation.

3.5 ENDANGERED SPECIES

Because of concern for the possible impact of ocean dumping activities on endangered or threatened species of marine mammals and turtles, the presence of these species in the area were investigated. Observations were made by a qualified observer on the 1985 and 1986 OSV Anderson surveys and on the 1985 RV Gyre Survey. These observations were recorded along predetermined survey paths in 15-min periods, where each period represented a transect.

The collected data were recorded into two major categories--location/environmental and species/behavior. Each category was recorded for each 15-min observation period and both categories were identified by a unique survey and observation number. Location/environmental data included latitude-longitude, start time, elapsed time, vessel speed and course, water depth and temperature, barometric pressure trend, visibility, and wind direction and speed. Species/behavior data included species group (mammal, turtle), species identification, numbers seen, age, distance and angle to sightings, heading, animal association, debris association, and behavior.

4.0 QUALITY CONTROL

4.1 DATA QUALITY REQUIREMENTS AND OBJECTIVES

The data requirements for chemical analyses and other targeted water and sediment parameters are summarized in Table 3. Accuracy and precision of the chemical measurement techniques were determined by the analysis of spiked blank samples or, when possible, the analysis of standard reference materials (SRM). The efficiency of the analytical techniques, expressed as percent recovery, was determined by adding surrogate compounds to samples prior to extraction and comparing the amount added to the amount determined after sample workup. Field blanks were collected and processed to document possible bias resulting from sample collection or storage. Analysis of method blanks ensured that analytical results could be corrected for compounds contributed by the reagents and chemicals used in the analytical procedures.

The accuracy and precision of some measurements (TSS, C. perfringens, benthic infauna, grain size, and water quality parameters) could not be estimated using SRM or spiked samples. The accuracy of infauna sorting procedures and taxonomy was confirmed by an independent check of 10 percent of the samples. The data were audited to confirm absolute number of organisms and proper taxonomic identification.

4.2 QUALITY CONTROL RESULTS

4.2.1 Water

4.2.1.1 WATER QUALITY

Total Suspended Solids (TSS). The results of the analysis of five blank filters and the reweighing of selected filters are given in Tables 4 and 5. The CV from all duplicates was less than 22 percent. The blank values were above the recommended detection limit of 0.01 mg/L, but still well below the amounts found in the samples. Thus, TSS values obtained during the survey truly reflect levels at the site.

TABLE 3. OBJECTIVES FOR ANALYTICAL MEASUREMENTS OF WATER AND SEDIMENT SAMPLES.

Parameter	Units	Detection Limit	Accuracy[a] Percent	Precision[b] Percent	Method
Seawater Filtrate or Particulate, Organic Compounds					
Aromatic hydrocarbons, phthalate	ng/L	1	50	100	Solvent extraction, GC/MS
PCB isomers, pesticides	ng/L	0.1-5	50	100	Solvent extraction, GC-ECD
Coprostanol	ng/L	1	50	100	Solvent extraction, GC-FID
Seawater Metals					
Ag, Cd, Zn	µg/L	.015	50	30	Chelation-extraction, GFAA
Cr, Pb, Cu	µg/L	.030	50	30	Chelation-extraction, GFAA
Fe	µg/L	.050	50	30	Chelation-extraction, GFAA
Hg	ng/L	0.5	100	50	Gold trap, AAS
Seawater TSS	mg/L	.01	30	30	Filtration, gravimetric determination
Seawater ATP	ng/L	10	30	30	Filtration, extraction, LSC
Sediment Metals					
Fe	mg/g	0.005	50	30	Acid digestion, FAA or ICP
Ag, Cd, Zn	µg/g	.005	50	30	Acid digestion, GFAA
Cu, Pb, Cr	µg/g	.02	50	30	Acid digestion, GFAA
Hg	µg/g	.02	50	30	Acid digestion, cold vapor
Sediment Organic Compounds					
Aromatic hydrocarbons phthalate	µg/g	.01	20	100	Soxhlet extraction, GC/MS
PCB isomers, pesticides	µg/g	.001-.005	50	100	Soxhlet extraction, GC-ECD
Coprostanol	µg/g	.01	20	100	Soxhlet extraction, GC-FID
Sediment TOC	mg/g	.01	50	30	TOC analyzer
Sediment Grain Size	phi	-	-	-	Sieve-pipet
Sediment Infauna	Individual/ sample	1	100	-	Sorting, taxonomic analysis
C. perfringens	Spores/g	NA	50	30	Filtration, direct enumeration

[a]Accuracy defined as percent difference between amount of analyte added and the amount determined by the method.

[b]Precision expressed as percent CV, where percent CV = $\frac{\sigma}{\bar{x}}$. σ is Standard deviation, and $\bar{x}$ is the mean of replicate measurements.

TABLE 4. ANALYSIS OF PROCEDURAL BLANKS FOR TSS AND ATP[a]

Sample Number	TSS (mg/L)	ATP (ng/L)
1	0.1	0.03
2	0.05	0.05
3	0.1	0.1
4	0.05 u	0.01
5	0.08	0.02

[a]OSV Anderson February 1986 Survey.
u = Sample Detection Limit (assumed volume: 3 L for TSS, 4 L for ATP).

TABLE 5. DETERMINATION OF PRECISION FROM DUPLICATE WEIGHINGS OF TSS FILTERS[a]

Station	Replicate	TSS Concentrations (mg/L) Measurement 1	Measurement 2	$\bar{x}$	CV
A2	2	1.0	1.0	1.0	0
A2	3	0.25	0.33	0.29	14
A4	1	1.1	1.1	1.1	0
A5	1	1.1	1.1	1.1	1.8
A5	3	0.34	0.46	0.40	15
A6	3	0.20	0.31	0.26	22
A6 T	3	0.85	0.87	0.86	1.4
A6 T	1	0.52	0.55	0.53	3.5

[a]OSV Anderson February 1986 Survey.
T = Subthermocline.

Adenosine Triphosphate (ATP). The results of the analysis of procedural blanks and the duplicate analysis of individual samples are presented in Tables 4 and 6. The highest blank value of 0.11 ng/L was well below the recommended detection limit of 10.0 ng/L (0.010 µg/L), indicating that the procedure did not contribute to ATP levels found in the field. The procedure was highly precise. The CV of replicate analysis never exceeded 2.6 percent.

4.2.1.2 TRACE METALS

The results of the analysis of duplicate aliquots of seawater samples is given in Tables 7. The reproducibility of the duplicates is very good, well within the precision limits given in Table 3. Seawater samples were spiked with Ag, Cd, Cr, Cu, Fe, Hg, Pb, and Zn and analyzed to evaluate matrix effects. The results are presented in Table 8. The recovery of the matrix spike solutions varies from 82 to 115 percent, depending on the metal. All recoveries are higher than the required 50 percent accuracy.

The chelation-extraction technique yielded poor Ag recoveriesTherefore, Ag was analyzed by direct injection of seawater into the GFAAS. The direct injection technique does not involve a concentration step resulting in a higher detection limit than given in Table 3. For all of the elements analyzed, oceanic detection levels were not achieved.

4.2.1.3 ORGANIC COMPOUNDS

The accuracy of the laboratory preparation procedures for trace organic analysis was determined by two methods. The recovery of PAH, PCB, and pesticide compounds and androstanol was determined by the addition of surrogate compounds to blank solvents which were prepared along with the filtrate and particulate extracts. These recoveries are given in Table 9. With the exception of dibromooctofluorobiphenyl and naphthalene, the recoveries were better than the 50 percent given as a requirement (Table 3). Naphthalene generally had lower recoveries because of its high volatility.

TABLE 6. DETERMINATION OF PRECISION FROM DUPLICATE ANALYSIS OF SELECTED ATP SAMPLE EXTRACTS[a]

Station[b]	Replicate	$\bar{x}$ nMol/L	CV
A1	1	43	0.81
A2	1	21	1.1
A3	1	45	0.28
A4	1	126	2.6
A5	1	62	2.2
A5 T	1	1.3	0.55
A5 T	3	4.6	0.88
A6	1	1.8	1.4
A6T	1	1.8	1.4

[a]OSV Anderson February 1986 Survey.
[b]Unless indicated, water samples were collected at the surface (10 m).
T = Subsurface water collected at 365 m.

TABLE 7. DETERMINATION OF PRECISION FROM DUPLICATE ANALYSIS OF SEAWATER FOR TRACE METALS[a]

Aliquot	Silver (µg/L)	Cadmium[b] (ng/L)	Chromium (µg/L)	Copper (µg/L)	Iron (µg/L)	Mercury (ng/L)	Lead (µg/L)	Zinc (µg/L)
1	0.61 u	6.3 u	0.20	0.73	12	2.1	0.042 u	0.76
2	0.61 u	6.3 u	0.23	0.72	13	2.0	0.042 u	0.72
Mean	-	-	0.22	0.72	12	2.0	-	0.74
CV	-	-	6.8	0.7	4.2	2.5	-	2.7

[a]Station A1, Replicate 3, OSV Anderson Survey, February 1986.
[b]The Station A2, Replicate 1 sample was used for the cadmium duplicate analysis because of insufficient quantity of the Station 1, Replicate 3 sample.
u = Sample Detection Limit.

TABLE 8. DETERMINATION OF ACCURACY FROM TRACE METAL MATRIX SPIKE RECOVERIES IN SEAWATER[a]

Sample	Silver	Cadmium[b]	Chromium	Copper	Iron	Mercury	Lead	Zinc
Amount ided (µg)	20	0.45	2.5	1.4	16	6.1	0.67	4.0
Percent Recovered Aliquot 1	110	82	92	100	98	100	100	110
Percent Recovered Aliquot 2	110	87	88	110	98	98	110	110

[a]OSV Anderson February 1986 Survey, Station A1, Replicate 3.

[b]The Station A2, Replicate 1 sample was used for the cadmium matrix spike analysis because of the insufficient quantity of the Station 1, Replicate 3 sample.

TABLE 9. DETERMINATION OF ACCURACY FROM RECOVERIES OF SURROGATE ORGANIC COMPOUNDS IN SEAWATER FILTRATE AND PARTICULATE EXTRACTS[a]

Surrogate Analytes	Station/Replicate											
	A1	A2	A3	A4	A5	A5T	A6/1	A6/2	A6/3	A6T	$\bar{x}^b$	CV[b]
	Filtrates											
Dibromooctafluorobiphenyl	20	29	41	40	40	101	0.0	39	29	34	41	54
Naphthalene-d_8	78	22	26	26	0.0	16	3.5	11	0.0	5.9	20	110
Phenanthrene-d_{10}	87	33	42	7.5	54	33	3.1	53	24	16	39	58
Anthracene-d_{10}	100	42	62	75	57	52	14	66	29	24	56	39
Benz(a)anthracene-d_{12}	89	120	52	30	58	61	8.7	52	51	21	59	48
Androstanol	16	36	3.5	220	100	38	320	98	140	42	77	85
	Particulates											
Dibromooctafluorobiphenyl	49	65	49	74	81	23	43	86	63	54	59	31
Naphthalene-d_8	26	33	21	29	52	79	57	44	44	66	45	39
Anthracene-d_{10}	97	100	98	98	98	99	100	101	100	95	99	1.7
Benz(a)anthracene-d_{12}	73	85	100	100	96	140	130	120	120	130	110	19
Androstanol	120	26	200	58	22	NA	35	NA	27	200	86	84

[a]OSV Anderson Survey, February 1986.
[b]The filtrate sample from Station A6, Replicate 1, is not included in the calculations.
T = Thermocline Sample.
NA = Not Analyzed.

The wide range of surrogate recoveries reflected the difficulty of performing the analysis near the method detection limits. The wide range of androstanol recoveries reflected the difficulty of the trace sterol analysis. The recoveries of phenanthrene and dibromooctofluorobiphenyl were low for the filtrate samples, possibly due to the increased handling required by the large volume of solvent in each extract. Handling problems during sample preparation likely caused the poor surrogate recoveries for the Station A6, Replicate 1, filtrate sample. Recovery of individual PAH and pesticide contaminants in these samples is assumed to be similar to those of the surrogate materials.

The accuracy of analytical method was also determined by the analysis of blanks and blank spikes. The recoveries of PAH and pesticides were greater than the required 50 percent (Tables 10 and 11) with the exception of naphthalene. Procedural blanks revealed no contamination that might bias results. The detection limits for the procedures are equal to or better than the 0.1 to 5 ng/L objectives presented in Table 3.

The accuracy of the at-sea filtrate extraction procedure method was also to be determined through the use of field surrogates. However, the amounts of surrogate compounds added to the seawater filtrate in the field were at or below method detection limits for all analytes. Therefore, the accuracy of the field extraction technique could not be determined.

An estimation of field variability of seawater trace organic analysis was to be addressed by the analysis of triplicate samples. However, because most of the target compounds were below detection limits, this determination of variability yielded little information. Only α-BHC in seawater filtrate ($\bar{x}$=26 pg/L, CV=33 percent) was found in all three field replicate samples.

4.2.2 Sediment

4.2.2.1 GRAIN SIZE

The results of the duplicate analysis of one replicate sediment are given in Table 12. There were no analytical objectives of accuracy or

TABLE 10. DETERMINATION OF ACCURACY FROM BLANK SPIKE RECOVERIES AND PROCEDURAL BLANK ANALYSIS OF POLYNUCLEAR AROMATIC HYDROCARBONS IN SEAWATER FILTRATE AND PARTICULATE EXTRACTS[a]

Compound	Amount Added (µg)	Percent Recovered			Procedural Blank (ng/L)
		Particulates	Filtrates Aliquot 1	Filtrates Aliquot 2	
Naphthalene	2	45	56	47	1 u
C_1-Naphthalene	4	50	60	54	2 u
C_2-Naphthalene	4	54	62	58	1 u
Biphenyl	2	52	60	57	1 u
Fluorene	2	56	61	62	1 u
Phenanthrene	2	64	72	72	1 u
Anthracene	2	52	60	64	2 u
C_1-Anthracene	2	65	74	80	2 u
Dibenzothiophene	2	53	46	29	2 u
Fluoranthene	2	66	78	80	1 u
Pyrene	2	64	76	76	1 u
Benz(a)anthracene	2	66	83	82	1 u
Chrysene	2	68	86	83	0.5 u
Benzo(a)pyrene	2	62	93	72	2 u
Perylene	2	59	93	73	1 u

[a]OSV Anderson February 1986 Survey.
u = Sample Detection Limit assuming a sample volume of 950L.

TABLE 11. DETERMINATION OF ACCURACY FROM BLANK SPIKE RECOVERIES AND PROCEDURAL BLANK ANALYSIS OF PESTICIDES AND PCBs IN SEAWATER FILTRATE EXTRACTS[a]

Analyte	Amount Added (µg)	Percent Recovered	Procedural Blank (pg/L)	
α-BHC	200	66	2	u
β-BHC	200	80	2	u
-BHC	200	72	3	u
-BHC	200	108	3	u
Heptachlor	200	68	2	u
Heptachlorepoxide	200	84	2	u
Aldrin	200	52	2	u
Dieldrin	200	93	2	u
Endrin	200	80	7	u
Endrin aldehyde	200	58	5	u
α-Endosulfan	200	96	2	u
β-Endosulfan	200	67	2	u
Endosulfan sulfate	200	78	5	u
4,4'-DDE	200	89	3	u
4,4'-DDD	200	111	4	u
4,4'-DDT	200	116	2	u
Methoxychlor	NA	NA	4	u
Mirex	NA	NA	3	u
Chlordane	NA	NA	530	u
Toxaphene	NA	NA	1000	u
PCB				
1242	NA	NA	200	u
1254	NA	NA	200	u
1260	NA	NA	200	u

[a]OSV Anderson February 1986 Survey.
u = Sample Detection Limit assuming sample volume of 950 L.
NA = Not Analyzed.

TABLE 12. DETERMINATION OF PRECISION FROM DUPLICATE SEDIMENT GRAIN-SIZE ANALYSES[a]

	Replicate Aliquot 1 (Percent Wt)	Replicate Aliquot 2 (Percent Wt)	Mean	CV (Percent)
Gravel	0.0	0.0	-	-
Sand	5.7	5.8	5.8	0.9
Silt	45	45	45	0
Clay	49	50	50	1.0

[a]RV Gyre November 1985 Survey, Station G, Replicate 1.

precision given for this procedure. However, the duplicate results were within 5 percent, which is considered optimal for this analysis.

4.2.2.2 TRACE METALS

The results of the analysis of quality assurance samples for sediment metals are given in Tables 13 to 16. The precision of the method as determined by quadruplicate analysis of one sample exceeded the analytical objectives (Table 13). The procedural blank concentrations were below the detection limits (Table 14).

The matrix spike recoveries (Table 15) and the analysis of standard reference materials (Table 16) were within the analytical objectives with the exception of Cd. The high recovery of Cd may be due to either a matrix mismatch or contamination of the samples. However, Cd was nondetectable in all three blank samples, indicating that contamination is not likely to be a problem. The low recoveries in the NBS 1646 sample were due to the differences in sample preparation. The NBS-certified values are determined by total digestion, therefore the certified value includes the concentrations in silicate minerals. The aqua regia digestion used in this program does not dissolve silicates and, therefore, reported concentrations are lower than the certified values.

4.2.2.3 ORGANIC COMPOUNDS

The accuracy of the extraction method for pesticides and TOC was determined by measuring the recoveries of organic surrogate materials added to the sediment sample before preparation (Table 17). The recoveries for both pesticides and TOC were within the analytical objective (Table 3).

The accuracy of the analysis for semivolatile organic compounds was determined by measuring the recoveries of surrogates added to the sample extracts before analysis (Table 18). These results were highly variable overall, but generally consistent for each compound.

TABLE 13. DETERMINATION OF PRECISION FROM QUADRUPLICATE DIGESTIONS OF A SEDIMENT SAMPLE FOR TRACE METAL ANALYSIS[a]

Aliquot	Silver (µg/g)	Cadmium (µg/g)	Chromium (µg/g)	Copper (µg/g)	Iron (mg/g)	Mercury (ng/g)	Lead (µg/g)	Zinc (µg/g)
1	.05 u	0.14	21	18	11	17	10	45
2	.05 u	0.16	28	19	14	13 u	10	51
3	.07 u	0.15	29	17	15	19	8.9	52
4	.07 u	0.16	29	17	14	20 u	9.6	49
Mean	-	0.15	27	18	14	-	9.6	49
CV	-	5.5	12	4.6	11	-	4.7	5.5

[a]Sample from Station G, Replicate 1, RV Gyre November 1985 Survey.
u = Sample Detection Limit.

TABLE 14. ANALYSIS OF PROCEDURAL BLANKS FOR SEDIMENT TRACE METALS[a]

Aliquot	Silver (µg/g)	Cadmium (ug/g)	Chromium (µg/g)	Copper (µg/g)	Iron (mg/g)	Mercury (ng/g)	Lead (µg/g)	Zinc (µg/g)
1	.05 u	0.002 u	4.0 u	4.5 u	0.025 u	7 u	2.5 u	0.50 u
2	.05 u	0.002 u	4.6 u	5.2 u	0.025 u	9 u	2.9 u	0.57 u
3	.05 u	0.002 u	3.9 u	4.4 u	0.025 u	8 u	2.5 u	0.49 u

[a]Reported as units per dry weight, assuming 2 g of sediment digested.
u = Sample Detection Limit.

TABLE 15. DETERMINATION OF ACCURACY FROM MATRIX SPIKE RECOVERIES OF TRACE METALS IN SEDIMENT[a]

Sample	Silver	Cadmium	Chromium	Copper	Iron	Mercury	Lead	Zinc
Amount Expected (µg)	0.50	0.20	50	15	NA	0.50	NA	100
Percent Recovered	110	200	120	100	NA	90	NA	100

[a]RV Gyre November 1985 Survey, Station G, Replicate 1 Sample.
NA = Not Analyzed.

TABLE 16. DETERMINATION OF ACCURACY FROM TRACE METAL ANALYSIS OF STANDARD REFERENCE SEDIMENTS

Reference Materials	Silver (µg/g)	Cadmium (µg/g)	Chromium (µg/g)	Copper (µg/g)	Iron (mg/g)	Mercury (ng/g)	Lead (µg/g)	Zinc (µg/g)
NBS 1646								
Certified Amount	a	0.36	76	18	34	63	28	140
Amount Recovered	.09	0.39	44	15	25	56	20	120
ICEMS-A								
Certified Amount	a	1.5	31	18	39	a	320	530
Amount Recovered	.69	1.9	35	12	34	350	290	450

a = No certified value from this element.

TABLE 17. DETERMINATION OF ACCURACY FROM SURROGATE ORGANIC COMPOUNDS MATRIX SPIKE RECOVERIES IN SEDIMENT [a]

Analyte	Aliquot 1		Aliquot 2	
	Amount Added	Percent Recovered	Amount Added	Percent Recovered
Heptachlor (ng)	9.0	91	8.6	84
Aldrin (ng)	9.0	139	8.6	99
Dieldrin (ng)	22	89	22	70
4,4'-DDT (ng)	22	140	22	123
Anthracene (µg)	0.90	49	0.86	43
Pyrene (µg)	0.90	69	0.86	57
Chrysene (µg)	0.90	64	0.86	55
TOC (µg)	20	100	20	97

[a]RV Oceanus August 1985 Survey, Station A, Replicate 1.

TABLE 18. DETERMINATION OF ACCURACY FROM SEMIVOLATILE ORGANIC SURROGATE RECOVERIES IN SEDIMENT EXTRACTS

Analyte	OSV Anderson August, 1984	OSV Anderson August, 1985		RV Oceanus August, 1985		RV Gyre November, 1985							
	Station/Replicate												
	11/1	D7/1	D7/2	A/1	A/2	F/2	F/3	F/1	G/1	G/2	G/3	$\bar{x}$	CV
	Percent Recovery												
Nitrobenzene-d_5	11	7	12	14	15	12	9	9	9	13	16	12	23
2-Fluorobiphenyl	25	14	21	24	25	21	19	21	17	27	29	23	20
Terphenyl-d_{14}	89	82	112	66	48	66	57	67	42	75	78	70	25
Phenol-d_5	18	9	15	18	20	15	13	15	12	21	24	17	24
2-Fluorophenol	9	6	9	11	11	9	8	9	7	12	14	10	21
2,4,6-Tribromophenol	34	36	29	24	0	39	35	49	32	45	34	33	37

4.2.2.4 TOTAL ORGANIC CARBON

The results of the analysis of matrix spike samples for TOC are given in Table 17. The results exceeded the analytical objectives given in Table 3.

5.0 RESULTS

5.1 WATER

5.1.1 Water Quality

The results of the water quality analyses from the OSV Anderson February 1986 survey are presented in Table 19. The results of each replicate are presented along with the mean; allowing an estimate of the water column variability. The variation between replicate samples was small for the dissolved parameters (S °/oo, temperature, DO, and pH). The particulate parameters (turbidity, chlorophyll a, phaeophytin, TSS and ATP) did show significant variation between replicate samples. The poor reproducibility may have been due to variation in particle distribution in the water column or particles settling before filtration.

The shelf station (A1) was characterized by cold, less saline water. This area was most productive, as demonstrated by highest chlorophyll a concentrations, and most turbid, as demonstrated by highest TSS and turbidity values compared to the slope waters (Stations A3, A4, A5, and A6). The surface water over the slope was uniform with respect to the water quality parameters. However, the offshore station (A4) water was slightly less saline, and the 106-Mile Site station (A6) had lower ATP. The slope stations had lower turbidity and were less productive than the nearshore stations. The salinity and temperature values for the shelf break station (A2) were between Station A1 and the slope stations. The shelf break was also less productive than other areas, having lower chlorophyll a, and ATP concentrations.

The subthermocline water was less saline and colder than the surface water. Also, the DO, chlorophyll a, and ATP concentrations were lower at depth than at the surface.

Only the shelf station had a significant concentration of C. perfringens spores. This station was resampled two days later to confirm the high value. The second sampling found even higher numbers of C. perfringens

TABLE 19. RESULTS OF WATER QUALITY PARAMETERS AND CONCENTRATION OF *Clostridium perfringens* SPORES AT THE 106-MILE SITE[a]

Station	Replicate	Depth (m)	Salinity (ppt)	Temperature (°C)	DO (mg/L)	Turbidity (NTU)[b]	pH	Total Suspended Solids (mg/L)	Chloro-phyll a (µg/L)	Phaeophytin (µg/L)	C/P[c]	ATP (ng/L)	*Clostridium perfringens* (MPN/100 mL)[d]
	1	10	34.52	10.00	8.60	0.96	8.06	4.76	0.857	0.597	1.4	29.7	
A1	2	10	34.41	9.50	9.10	0.51	8.03	4.39	1.169	0.517	2.3	40.9	0.16
	3	10	34.40	8.50	9.65	0.31	[e]	1.80	0.929	0.526	1.8	96.0	4.93[f]
	Mean		34.44	9.33	9.12	0.59	8.05	3.65	0.985	0.547	1.8	55.5	
	1	10	35.64	12.00	8.10	0.08	8.07	0.89	0.206	0.128	1.6	11.8	
A2	2	10	35.50	12.50	8.00	0.09	8.09	1.05	0.246	0.135	1.8	27.8	0.004
	3	10	35.52	12.00	7.95	0.09	8.12	0.25	0.201	0.126	1.6	6.27	
	Mean		35.55	12.17	8.02	0.09	8.09	0.73	0.218	0.130	1.7	15.3	
	1	10	36.06	15.00	7.60	0.12	8.29	1.25	0.364	0.236	1.5	24.6	
A3	2	10	36.21	15.00	7.55	0.12	8.23	0.73	0.300	0.164	1.8	48.4	0.004 u
	3	10	36.34	15.20	7.40	0.10	8.23	0.83	0.289	0.174	1.7	52.8	
	Mean		36.21	15.07	7.52	0.11	8.25	0.94	0.318	0.191	1.7	41.9	
	1	10	35.83	13.20	7.85	0.12	8.17	1.10	0.268	0.223	1.2	69.2	
A4	2	10	35.97	14.00	7.95	0.11	8.20	0.43	0.321	0.169	1.9	50.3	0.004 u
	3	10	35.75	13.80	7.80	0.08	8.20	0.44	0.364	0.236	1.5	49.7	
	Mean		35.85	13.67	7.87	0.10	8.19	0.66	0.318	0.209	1.5	56.4	
	1	10	36.18	14.20	7.25	0.11	8.13	1.08	0.300	0.218	1.4	33.9	
A5	2	10	36.30	14.00	7.80	0.06	8.19	1.00	0.364	0.249	1.5	59.2	0.011
	3	10	36.10	13.80	7.30	0.10	8.16	0.34	0.418	0.182	2.3	60.5	
	Mean		36.19	14.00	7.45	0.09	8.16	0.81	0.361	0.217	1.7	51.2	
	1	365	35.29	8.00	5.25	0.12	7.86	0.52	0.002	0.013	0.2	0.68	
A5T	2	365	35.36	8.50	5.10	0.14	7.90	0.55	0.003	0.018	0.2	2.19	0.004
	3	365	35.32	10.00	4.70	0.12	7.91	0.41	0.001	0.018	0.1	2.51	
	Mean		35.32	8.83	5.02	0.13	7.89	0.49	0.002	0.016	0.1	1.80	
	1	10	36.19	15.50	7.30	0.13	8.15	0.55	0.343	0.216	1.6	0.95	
A6	2	10	36.13	13.50	7.25	0.08	8.19	0.59	0.289	0.188	1.5	20.8	0.029
	3	10	36.17	13.80	7.25	0.14	8.19	0.20	0.300	0.205	1.5	18.3	
	Mean		36.16	14.27	7.27	0.12	8.18	0.45	0.311	0.203	1.5	13.3	
	1	366	34.98	9.50	5.00	0.11	7.91	0.60	0.003	0.021	0.1	0.94	
A6T	2	366	35.43	10.00	4.90	0.12	7.80	0.54	0.003	0.021	0.1	3.36	0.004
	3	366	35.47	10.50	5.00	0.15	7.80	0.85	0.003	0.021	0.1	3.21	
	Mean		35.29	10.00	4.97	0.13	7.84	0.66	0.003	0.021	0.1	2.50	

[a]OSV *Anderson* February 1986 Survey.
[b]Nephelometric turbidometric units.
[c]Chlorophyll *a*/phaeophytin ratio.
[d]Most probable number; all replicates were used in the calculation.
[e]Sample was lost.
[f]Reoccupied station.
T = Thermocline.
u = Sample Detection Limit.

spores. Spores were also measurable in surface water collected at Stations A5 and A6, located to the southwest and in the 106-Mile Site. The subthermocline water, and the surface water at the shelf break showed traces of C. perfringens spores. The previous baseline surveys (OSV Anderson August 1984 and 1985) found evidence of C. perfringens spores in the water column north of the 106-Mile Site (Table 20).

5.1.2 Seawater Trace Metals

The concentrations of selected trace metals in unfiltered seawater collected on the OSV Anderson February 1986 Survey are presented in Table 21. Copper, lead, mercury, silver, and zinc concentrations were not detected above the field blank levels. Cadmium was only measurable below the thermocline. The chromium concentrations were slightly higher in the slope water than on the shelf. The iron concentration at the shelf station was significantly higher than at the shelf break or on the slope.

The concentrations for most trace metals were more than a thousand times lower than required by EPA's Water Quality Criteria for seawater. The reported copper concentrations were only three to five times lower; however, the accuracy of these values is uncertain because of the high concentration of copper found in the field blank.

The silver, iron, lead, and zinc concentrations in filtered seawater collected on the OSV Anderson Survey in August 1984, (JRB, 1985) are presented in Table 22. Only zinc was detected in these samples. However, because of the high concnetrations in the field blank, the accuracy of the results is uncertain.

Seawater particulate samples were also collected for analysis of trace metals during the OSV Anderson August, 1984 Survey (Table 23). Only zinc and iron were detectable. The Hudson Canyon station had higher metal concentrations than the other areas.

5.1.3 Organic Compounds

The results of the analysis of seawater particulate and filtrate for pesticides, PCBs, PAH, and coprostanol are presented in Tables 24 through 27.

TABLE 20. MICROBIAL ANALYSIS OF SEAWATER AT THE 106-MILE SITE

OSV Anderson Survey	Station	Depth	C. perfringens		Coliform			Enterococci[b]
			Isolated[a]	Confirmed[b]	Total[a]	Fecal[a]	E. coli[a]	
August 1984[c]	1	Surface	0.014	0.33 u	NA	NA	NA	NA
		Bottom	0.020 M	0.33	NA	NA	NA	NA
	3	Surface	0.0058 u	0.14 u	NA	NA	NA	NA
	6	Surface	0.0058 u	0.14 u	NA	NA	NA	NA
		Bottom	0.0041	0.33 u	0.011 M	0.004 u	0.004 u	NA
		Bottom[d]			0.016 M	0.004	0.004 u	0.14 u
	10	Surface	0.016 u	0.14 u	NA	NA	NA	NA
	12	Surface	0.0058 u	0.14 u	NA	NA	NA	NA
	14	Surface	0.0058	0.14 u	NA	NA	NA	NA
	15	Surface	0.0058 u	0.14 u	NA	NA	NA	NA
August 1985[e]	D2	Surface	2.8	0.001 u	6 M	NA	6 M	0.001 u
		Bottom	2.8	0.001 u	6 M	NA	0.001 u	NA
	D11	Surface	2.8	0.001 u	0.001 u	NA	NA	6 M
		Bottom	2.8	0.001 u	0.001 u	NA	NA	0.001 u

[a]Most probable number/100 mL--High-Volume Sampling procedure.
[b]Colony forming units/100 mL--Membrane filter procedure.
[c]Data From JRB (1985).
[d]Station reoccupied.
eData From URI, unpublished.
u = Sample Detection Limit.
M = Greater than, colonies too numerous to quantify.
NA = Not Analyzed.

TABLE 21. CONCENTRATION OF SELECTED TRACE METALS IN UNFILTERED SEAWATER AT THE 106-MILE SITE[a]

Sta	Rep	Silver (µg/L)	Cadmium (ng/L)	Chromium (µg/L)	Copper (µg/L)	Iron (µg/L)	Mercury (ng/L)	Lead (µg/L)	Zinc (µg/L)
A 1	1	0.61 u	6.3 u	0.30	0.82	16	1.4	0.042 u	0.34
	2	0.61 u	6.3 u	0.24	0.72	9.2	1.8	0.042 u	0.56
	3	0.61 u	6.3 u	0.21	0.73	13	2.1	0.042 u	0.74
A 2	1	0.61 u	6.3 u	0.29	0.83	0.73	0.6	0.042 u	0.22
	2	0.61 u	6.3 u	0.29	0.71	0.73	0.6	0.042 u	0.19
	3	0.61 u	6.3 u	0.27	0.59	0.69	1.3	0.042 u	0.22
A 3	1	0.61 u	6.3 u	0.23	0.66	1.6	1.3	0.042 u	0.25
	2	0.61 u	6.3 u	0.28	0.73	1.8	0.9	0.042 u	0.26
	3	0.61 u	6.3 u	0.29	0.70	1.5	0.7	0.042 u	0.23
A 4	1	0.61 u	6.3 u	0.28	0.55	1.0	1.0	0.042 u	0.23
	2	0.61 u	6.3 u	0.31	0.73	1.2	0.4	0.042 u	0.28
	3	0.61 u	6.3 u	0.35	0.55	1.1	0.6	0.042 u	0.21
A 5	1	0.61 u	6.3 u	0.32	0.60	1.3	0.8	0.042 u	0.20
	2	0.61 u	6.3 u	0.36	0.59	0.95	1.0	0.042 u	0.23
	3	0.61 u	6.3 u	0.31	0.60	1.0	1.0	0.042 u	0.25
A 5T	1	0.61 u	22	0.39	0.46	0.76	0.8	0.042 u	0.51
	2	0.61 u	10	0.35	0.60	0.85	1.5	0.042 u	0.37
	3	0.61 u	6.3 u	0.27	0.51	0.77	1.3	0.042 u	0.35
A 6	1	0.61 u	6.3 u	0.34	0.50	0.57	0.8	0.042 u	0.32
	2	0.61 u	6.3 u	0.33	0.47	0.73	0.5	0.042 u	0.39
	3	0.61 u	6.3 u	0.32	0.46	0.62	0.8	0.042 u	0.27
A 6T	1	0.61 u	20	0.26	0.39	0.84	1.2	0.042 u	0.38
	2	0.61 u	22	0.38	0.57	0.74	0.9	0.042 u	0.46
	3	0.61 u	6.3 u	0.33	0.64	0.93	1.3	0.042 u	0.38
Water Quality Criteria		NA	9300	50[b]	2.9	NA	25	5.6	86
Field Blank[c]		0.61 u	6.3 u	0.10	0.49	0.38	1.2	0.042 u	0.51

[a]OSV Anderson February 1986 Survey.
[b]Hexavalent Cr
[c]Deionized water rinsed through the GO-FLO bottle.
u = Sample Detection Limit.
T = Thermocline Sample.
NA = Not Available

TABLE 22. CONCENTRATION OF SELECTED TRACE METALS IN FILTERED SURFACE WATER AT THE 106-MILE SITE[a]

Station	Silver (µg/L)	Iron (µg/L)	Lead (µg/L)	Zinc (µg/L)
1	0.005 u	0.32 u	0.05 u	0.090
3	0.005 u	0.32 u	0.05 u	0.84
6	0.005 u	0.32 u	0.05 u	0.091
10	0.005 u	0.32 u	0.05 u	0.091
12	0.005 u	0.32 u	0.05 u	5.9
14	0.005 u	0.32 u	0.05 u	0.091
15	0.005 u	0.32 u	0.05 u	0.72

[a]OSV Anderson August 1984 Survey data from JRB (1985).
u = Sample Detection Limit.

TABLE 23. CONCENTRATION OF TRACE METALS IN SUSPENDED PARTICULATES AT THE 106-MILE SITE[a]

Station[b]	Silver (µg/L)	Iron (µg/L)	Lead (µg/L)	Zinc (µg/L)
1	0.001 u	0.042 u	0.011 u	0.003
3	0.001 u	0.053	0.013 u	0.009
6	0.001 u	0.072	0.013 u	0.010
10	0.001 u	0.056	0.008 u	0.008
12	0.001 u	0.024 u	0.002	0.012
14	0.001 u	1.10	0.006	0.024
15	0.001 u	0.014	0.014 u	0.007

[a]OSV Anderson August 1984 Survey Data From JRB (1985).
[b]Surface Water.
u = Sample Detection Limit.

TABLE 24. CONCENTRATION (pg/L) OF PESTICIDES, PCBs, AND COPROSTANOL IN SUSPENDED PARTICULATE MATTER AT THE 106-MILE SITE[a]

Compound	Station Number													
	A1		A2		A3		A4		A5		A5T		A6[b]	A6T
α-BHC	1	u	1	u	1	u	1	u	1	u	1	u	1 u	1 u
β-BHC	1	u	1	u	1	u	1	u	1	u	1	u	1 u	2 u
γ-BHC	1	u	1	u	1	u	1	u	1	u	1	u	2 u	2 u
δ-BHC	1	u	1	u	1	u	1	u	1	u	1	u	2 u	2 u
Heptachlor	1	u	1	u	1	u	1	u	1	u	1	u	1	2 u
Heptachlorepoxide	1	u	1	u	1	u	1	u	1	u	1	u	1 u	1 u
Aldrin	1	u	1	u	44		10		10		1	u	9	1 u
Dieldrin	1	u	1	u	1	u	1	u	1	u	1	u	1 u	1 u
Endrin	2	u	3	u	3	u	3	u	2	u	2	u	3 u	4 u
Endrin aldehyde	1	u	2	u	2	u	2	u	1	u	2	u	2 u	3 u
α-Endosulfan	1	u	1	u		c		c		c	1	u	c	1 u
-Endosulfan	1	u	1	u		c	1	u		c	1	u	1 u	1 u
ndosulfan sulfate	1	u	2	u	2	u	2	u	1	u	2	u	2 u	2 u
4,4'-DDE	1	u	1	u	1	u	1	u	1	u	1	u	2 u	2 u
4,4'-DDD	1	u	2	u	2	u	2	u	1	u	1	u	2 u	2 u
4,4'-DDT	1	u	1	u	1	u	1	u	1	u	1	u	1 u	2 u
Methoxychlor	1	u	1	u	2	u	2	u	1	u	1	u	2 u	2 u
Mirex		c	1	u		c	1	u		c	1	u	c	1 u
Chlordane	120	u	210	u	210	u	210	u	130	u	170	u	260 u	290 u
Toxaphene	250	u	420	u	420	u	420	u	260	u	330	u	530 u	570 u
PCB														
1242	100	u	170	u	170	u	170	u	100	u	130	u	210 u	230 u
1254	100	u	170	u	170	u	170	u	100	u	130	u	210 u	230 u
1260	100	u	170	u	170	u	170	u	100	u	130	u	210 u	230 u
Coprostanol	270		220	u	230	u	230	u	230	u	NA		230 u	310 u

[a]Seawater collected at 10 m, except A5T and A6T which was collected at 365 m. OSV Anderson February 1986 Survey.

[b]Mean of 3 replicates.

[c]Matrix interference, analyte not confirmed.

NA = Not Analyzed.

u = Sample Detection Limit.

TABLE 25. CONCENTRATION (pg/L) OF PESTICIDES, PCBs, AND COPROSTANOL IN SEAWATER FILTRATES AT THE 106-MILE SITE[a]

Compound	Station Number																Water Quality Criteria (ng/L)
	A1[b]		A2[b]		A3		A4		A5		A5T		A6[c]		A6T		
Sample Volume (L)	1000		1000		950		950		950		750		950		700		
α-BHC	46		11		25		44		19		68		26		60		340
β-BHC	22		25		6		16		2	u	38		2	u	105		
γ-BHC	17	u	4	u	3	u		d	3	u	4	u		d	4	u	
δ-BHC	20	u	4	u	4	u	4	u	4	u		d	4	u	5	u	
Heptachlor	14	u	15		3	u	12		2	u	50		8		42		3.6
Heptachlorepoxide	11	u	4	u	2	u	2	u	2	u	2	u	2	u	26		
Aldrin	14	u	10		4		2	u	2	u	17		2	u	43		1300
Dieldrin	14	u		d	2	u	2	u	2	u	3	u	2	u		d	
Endrin	38	u	13	u	7	u	7	u	7	u	8	u	7	u		d	2.3
Endrin aldehyde	29	u	10	u	5	u	5	u	5	u	6	u	5	u	7	u	
α-Endosulfan	14	u		d		d	2	u		d		d		d		d	8.7
β-Endosulfan	14	u	5	u	2	u	2	u	2	u	3	u	2	u		d	
Endosulfan sulfate	27	u	9	u	5	u	5	u	5	u	6	u	5	u	6	u	
4,4'-DDE	16	u	5	u	5	u	3	u	3	u	4	u	3	u	4	u	
4,4'-DDD	24	u	8	u	4	u	4	u	4	u	5	u	4	u	6	u	
4,4'-DDT	14	u	23		19		2	u	39		3	u	2	u	3	u	1
Methoxychlor	22	u	17		4	u	4	u	4	u	430		4	u	5	u	3
Mirex	16	u	5	u		d		d		d	4	u		d		d	1
Chlordane	3000	u	1000	u	530	u	530	u	530	u	670	u	530	u	710	u	4
Toxaphene	6000	u	2000	u	1000	u	1000	u	1000	u	1300	u	1000	u	1400	u	0.2
PCB																	
1242	2400	u	800	u	420	u	420	u	420	u	530	u	420	u	570	u	30
1242	2400	u	800	u	420	u	420	u	420	u	530	u	420	u	570	u	
1260	2400	u	800	u	420	u	420	u	420	u	530	u	420	u	570	u	
Coprostanol	220	u	220	u	230	u	230	u	230	u	290	u	230	u	310	u	

[a]Seawater collected at 10 m, except A5T and A6T which was collected at 365 m. OSV Anderson February 1986 Survey.
[b]Extracts were diluted to remove analytical interferences.
[c]Mean of 3 replicates.
u = Sample Detection Limit.
d = Matrix interference, analyte not confirmed.

TABLE 26. CONCENTRATION (ng/L) OF POLYNUCLEAR AROMATIC HYDROCARBONS IN SUSPENDED PARTICULATE MATTER AT THE 106-MILE SITE[a]

Compound	Station Number							
	A1	A2	A3	A4	A5	A5T	A6[b]	A6T
Naphthalene	1 u	1 u	1 u	1 u	1 u	1 u	1 u	1 u
C_1-Naphthalene	1 u	1 u	1 u	1 u	1 u	2 u	1 u	2 u
C_2-Naphthalene	1 u	1 u	1 u	1 u	1 u	1 u	1 u	1 u
C_3-Naphthalene	1 u	1 u	1 u	1 u	1 u	1 u	1 u	1 u
C_4-Naphthalene	1 u	1 u	1 u	1 u	1 u	1 u	1 u	1 u
Acenaphthalene	1 u	1 u	1 u	1 u	1 u	1 u	1 u	1 u
Acenaphthene	1 u	1 u	1 u	1 u	1 u	1 u	1 u	2 u
Biphenyl	1 u	1 u	1 u	1 u	1 u	1 u	1 u	1 u
Fluorene	1 u	1 u	1 u	1 u	1 u	1 u	1 u	1 u
C_1-Fluorene	1 u	1 u	1 u	1 u	1 u	1 u	1 u	1 u
C_2-Fluorene	1 u	1 u	1 u	1 u	1 u	1 u	1 u	1 u
Phenanthrene	1 u	1 u	1 u	1 u	1 u	2 u	1 u	2 u
C_1-Phenanthrene	1 u	1 u	1 u	1 u	1 u	2 u	1 u	2 u
C_2-Phenanthrene	1 u	1 u	1 u	1 u	1 u	1 u	1 u	1 u
C_3-Phenanthrene	1 u	1 u	1 u	1 u	1 u	1 u	1 u	1 u
C_4-Phenanthrene	1 u	1 u	1 u	1 u	1 u	1 u	1 u	1 u
Anthracene	1 u	1 u	1 u	1 u	1 u	2 u	1 u	2 u
C_1-Anthracene	1 u	1 u	1 u	1 u	1 u	2 u	1 u	2 u
C_2-Anthracene	4 u	4 u	4 u	4 u	4 u	6 u	4 u	6 u
Dibenzothiophene	1 u	1 u	1 u	1 u	1 u	1 u	1 u	2 u
C_1-Dibenzothiophene	1 u	1 u	1 u	1 u	1 u	1 u	1 u	2 u
C_2-Dibenzothiophene	1 u	1 u	1 u	1 u	1 u	1 u	1 u	2 u
C_3-Dibenzothiophene	1 u	1 u	1 u	1 u	1 u	1 u	1 u	2 u
Fluoranthene	1 u	1 u	1 u	1 u	1 u	1 u	1 u	1 u
C_1-Fluoranthene	1 u	1 u	1 u	1 u	1 u	1 u	1 u	1 u
Pyrene	1 u	1 u	1 u	1 u	1 u	1 u	1 u	1 u
C_1-Pyrene	1 u	1 u	1 u	1 u	1 u	1 u	1 u	1 u
Benz(a)anthracene	1 u	1 u	1 u	1 u	1 u	1 u	1 u	1 u
Chrysene	0.4 u	0.4 u	0.5 u	0.5 u	0.5 u	0.6 u	0.5 u	0.6 u
C_1-Chrysene	1 u	1 u	1 u	1 u	1 u	1 u	1 u	1 u
C_2-Chrysene	1 u	1 u	1 u	1 u	1 u	1 u	1 u	1 u
Triphenylene	0.4 u	0.4 u	0.5 u	0.5 u	0.5 u	0.6 u	0.5 u	0.6 u
Benzofluoranthene	1 u	1 u	1 u	1 u	1 u	1 u	1 u	1 u
Benzo(e)pyrene	1 u	1 u	1 u	1 u	1 u	1 u	1 u	1 u
Benzo(a)pyrene	1 u	1 u	1 u	1 u	1 u	1 u	1 u	1 u
Perylene	1 u	1 u	1 u	1 u	1 u	1 u	1 u	1 u
Ideno(1,2,3,-cd)perylene	2 u	2 u	2 u	2 u	2 u	3 u	2 u	3 u
Benzo(g,h,i)perylene	2 u	2 u	2 u	2 u	2 u	3 u	2 u	3 u
Dibenzo(a,b)anthracene	1 u	1 u	1 u	1 u	1 u	1 u	1 u	1 u
Bis(2-ethylhexyl)phthalate	1 u	1 u	1 u	1 u	1 u	1 u	30	1 u

[a]Seawater collected at 10 m, except A5T and A6T (subthermocline)
which were collected at 365 m. OSV Anderson February 1986 Survey.
-Mean of 3 replicates.
u = Sample Detection Limit.

TABLE 27. CONCENTRATION (ng/L) OF POLYNUCLEAR AROMATIC HYDROCARBONS IN FILTERED SEAWATER AT THE 106-MILE SITE[a]

Compound	Station Number								Water Quality Criteria (µg/L)
	A1	A2	A3	A4	A5	A5T	A6[b]	A6T	
Sample Volume (L)	1000	1000	950	950	950	750	950	700	
Naphthalene	17	1 u	2	1 u	1 u	2	1 u	1 u	7.5
C_1-Naphthalene	20	2	2	2	1 u	2 u	1 u	2 u	
C_2-Naphthalene	30	2	3	3	1 u	3	1 u	1 u	
C_3-Naphthalene	15	1 u	2	1 u	1 u	1 u	1 u	1 u	
C_4-Naphthalene	5	1 u	1 u	1 u	1 u	1 u	1 u	1 u	
Acenaphthalene	1 u	1 u	1 u	1 u	1 u	1 u	1 u	1 u	
Acenaphthene	1 u	1 u	1 u	1 u	1 u	1 u	1 u	2 u	
Biphenyl	2	1 u	1 u	1 u	1 u	1 u	1 u	1 u	
Fluorene	2	1 u	1 u	1 u	1 u	1 u	1 u	1 u	
C_1-Fluorene	2	1 u	1 u	1 u	1 u	1 u	1 u	1 u	
C_2-Fluorene	1 u	1 u	1 u	1 u	1 u	1 u	1 u	1 u	
Phenanthrene	3	1 u	1 u	1 u	1 u	1 u	1 u	1 u	
C_1-Phenanthrene	5	1 u	1 u	1 u	1 u	2 u	1 u	2 u	
C_2-Phenanthrene	4	1 u	1 u	1 u	1 u	2 u	1 u	2 u	
C_3-Phenanthrene	3	1 u	1 u	1 u	1 u	1 u	1 u	1 u	
C_4-Phenanthrene	1 u	1 u	1 u	1 u	1 u	1 u	1 u	1 u	
Anthracene	1 u	1 u	1 u	1 u	1 u	2 u	1 u	2 u	
C_1-Anthracene	1 u	1 u	1 u	1 u	1 u	2 u	1 u	2 u	
C_2-Anthracene	4 u	4 u	4 u	4 u	4 u	6 u	4 u	6 u	
Dibenzothiophene	1 u	1 u	1 u	1 u	1 u	1 u	1 u	2 u	
C_1-Dibenzothiophene	1 u	1 u	1 u	1 u	1 u	1 u	1 u	2 u	
C_2-Dibenzothiophene	2	1 u	1 u	1 u	1 u	1 u	1 u	2 u	
C_3-Dibenzothiophene	2	1 u	1 u	1 u	1 u	1 u	1 u	2 u	
Fluoranthene	1 u	1 u	1 u	1 u	1 u	1 u	1 u	1 u	16
C_1-Fluoranthene	1 u	1 u	1 u	1 u	1 u	1 u	1 u	1 u	
Pyrene	1 u	1 u	1 u	1 u	1 u	1 u	1 u	1 u	
C_1-Pyrene	1 u	1 u	1 u	1 u	1 u	1 u	1 u	1 u	
Benz(a)anthracene	1 u	1 u	1 u	1 u	1 u	1 u	1 u	1 u	
Chrysene	0.4 u	0.4 u	0.5 u	0.5 u	0.5 u	0.6 u	0.5 u	0.6 u	
C_1-Chrysene	1 u	1 u	1 u	1 u	1 u	1 u	1 u	1 u	
C_2-Chrysene	1 u	1 u	1 u	1 u	1 u	1 u	1 u	1 u	
Triphenylene	0.4 u	0.4 u	0.5 u	0.5 u	0.5 u	0.6 u	0.5 u	0.6 u	
Benzofluoranthene	1 u	1 u	1 u	1 u	1 u	1 u	1 u	1 u	
Benzo(e)pyrene	1 u	1 u	1 u	1 u	1 u	1 u	1 u	1 u	
Benzo(a)pyrene	1 u	1 u	1 u	1 u	1 u	1 u	1 u	1 u	
Perylene	1 u	1 u	1 u	1 u	1 u	1 u	1 u	1 u	
Ideno(1,2,3,-cd)perylene	2 u	2 u	2 u	2 u	2 u	3 u	2 u	3 u	
Benzo(g,h,i)perylene	2 u	2 u	2 u	2 u	2 u	3 u	2 u	3 u	
Dibenzo(a,b)anthracene	1 u	1 u	1 u	1 u	1 u	1 u	1 u	1 u	
Bis(2-ethylhexyl)phthalate	137	2	2	1	0	1	5	7	
Total PAH	**112**	**4**	**9**	**5**	**u**	**5**	**u**	**u**	300

[a]Seawater collected at 10 m, except A5T and A6T (subthermocline) which were collected at 365 m. OSV Anderson February 1986 Survey.

[b]Mean of 3 replicates.

u = Sample Detection Limit.

With the exception of aldrin found in the slope samples and coprostanol in the shelf sample, no contaminants of interest were found in seawater particulate samples. PCBs were not detected in any of the samples in either the particulate or filtrate phase.

Seawater filtrate samples did contain some analytes in concentrations above method detection limits. Naphthalenes, phenanthrenes, and dibenzothiophenes were found in shelf waters at Station A1, but were not found elsewhere. α-BHC appeared to be the most ubiquitous trace contaminant in these samples, being found in shelf and slope waters. Heptachlor and aldrin were also found in several samples. However, no pattern of contaminant distribution was evident from these few samples.

5.2 LABORATORY ANALYSIS OF SEDIMENTS

5.2.1 Grain-Size Distribution

The grain-size distribution in sediment samples collected on the OSV Anderson August 1984 Survey (JRB, 1985) and the RV Gyre 1985 Survey are presented in Table 28. The distribution was variable around Station F. In general, the sediments in the 106-Mile Site (on the continental slope) were greater than 75 percent silt-clay, while the shelf had predominately sandy sediments.

5.2.2 Trace Metals

The results of the sediment trace metal analysis are presented in Tables 29 and 30. Four metals were analyzed in the 1984 survey by JRB (1985). Higher sediment contaminant levels were reported in 1984 than were found in 1986. However, it appears that the higher values are most likely due to differences in analytical technique. One sample (Station 11) analyzed by JRB (1985) had results that were between 124 (Zn) and 300 (Hg) percent higher than found upon reanalysis.

The samples collected in replicate showed greater variability within and between station replicates than between stations. The high mercury and

TABLE 28. GRAIN-SIZE DISTRIBUTION IN SEDIMENTS AT THE 106-MILE SITE

Survey	Station	Replicate	Distribution (Percent/g Dry Sediment) Gravel	Sand	Silt	Clay	Water
OSV Anderson August 1984[a]	1		0.0	2.7	75	22	78
	2		0.0	22	60	17	48
	3		0.0	17	63	20	47
	4		0.1	13	59	28	52
	5		0.0	1.1	74	25	58
	6		0.0	34	48	14	43
	10		0.0	4.7	64	31	58
	11		1.0	1.7	70	28	56
	12		4.6	93	2.2	0.0	26
	13		35	63	1.4	0.0	23
	14		5.3	95	0.0	0.0	1.5
	15		56	44	0.2	0.0	33
	16		0.7	36	45	19	44
	17		0.1	27	55	17	52
RV Gyre November 1985	F	1	NA	NA	NA	NA	NA
		2	0.0	52	23	24	NA
		3	0.0	15	44	41	NA
	G	1	0.0	5.7	45	49	NA
		2	0.0	4.6	50	45	NA
		3	0.0	5.0	47	48	NA

[a]Data from JRB. (1985).
NA = Not Analyzed.

TABLE 29. CONCENTRATION OF SELECTED TRACE METALS IN SEDIMENTS AT THE 106-MILE SITE

Survey (Station)	Rep No.	Silver (µg/g)	Cadmium (µg/g)	Chromium (µg/g)	Copper (µg/g)	Iron (mg/g)	Mercury (µg/g)	Lead (µg/g)	Zinc (µg/g)
RV Oceanus(A)	1	.04 u	.14	27	23	10	.007 u	10	49
August 1985	2	.04 u	.12	22	18	9.1	.008 u	7.3	40
	3	.05 u	.16	28	23	11	.012	11	50
OSV Anderson(7)	1	.06 u	.10	20	11	10	.018	9.4	37
August 1985	2	.05 u	.10	23	9	8.4	.012 u	6.7	32
RV Gyre(G)	1[a]	.06 u	.15	27	18	13	.013[b]	9.8	49
November 1985	2	.03	.04	22	16	9.5	.002	9.9	39
	3	.04 u	.08	21	14	7.8	.006	9.7	35
RV Gyre(F)	1	.05	.14	22	23	8.9	.034[c]	35[c]	42
November 1985	2	.05 u	.10	23	11	7.9	.002	7.4	32
	3	.04 u	.07	23	16	9.1	.008	11	40
OSV Anderson(11)	1	.07 u	.17	34	21	13	.009	14	54
August 1984									

[a]Mean of 4 replicates.
[b]One-half of detection limit used to calculate mean.
[c]Possible contamination.
u = Sample Detection Limit.

TABLE 30. CONCENTRATION OF SELECTED TRACE METALS IN SURFACE SEDIMENT AT THE 106-MILE SITE[a]

Station	Iron (mg/g)	Mercury (µg/g)	Lead (µg/g)	Zinc (µg/g)
1	28	0.080	30	76
2	19	0.043	13	56
3	20	0.028	14	52
4	27	0.069	20	64
5	27	0.032	19	72
6	170	0.020	10	39
10	26	0.028	16	67
11	27	0.028	19	67
12	12	0.004	4.9	21
13	22	0.007	9.2	31
14	4.8	0.066	3.2	7.6
15	22	0.030	13	34
16	23	0.060	14	55
17	21	0.035	14	53

[a]OSV Anderson August 1984 Survey data from JRB (1985).

lead values from the Station F, Replicate 1 sample may have been due to contamination.

5.2.3 Organic Compounds and Priority Pollutants

Organic compounds (pesticides, PCBs, and PAHs) were not detected in any of the sediments (Tables 31 and 32). The exception was 4,4'-DDT which was detected in trace amounts along a southwest transect through the 106-Mile Site (Stations 11, F, and G). The variation within a station was greater than the variation between stations for TOC concentrations (Tables 31 and 32). The values ranged from 4.1 to 9.8 mg/g.

5.2.4. Benthic Infauna

Benthic infaunal samples collected at Station G contained slightly more individuals than samples collected at Station F (Table 33). When the numbers are extrapolated, Station F had mean densities of 2907 individuals per square meter and Station G had mean densities of 4118 individuals per square meter. The top dominant species at Station F was the spionid polychaete Aurospio dibranchiata, which accounted for almost 10 percent of all benthic individuals collected at that station. The species that ranked second and third at Station F were undescribed species of polychaetes, Prionospio sp. 2 and Tharyx sp. 1, respectively.

The top dominant species recorded at Station G was the sipunculan, Aspidosiphon zinni, which accounted for over 12 percent of the total individuals collected at that station. The second ranked species was the polychaete Aurospio dibranchiata.

5.2.5 Clostridium perfringens

The number of C. perfringens spores counted in sediments collected on the RV Gyre August 1985 and the OSV Anderson August 1985 and February 1986

TABLE 31. CONCENTRATION OF SELECTED ORGANIC COMPOUNDS IN SEDIMENTS AT THE 106-MILE SITE

	OSV Anderson August, 1984	OSV Anderson August, 1985		RV Oceanus August, 1985		RV Gyre November, 1985					
	Station/Replicate										
Analyte	11/1	D7/1	D7/2	A/1	A/2	F/2	F/3	F/1	G/1	G/2	G/3
Pesticides (ng/g)											
Heptachlor	0.42 u	1.2 u	1.1 u	0.86 u	0.57 u	0.50 u	0.69 u	0.79 u	1.0 u	0.89 u	0.67 u
Aldrin	0.47 u	1.3 u	1.2 u	0.96 u	0.64 u	0.56 u	0.77 u	0.88 u	1.1 u	0.99 u	0.75 u
Dieldrin	0.56 u	1.6 u	1.4 u	1.1 u	0.76 u	0.66 u	0.92 u	1.0 u	1.4 u	1.2 u	0.89 u
4,4'-DDT	8.5	1.8 u	1.6 u	1.3 u	0.86 u	0.74 u	1.0 u	1.2 u	17	12	1.0 u
Toxaphene	58 u	160 u	140 u	120 u	79 u	68 u	95 u	110 u	140 u	120 u	93 u
Chlordane	12 u	33 u	30 u	24 u	16 u	14 u	20 u	22 u	29 u	25 u	19 u
PCB (ng/g)											
1242	28 u	79 u	70 u	58 u	39 u	33 u	47 u	53 u	69 u	60 u	45 u
1254	15 u	42 u	37 u	31 u	20 u	18 u	25 u	28 u	36 u	32 u	24 u
1260	13 u	37 u	33 u	27 u	18 u	16 u	22 u	25 u	33 u	28 u	21 u
PAH (µg/g)											
Naphthalene	0.11 u	0.58 u	0.37 u	0.41 u	0.22 u	0.20 u	0.29 u	0.28 u	0.31 u	0.29 u	0.23 u
Acenaphthylene	0.11 u	0.58 u	0.37 u	0.41 u	0.22 u	0.20 u	0.29 u	0.28 u	0.31 u	0.29 u	0.23 u
Acenaphthene	0.11 u	0.58 u	0.37 u	0.41 u	0.22 u	0.20 u	0.29 u	0.28 u	0.31 u	0.29 u	0.23 u
Fluorene	0.11 u	0.58 u	0.37 u	0.41 u	0.22 u	0.20 u	0.29 u	0.28 u	0.31 u	0.29 u	0.23 u
Phenanthrene	0.11 u	0.58 u	0.37 u	0.41 u	0.22 u	0.20 u	0.29 u	0.28 u	0.31 u	0.29 u	0.23 u
Anthracene	0.11 u	0.58 u	0.37 u	0.41 u	0.22 u	0.20 u	0.29 u	0.28 u	0.31 u	0.29 u	0.23 u
Fluoranthene	0.11 u	0.58 u	0.37 u	0.41 u	0.22 u	0.20 u	0.29 u	0.28 u	0.31 u	0.29 u	0.23 u
Pyrene	0.11 u	0.58 u	0.37 u	0.41 u	0.22 u	0.20 u	0.29 u	0.28 u	0.31 u	0.29 u	0.23 u
Benzo(a)anthracene	0.11 u	0.58 u	0.37 u	0.41 u	0.22 u	0.20 u	0.29 u	0.28 u	0.31 u	0.29 u	0.23 u
Chrysene	0.11 u	0.58 u	0.37 u	0.41 u	0.22 u	0.20 u	0.29 u	0.28 u	0.31 u	0.29 u	0.23 u
Benzo(b)fluoranthene	0.11 u	0.58 u	0.37 u	0.41 u	0.22 u	0.20 u	0.29 u	0.28 u	0.31 u	0.29 u	0.23 u
Benzo(k)fluoranthene	0.11 u	0.58 u	0.37 u	0.41 u	0.22 u	0.20 u	0.29 u	0.28 u	0.31 u	0.29 u	0.23 u
Benzo(a)pyrene	0.11 u	0.58 u	0.37 u	0.41 u	0.22 u	0.20 u	0.29 u	0.28 u	0.31 u	0.29 u	0.23 u
Indeno(1,2,3-c,d)pyrene	0.11 u	0.58 u	0.37 u	0.41 u	0.22 u	0.20 u	0.29 u	0.28 u	0.31 u	0.29 u	0.23 u
Dibenz(a,h)anthracene	0.11 u	0.58 u	0.37 u	0.41 u	0.22 u	0.20 u	0.29 u	0.28 u	0.31 u	0.29 u	0.23 u
Benzo(g,h,i)perylene	0.11 u	0.58 u	0.37 u	0.41 u	0.22 u	0.20 u	0.29 u	0.28 u	0.31 u	0.29 u	0.23 u
Bis(2-ethylhexyl)-phthalate	0.50	0.34 u	1.4	0.41 u	1.7	1.1	0.28 u	1.2	0.78	3.5	0.45
Total Organic Carbon (mg/g)	**9.8**	**6.6**	**4.1**	**7.9**	**5.9**	**4.9**	**7.2**	**8.0**	**7.6**	**6.9**	**6.7**

u = Sample Detection Limit.

TABLE 32. CONCENTRATION OF PRIORITY POLLUTANTS IN SEDIMENTS AT THE 106-MILE SITE[a]

301(h) Monitoring Parameters	Concentration (µg/g)
N-Nitrosodimethylamine	0.23 u
Phenol	1.5 u
bis(2-chloroethyl)ether	0.23 u
1,3-Dichlorobenzene	0.23 u
1,4-Dichlorobenzene	0.23 u
1,2-Dichlorobenzene	0.23 u
bis(2-Chloroisopropyl) ether	0.23 u
Hexachlorethane	0.23 u
N-Nitrosodi-n-propylamine	0.23 u
Nitrobenzene	0.23 u
Isophorone	0.23 u
2,4-Dimethylphenol	0.23 u
bis(2-Chloroethoxy)methane	0.23 u
1,2,4-Trichlorobenzene	0.23 u
Naphthalene	0.23 u
Hexachlorobutadiene	0.23 u
Hexachlorocyclopentadiene	0.23 u
2-Chloronaphthalene	0.23 u
Biphenyl	0.23 u
Acenaphthylene	0.23 u
Dimethyl phthalate	0.23 u
2,6-Dinitrotoluene	0.23 u
Acenaphthene	0.23 u
Dibenzofuran	0.23 u
Fluorene	0.23 u
4-Chlorophenyl phenyl ether	0.23 u
Diethyl phthalate	0.23 u
2,4-Dinitrotoluene	0.23 u
1,2-Diphenylhydrazine	0.23 u
Diphenylamine	0.23 u
N-Nitrosodiphenylamine	0.23 u
4-Bromophenyl phenyl ether	0.23 u
Hexachlorobenzene	0.23 u
Phenanthrene	0.02 j
Anthracene	0.23 u
Dibenzothiophene	0.23 u
Carbazole	0.23 u
Di-n-butyl phthalate	0.23 u
Fluoranthene	0.23 u
Pyrene	0.23 u
Benzidine	0.23 u
Butylbenzyl phthalate	0.23 u
Chrysene	0.23 u
Benzo(a)anthracene	0.23 u
3,3'-Dichlorobenzidine	0.23 u
bis(2-Ethylhexyl)phthalate	3.5

TABLE 32. (Continued)

301(h) Monitoring Parameters	Concentration (µg/g)	
Di-n-octyl phthalate	0.23	u
Benzo(b)fluoranthene	0.23	u
Benzo(k)fluoranthene	0.23	u
Benzo(a)pyrene	0.23	u
Benzo(g,h,i)perylene	0.23	u
Indeno(1,2,3-c,d)pyrene	0.23	u
Dibenzo(a,h)anthracene	0.23	u
2-Chlorophenol	1.5	u
2-Nitrophenol	1.5	u
2,4-Dichlorophenol	1.5	u
4-Chloro-3-methylphenol	1.5	u
2,4,6-Trichlorophenol	1.5	u
2,4-Dinitrophenol	1.5	u
4-Nitrophenol	1.5	u
2-Methyl-4,6-Dinitrophenol	1.5	u
Pentachlorophenol	1.5	u
Toxaphene	0.13	u
Aroclor 1242	0.063	u
Aroclor 1254	0.034	u
Aroclor 1260	0.030	u
α-BHC	0.00066	u
β-BHC	0.0019	u
-BHC	0.00075	u
-BHC	0.00094	u
Aldrin	0.0011	u
Heptachlor	0.00094	u
Heptachlor epoxide	0.0012	u
-Chlordane	0.0010	u
Endosulfan I	0.0013	u
α-Chlordane	0.0011	u
Dieldrin	0.0013	u
4,4'-DDE	0.0014	u
Endosulfan II	0.0015	u
Endrin	0.0015	u
Endrin aldehyde	0.0023	u
4,4'-DDD	0.0019	u
Endosulfan sulfate	0.0015	u
4,4'-DDT	0.0014	u
Total Organic Carbon (mg/g)	**7.2**	

[a]RV Oceanus August 1985 Survey: Station A, Replicate 3.
u = Sample Detection Limit.
j = Estimated value. Data indicate the presence of a target compound that meets the identification criteria, but the result is less than the specified detection limit.

TABLE 33. TOTAL NUMBER OF INVERTEBRATE SPECIES (>300 μm) FOUND IN SIX BOX CORE SAMPLES TAKEN AT TWO STATIONS AT THE 106-MILE SITE.

Species	Station F			Station G		
	1	2	3	1	2	3
CNIDARIA						
Hydrozoa						
*Egmundella superba					x	
*Monobrachium parasitum	x			x		
Hydrozoa sp. 2				1		
Hydromedusae spp. indeterminate			1	1		
**Siphonophora spp. indeterminate		x	x			
Scyphozoa						
Coronatae scyphistoma sp. 1	1			1		
PLATYHELMINTHES						
Turbellaria spp. indeterminate	2					1
NEMERTEA						
Lineus spp. indeterminate						1
Micrura sp. 1	1	2				
Nemertea sp. 2	3	1	12	14	12	9
Nemertea sp. 5	9	6	6	3	9	6
Nemertea sp. A			2	3	1	
ANNELIDA						
Polychaeta						
Acrocirridae						
Flabelligella cirrata		1		2	2	
Ampharetidae						
Amphicteis vestis			1			
Anobothrus gracilis	1	1			2	
Anobothrus sp. 1	1	3	2	2		3
Melinna cristata				1		
Mugga wahrbergi				1		
Sosanopsis wireni					1	
Ampharetidae spp. juvenile	1	2	2	6	5	1
Ampharetidae spp. indeterminate				1		
Amphinomidae						
Paramphinome jeffreysii	5			2	6	1

Table 33. Continued.

Species	Station F			Station G		
	1	2	3	1	2	3
Chaetopteridae						
Phyllochaetopterus sp. 1					1	
Chaetopteridae spp. indeterminate						1
Chrysopetalidae						
Dysponetus sp. 4	1					1
Cirratulidae						
Caulleriella sp. 1						1
Caulleriella sp. B						1
Chaetozone sp. 1	3	2	5	3	3	1
Chaetozone sp. 6	3					
Chaetozone sp. 10	4	6	2	8	1	6
Tharyx nr. monilaris				1		
Tharyx sp. 1	20	9	9	8	8	10
Tharyx sp. 9		1				1
Cirratulidae spp. juvenile	1					
Cirratulidae spp. indeterminate		6	6	2	7	4
Dorvilleidae						
Exallopus sp. 2						1
Exallopus sp. 3	1					
Ophryotrocha sp. 1	2		1			1
Ophryotrocha sp. 2	1				2	1
Ophryotrocha sp. 3					4	1
Ophryotrocha sp. 5	2		1			
Dorvilleidae sp. 2				1		
Fauveliopsidae						
Fauveliopsis brevis	5	6	6	5	1	5
Glyceridae						
Glycera capitata	5	4	3	7	3	4
Goniadidae						
Goniada norvegica	1					
Goniadidae spp. juvenile					1	
Hesionidae						
Nereimyra sp. 3	1			4	3	4
Hesionidae sp. 3				2	1	4
Heterospionidae						
Heterospio nr. longissima			1			

Table 33. Continued.

Species	Station F			Station G		
	1	2	3	1	2	3
Lacydoniidae						
Lacydonia cirrata		1				
Lumbrineridae						
Augeneria bidens	1			3		2
Lumbrineris latreilli				3		
Ninoe nr. *brevipes*	2		1	1		1
Lumbrineridae sp. juvenile				2		1
Maldanidae						
Clymenura lankesteri		1				1
Clymenura polaris					1	2
Notoproctus nr. *abyssus*		1				
Maldanidae sp. 1		2				
Maldanidae sp. 3				1		
Maldanidae spp. juvenile	3		1	1	1	
Nephtyidae						
Aglaophamus sp. 1	2		1	1	1	1
Aglaophamus sp. 2	3					
Opheliidae						
Kesun gravieri		3				
Ophelina abranchiata	1	1				
Ophelina aulogastrella				1		
Ophelina cylindricaudata	1	2				1
Tachytrypane cf. *jeffreysii*			1			
Orbiniidae						
Orbiniella sp. 1	1				1	
Orbiniella sp. 2					1	
Orbiniidae spp. juvenile		1				
Oweniidae						
Galathowenia sp. 1	1		3	3	1	1
Myriochele cf. *heeri*			1			
Myriochele sp. 1			2	4	5	1
Myriochele sp. 4				5		5
Oweniidae spp. indeterminate			2			

Table 33. Continued.

Species	Station F			Station G		
	1	2	3	1	2	3
Paraonidae						
Aricidea abranchiata		1			1	
Aricidea catherinae	1			1		
Aricidea nr. *facilis*					1	2
Aricidea quadrilobata	3					
Aricidea tetrabranchia	6	2	3	4	3	2
Aricidea sp. 4		2		1	1	
Aricidea sp. 5			2		2	1
Levinsenia sp. 1		1	3	3	3	1
Levensenia sp. 8	1					
Paradoneis abranchiata		2	3	1	6	7
Paraonella sp. 1		1				
Sabidius cornatus	1	3	5	1	1	6
Paraonidae spp. indeterminate		1				
Pholoididae						
Pholoe anoculata	16	4	1	13	14	16
Phyllodocidae						
Mystides rarica			1	2	2	1
Protomystides sp. 2	1					
Pilargidae						
Ancistrosyllis groenlandica			1	1	1	
Synelmis sp. 1	2					
Sabellidae						
Euchone scotiarum		2	1		2	
Euchone sp. 3		5	2			
Sabellidae sp. 5		1				
Scalibregmatidae						
Oligobregma aciculatum				1		
Sclerobregma branchiata		7	2	3	3	5
Scalibregmatidae spp. juvenile					1	
Serpulidae						
Serpulidae spp. indeterminate				1		
Sigalionidae						
Leanira minor			1	1	2	1
Sigalionidae spp. juvenile	1				2	

Table 33. Continued.

Species	Station F			Station G		
	1	2	3	1	2	3
Spionidae						
Aurospio dibranchiata	14	35	28	22	18	14
Laonice magnacristata	1					
Laonice sp. 4			1			
Prionospio sp. 1		1				
Prionospio sp. 2	11	20	24	16	18	19
Prionospio sp. 6				1	1	1
Prionospio sp. 11			4	3	4	7
Prionospio sp. 20	1		4	5	5	1
Prionospio sp. 21	1					1
Prionospio spp. juvenile	1					
Prionospio spp. indeterminate	4	2		7	4	7
Spiophanes sp. 3			2	1		
Spionidae n. gen. 3		1				
Syllidae						
Exogone sp. 1	2	3	5	7		1
Syllis sp. 1				1		
Terebellidae						
Amphitritinae sp. 1					3	7
Amphitritinae spp. juvenile	1		1			
Terebellidae spp. juvenile		1			1	1
Tomopteridae						
**Tomopteris spp. indeterminate			1			
Trichobranchidae						
Terebellides sp. 4					1	
Terebellides sp. 5				1		
Terebellides spp. juvenile		1	1			3
Trichobranchidae sp. 5						2
Trichobranchidae spp. juvenile				1	1	
Trochochaetidae						
Trochochaeta watsoni					1	
Oligochaeta						
Adelodrilus fimbriatus		1		2	2	
Grania atlantica	2	4	3			3
Grania sp. 2				1		
Phallodrilus grasslei		3		17	23	
Tubificoides aculeatus	9	6	1	17	4	4
Tubificoides apectinatus	1					
Tubificoides sp. 6	10					
Tubificoides spp. juvenile	3		1	13	3	
Tubificoides spp. indeterminate	2					

Table 33. Continued.

Species	Station F			Station G		
	1	2	3	1	2	3
ECHIURA						
Echiura sp. 1			3			
Echiura sp. 2			2			
SIPUNCULA						
Aspidosiphon zinni		1	2	95	8	35
Golfingia (Nephasoma) capilleforme		1		3	2	
Golfingia (Nephasoma) diaphanes				5	4	
Golfingia (Nephasoma) flagriferum		8		4	1	2
Golfingia (Apionsoma) murinae		2	2			
Sipuncula spp. juvenile	1	2	3	1		
POGONOPHORA						
Siboglinum bayeri		1				
Siboglinum pholidotum		1				
Siboglinum sp. 2		1				
MOLLUSCA						
Bivalvia						
Dacrydium sp. 1		3	1	1	8	3
Lametila abyssorum	1					1
Malletia johnsoni	10		2		5	2
Myonera atlantica		1				
Neilonella subovata	1			2	3	
Nucula cancellata	10	5	7	8	12	6
Pristogloma alba			1			
Pristogloma nitens		1		1	2	
Thyasira croulinensis	4	3		3	6	4
Thyasira ferruginea	4		1			
Thyasira pygmaea	2	5	5	4	8	1
Thyasira subovata	2		2			
Xyloredo sp. 1	1		1	1		
Yoldiella curta	1	1			1	4
Gastropoda						
Cyclichna vortex				1		
Haliella stenostoma		1	1			2
Retusa obtusa		1	1		1	
Gastropoda spp. juvenile						1

Table 33. Continued.

Species	Station F			Station G		
	1	2	3	1	2	3
Scaphopoda						
Cadulus spp. indeterminate	1					
Pulsellum affine			5	2		3
Pulsellum verrilli	5	3	2	3	3	
Aplacophora						
Falcidens sp. 4		3				
Spathoderma clenchi	19	7	10	14	8	10
Lepidomeniidae sp. 2		1		1	2	
Lepidomeniidae sp. 8				1		
Neomeniidae sp. 3					1	2
ARTHROPODA						
Arachnida						
Acarina spp. indeterminate		3	2	6		2
Crustacea						
Ostracoda						
Myodocopa spp. indeterminate		4			1	
Euphausiacea						
**Meganyctiphanes norvegica		1				
**Euphasiacea larvae		1		1	1	
Decapoda						
**Decapoda zoea			2			1
Cumacea						
Eudorella spp. indeterminate					1	
Leucon siphonatus	1			1	1	
Leucon spp. indeterminate		1				1
Cumacea sp. 1			1			1
Cumacea sp. 2						1
Cumacea spp. indeterminate				1		

Table 33. Continued.

Species	Station F			Station G		
	1	2	3	1	2	3
Tanaidacea						
Agathotanais cf. hanseni				2	7	
Collettea cf. cylindrata					1	1
Leptognathia breviremus	3		1	1	4	2
Leptognathia sp. 5	8					
Leptognathia sp. 41						1
Leptognathiella sp. 2	2		1	2		2
Neotanais giganteus					1	
Paranarthrura cf. insignis				1		
Pseudotanais sp. 1				4		
Pseudotanais sp. 2		2			2	3
Pseudotanais sp. 3					1	
Pseudotanais spp. indeterminate						1
Siphonolabrum sp. 2	5					
Stenotanais sp. 1			2		2	
Typhlotanais sp. 1	3		1	3	3	2
Typhlotanais sp. 3						1
Typhlotanais trispinosus	2					1
Leptognathiidae spp. indeterminate	2					
Isopoda						
Chelator insignis					6	
Eurycope cf. producta				1		
Eurycope spp. juvenile					1	
Eugerda fulcimandibulata					1	
Eugerda spp. indeterminate						1
Exiliniscus clipeatus				2		
Haplomesus sp. 2				1		
Ilyarachna spp. juvenile		1			1	
Macrostylis sp. 2	6		2	3	1	3
Mirabilicoxa similis						1
Momedossa sp. 1			1	2		2
Oecidiobranchus plebejum				3	3	1
Paramunnopsis sp. 2						1
Pseudomesus sp. 1						1
Thambema sp. 1						1
Whoia angusta			2			
Amphipoda						
Aceroides sp. 1						1
Leptophoxis sp. 1	1			1		
Listriella sp. 1						1
Lysianassidae sp. 10						1

Table 33. Continued.

Species	Station F			Station G		
	1	2	3	1	2	3
ECHINODERMATA						
Echinoidea						
Brissopsis sp. 1			1			
Echinoidea sp. 2 juvenile			1		1	
Echinoidea sp. 3 juvenile					1	
Echinoidea sp. 4 juvenile	1					
Echinoidea spp. indeterminate					1	
Ophiuroidea						
Amphiura griegi						1
Ophiura ljungmani	2	2	3		1	1
Ophiura sp. 1 juvenile	6	3	2	8	11	4
Holothuroidea						
Acanthotrocus mirabilis	1			1	1	
Labidoplax buskii	1	1	1		1	2
Myriotrochus bathybius						1
Myriotrochinae sp. 1 juvenile	3		3	1	2	
CHAETOGNATHA						
**Chaetognatha spp. indeterminate	x	x	x			
HEMICHORDATA						
Enteropneusta sp. 1	1					
Enteropneusta sp. 3			1			
CHORDATA						
Urochordata						
Ascidiacea						
Dicarpa simplex	1		1			
Thaliacea						
**Salpa fusiformis			8			
Total number of benthic animals	295	241	249	446	349	317
Total number of benthic species	89	76	83	101	101	101

x - present
* - colonial forms for which counts could not be determined
** - pelagic forms not included in totals of benthic organisms

Surveys are presented in Table 34. The results of the microbial analysis of sediments collected on the OSV Anderson August 1984 Survey are presented in Table 35. A background level of 6 colony forming units (CFU/g dry weight) was found on the shelf (Stations D2, D3, D14, and A1) and on the slope (Stations 5, 6, 10, and 11). The levels were elevated along the Hudson, Toms, and Wilmington Canyons (Stations 1, 2, 4, 12, 15, 16, 17, D7, D11, and D12), and on the slope south of the 106-Mile Site (Stations A, B, and C). Total coliform bacteria were detected on the shelf (Station 12) during the OSV Anderson August 1984 Survey.

5.3 ENDANGERED SPECIES

A list of endangered or threatened species observed during the three surveys to the 106-Mile Site from August, 1985 to February, 1986, appears in Table 36 (From Battelle, 1987a). Figure 5 shows the locations of these sightings in relation to the 106-Mile Site. The majority of sightings in and adjacent to the 106-Mile Site included several species of dolphins and grampus. A small number of fin and pilot whales and the leatherback turtle were also sighted in the vicinity of the 106-Mile Site during the three surveys.

TABLE 34. *Clostridium perfringens* SPORES PER GRAM DRY WEIGHT OF SEDIMENT COLLECTED FROM THE 106-MILE SITE.

Survey/ Station	Replicate	Number of Assays	$\bar{x}$	CV
OSV Anderson August 1985				
D2	1	2	3.0	7.2
D2	2	4	7.6	101.0
D2	3	4	5.1	72.6
		Overall[1]	5.2	44.0
D3	1	2	2.8	20.2
D3	2	4	6.0	20.1
D3	3	4	6.0	82.8
D3	4	4	11.3	78.0
		Overall	6.5	54.0
D7	1	6	110.0	65.0
D7	2	3	150.0	21.0
		Overall	130.0	21.8
D10	1	5	12.6	54.8
D10	2	6	9.1	73.7
D10	3	6	12.3	41.7
		Overall	11.3	17.1
D11	1	6	48.9	55.8
D11	2	4	28.4	70.2
D11	3	4	46.4	100.0
		Overall	41.2	27.1
D12	1	2	48.9	4.0
D12	1	5	34.0	29.0
D12	3	6	26.9	65.0
		Overall	36.6	30.7
D14	1	4	6.0	47.0
D14	2	4	5.2	42.0
D14	3	2	6.5	41.0
D14	4	4	7.0	41.3
		Overall	6.2	12.4
RV Oceanus August 1985				
A	1	2	76.4	4.4
A	2	2	66.7	39.0
A	3	2	223.8	18.5
		Overall	122.3	72.0
B	1	3	83.2	61.0
B	2	2	70.3	41.0
B	2	3	107.5	36.0
		Overall	87.0	22.0
C	1	2	74.7	49.0
C	2	3	27.0	49.0
C	3	3	34.1	45.9
		Overall	45.3	56.8
OSV Anderson February 1986				
A[1]	1	2	8.5	55.1
A[1]	2	2	6.2	0.6
A[1]	3	2	5.5	0.8
		Overall	6.7	23.3

[1]All assays treated as a single sample per station.

TABLE 35. MICROBIAL ANALYSIS OF SEDIMENTS AT THE 106-MILE SITE (NUMBERS PER GRAM DRY WEIGHT)[a]

Station	C. perfringens Spores $\bar{x}$[b]	CV	Enterococci	Coliform Total	Coliform Fecal	Coliform E. coli	Antiobiotic Resistant Bacteria
1	89	8.1	NA	NA	NA	NA	NA
2	60	24	NA	NA	NA	NA	NA
3	16	NA	3.0 u	3.0 u	3.0 u	3.0 u	3.0 u
4	40	8.8	NA	NA	NA	NA	NA
5	4.8	NA	NA	NA	NA	NA	NA
6	7.4	NA	1.3 u	1.3 u	1.3 u	1.3 u	16 u
10	3.6	NA	NA	NA	NA	NA	NA
11	5.9	NA	NA	NA	NA	NA	NA
12	6.0	23	370	36	5.4 u	5.4 u	NA
13	84	33	6.1 u	6.1 u	6.1 u	6.1 u	61 u
14	14	NA	9.3 u	9.3 u	9.3 u	9.3 u	93 u
15	120	44	4.2 u	4.2 u	4.2 u	4.2 u	NA
16	50	3.2	3.2 u	3.2 u	3.2 u	3.2 u	32 u
17	68	14	2.7 u	2.7 u	2.7 u	2.7 u	27 u

[a]OSV Anderson August 1984 Survey. Source: JRB, (1985).
[b]C. perfringens, triplicate determinations.
u = Sample Detection Limit.
NA = Not Analyzed.

TABLE 36. LISTING OF ALL CETACEAN SPECIES, NUMBERS, AND LOCATIONS OF SIGHTINGS OBSERVED DURING THREE SURVEYS TO THE 106-MILE SITE

Region/ Subregion	Linear km Surveyed	Species	Number	Date	Location
106-MILE DUMPSITE 18 AUG TO 30 AUG 1985					
Southern New England					
Mid-shelf	29.63*	None			
Outer-shelf	5.55	None			
Mid-Atlantic					
Near-shelf	184.26	Leatherback turtle, *Dermochelys coriacea*	1	28 Aug 85	38°48'N, 74°17'W
Mid-shelf	121.76	Bottlenosed dolphin, *Tursiops truncatus*	200 (1)	22 Aug 85	38°35'N, 73°15'W
Outer-shelf	98.15	*T. truncatus*	6	22 Aug 85	38°32'N, 73°17'W
		T. truncatus	25	22 Aug 85	39°14'N, 72°29'W
		Globicephala sp.	3	25 Aug 85	38°30'N, 73°26'W
		Delphinidae sp.	20	23 Aug 85	38°31'N, 73°22'W
		Delphinidae sp.	100	23 Aug 85	38°30'N, 73°26'W
		Balaenoptera sp.	1	21 Aug 85	38°22'N, 74°20'W
		B. sp.	3	22 Aug 85	38°19'N, 73°29'W
		B. physalus	5	22 Aug 85	38°19'N, 73°29'W
		B. physalus	1	22 Aug 85	38°19'N, 73°29'W
106-MILE DUMPSITE 9 TO 19 NOV 1985					
Southern New England					
Mid-shelf	19.90	None			
Near-shelf	74.08	None			
Mid-shelf	106.02	Common dolphin, *Delphinus delphis*	200	19 Nov 85	40°40'N, 71°18'W
		D. delphis	25	19 Nov 85	40°04'N, 71°39'W
Shelf-break	29.16	Grampus, *Grampus griseus*	3	19 Nov 85	39°48'N, 71°48'W
Slope	272.70	Bottlenosed dolphin, *Tursiops truncatus*	75	14 Nov 85	38°29'N, 72°48'W
		T. truncatus	15	11 Nov 85	38°44'N, 72°40'W
		Striped dolphin, *Stenella coeruleoalba*	15	14 Nov 85	38°26'N, 73°03'W
		S. coeruleoalba	75	14 Nov 85	38°27'N, 73°03'W
		S. coeruleoalba	50	15 Nov 85	37°52'N, 73°43'W
		S. coeruleoalba	50	17 Nov 85	38°14'N, 73°15'W
		S. coeruleoalba	50	18 Nov 85	38°49'N, 72°14'W
		Spotted dolphin, *Stenella* sp.	50	15 Nov 85	37°52'N, 73°44'W
		Stenella sp.	30	16 Nov 85	37°51'N, 73°33'W
		Stenella sp.	15	17 Nov 85	38°16'N, 73°13'W
		Common dolphin, *D. delphis*	100	11 Nov 85	38°51'N, 72°33'W
		D. delphis	150	15 Nov 85	37°47'N, 73°44'W
		Grampus, *G. griseus*	3	10 Nov 85	39°10'N, 72°01'W
		Unidentified Delphinid	1	18 Nov 85	38°49'N, 72°14'W
106-MILE DUMPSITE 5 TO 24 FEB 1986					
Southern New England					
Mid-shelf	55.56	None			
Near-shelf	90.28	None			
Mid-shelf	42.13	None			
Mid-Atlantic					
Coastal	94.45	None			
Near-shelf	195.84	Fin whale, *Balaenoptera physalus*	1	14 Feb 86	38°51'N, 74°06'W
		B. physalus	3	16 Feb 86	38°47'N, 74°03'W
		B. physalus	1	16 Feb 86	38°45'N, 73°18'W
		Pilot whale, *Globicephala* spp.	7	16 Feb 86	38°47'N, 73°51'W
Mid-shelf	111.58	Fin whale, *B. physalus*	1	23 Feb 86	38°48'N, 73°02'W
Outer-shelf	17.69	None			
Slope	337.99	Grampus, *Grampus griseus*	6	10 Feb 86	38°37'N, 72°35'W
		G. griseus	6	24 Feb 86	38°37'N, 72°35'W
		G. griseus	3	24 Feb 86	38°37'N, 72°35'W
		Pilot whale, *Globicephala* spp. --	1	23 Feb 86	38°52'N, 73°45'W
		Globicephala spp.	7	24 Feb 86	38°37'N, 72°35'W
		Striped dolphin, *Stenella coeruleoalba*	30	23 Feb 86	38°47'N, 72°33'W
		S. coeruleoalba	150	24 Feb 86	38°37'N, 72°35'W
		Dolphin, unidentified spp.	30	16 Feb 86	38°44'N, 72°42'W

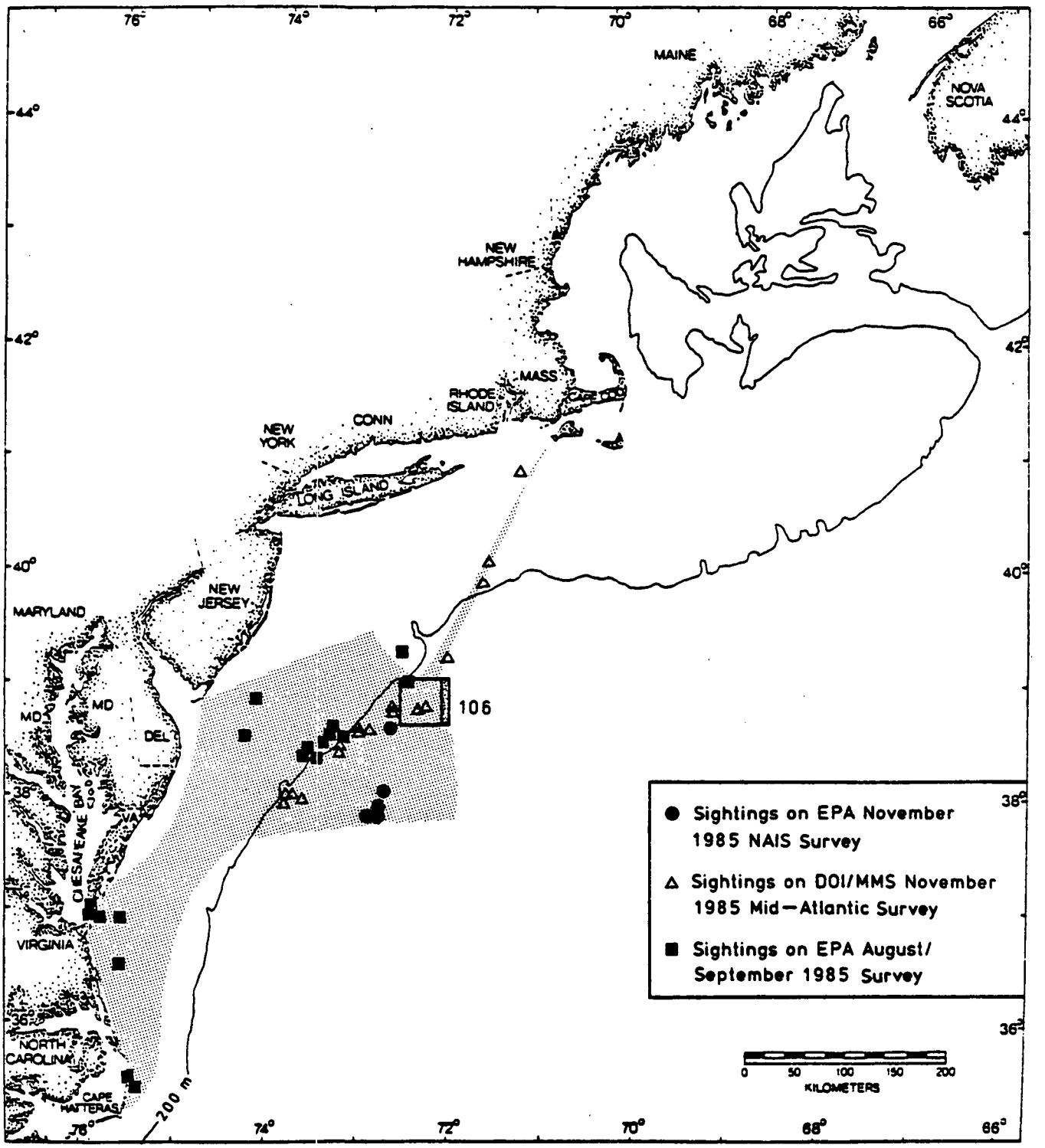

FIGURE 5. LOCATIONS OF CETACEAN SIGHTINGS FROM NAIS AND THE 106-MILE SITE SURVEYS. SHADING DENOTES APPROXIMATE AREA COVERED BY THE THREE SURVEYS.

6.0 DISCUSSION

6.1 COMPARISON OF RESULTS WITH OTHER DATA SETS

6.1.1 Water

6.1.1.1 WATER QUALITY

The estimates of the productivity of site waters (chlorophyll a: 0.3 ng/L, ATP: 25-70 ng/L) obtained on the February 1986 Survey were similar to those obtained by NOAA (1977; chlorophyll a: 0.1 to 0.7 ng/L, ATP: 30 to 300 ng/L). The TSS levels at the site appeared to be higher in 1986 (0.5 to 1 ng/L) than in 1977 (0.03 to 0.1 mg/L; NOAA, 1981). However, the technique used for analysis on the 1986 survey is not sensitive enough to allow conclusions to be made.

6.1.1.2 TRACE METALS

If the chromium concentrations are corrected for the field blank, the values on the slope were similar to concentrations reported for the North Atlantic (Campbell and Yeats, 1981). Iron increased in concentration (13 µg/L) at the nearshore Station A1. Symes and Kester (1985) found that iron concentrations decreased from 28 µg/L in the New York Bight to 0.2 µg/L on the edge of the shelf, suggesting that the elevated levels at A1 were due to offshore transport of the more highly contaminated coastal waters. Cadmium showed an enrichment in the subthermocline water. This increase, typical for cadmium in open-ocean water (Wallace et al., 1983), is thought to be due to desorbtion of the metal from settling particles.

6.1.1.3 ORGANIC COMPOUNDS

Because of the difficulty in detecting organic compounds at open-ocean levels, there have been few studies in this area. A study by Battelle

(1987d) in 1985 at the proposed North Atlantic Incineration Site, located on the southern edge of the 106-Mile Site, did detect small amounts (1-8 ng/L) of dissolved naphthalene compounds. Benzofluoranthene, benzo-(a)pyrenes, and benzo(e)pyrene were also detected in three samples. The benzofluoranthene concentration was 72 ng/L at a station in the southeast corner of the proposed incineration site. PCBs (210-960 pg/L) were also detected at three stations (Battelle, 1987a). These levels were lower than previously reported levels of PCB in open-ocean North Atlantic water (Harvey and Steinhauer, 1976). The concentrations of organic compounds in suspended particulate matter at the NAIS site were at or below detection limits (Battelle, 1987a).

6.1.2 Sediments

6.1.2.1 GRAIN SIZE

The results of the grain size, TOC, and metals analyses of site and adjacent sediments were within the ranges reported by NOAA (1977, 1983) and Maciolek et al. (1986). The grain-size distributions for slope sediments ranged between 75 and 95 percent silt-clay. There was one exception, an area to the southwest of the site (Station 6, OSV Anderson, August 1984 Survey and one replicate of Station F, RV Gyre, November 1985 Survey) found to contain approximately 50 percent sand. This distribution was found when this area was sampled during the MMS Mid-Atlantic Sampling Program (Maciolek et al., 1986; Station 12).

The coarse-grain material tends to dominate sediments along seaward extensions of canyons (NOAA, 1983). This enrichment of coarse material may be due to bottom currents in the canyons that resuspend and tranport fine-grain sediments (Shepard, 1973).

6.1.2.2 TRACE METALS

The trace metal content of the fine-grain sediments on the slope was relatively uniform (Cd: 1.1-1.8 µg/g, Cr: 20-30 µg/g, Cu: 20-30 µg/g, Pb: 8

to 20 µg/g, and Zn: 40-55 µg/g (NOAA, 1977)). The metal concentrations of the sediments reported in this document (Tables 29 and 30) were within these ranges.

6.1.2.3 ORGANIC COMPOUNDS

The concentrations of individual PAH compounds ranged from 1 to 100 ng/g in sediments on the slope (Maciolek et al., 1986). These concentrations are below the detection limits found for the analyses reported in this document. The MMS Study (Maciolek et al., 1986) reported TOC concentrations of 8 to 15 mg/g. The TOC concentrations reported in this document were between 4 and 10 mg/g.

6.1.2.4 BENTHIC INFAUNA

In general, the species compositions at both Stations F and G were highly similar to those recorded by Maciolek et al. (1986) at the MMS stations. The infaunal densities of Stations G and F correspond very well with densities reported from stations sampled at similar depths (2020 to 2500 m) on the Mid-Atlantic slope (Maciolek et al., 1986), and are much higher than densities reported by Pearce et al. (1977). In the latter study, screens with coarser mesh than those used in the current study probably resulted in a loss of many of the small-bodied organisms that constitute the infauna at these depths.

Aurospio dibranchiata, the dominant species at Station F, was also reported as the top dominant at the MMS station at 2500 m as well as at several stations between 2020 and 2195-m depth in the same general area (Maciolek et al., 1986); at those stations A. dibranchiata also accounted for 7 to 10 percent of the infaunal organisms.

The dominant species at Station G, Aspidosiphon zinni, is common in slope and rise depths, but has previously been recorded as a dominant only at mid-slope depths of 1500 to 1600 m (Maciolek et al., 1986). Only three individuals of this species occurred at Station F, accounting for less than 1

percent of the fauna. At the MMS station at 2500 m, A. zinni accounted for 1.8 percent of the fauna over a two-year period. The occurrence of this large burrowing form does not appear to be correlated to total organic carbon in the sediments nor to grain size.

6.2 DISTRIBUTIONAL TRENDS OF THE MEASURED PARAMETERS

The surface waters of the 106-Mile Site and vicinity was characterized by two water masses during the February 1986 Survey. The warmer, more saline Gulf Stream water was above the colder, less saline shelf water at Stations A3, A5, and A6. Station A1 was entirely shelf water, whereas Stations A2 and A4 were mixtures of the two water masses.

The two water masses had distinct characteristics. The shelf water (Station A1) was more turbid and highly productive than the Gulf Stream water (Stations A3, A5, and A6). The shelf water was also more contaminated by some parameters, e.g., higher concentrations of Fe, PAH, and C. perfringens spores. The detection of C. perfringens spores and particulate coprostanol is indicative of the presence of sewage sludge. Although seawater filtrate would be contain higher levels of PAH and selected pesticides, PAH, pesticide, and PCB levels were uniformly low in both filtrate and particulate samples. Except for α-BHC found in all filtrate samples, no contaminant distribution patterns were evident from these analyses. No significant differences were seen between shelf and slope, or between surface and subsurface waters. Metals analyses revealed that cadmium was enriched in subthermocline water due to desorbtion of particles.

The only sediment parameter to show a trend was the number of C. perfringens spores. The microbial data indicated that the spores may be transported down the Hudson Canyon and out onto the continental slope (RV Gyre August 1985 Survey, Stations A, B, and C). This observation is substantiated by the detection of spores in the bottom water. The reproducibility of the measurements can be demonstrated by comparing the results found at one site in 1984 (Station 12, 61 CFU/g dry weight) with the results from 1985 (Station 11, 41 CFU/g dry weight).

6.3 CONCLUSIONS

The analyses reported in this document establish the baseline conditions at the 106-Mile Site. In general, the environmental conditions measured at the 106-Mile Site are similar to those in other slope areas. This similarity allows comparisons between these areas and the 106-Mile Site to determine changes in environmental conditions.

The 106-Mile Site is subject to the transport of contaminants from the coast. Sediment particles from the shelf may be transported down canyons out onto the slope. The occurrence of C. perfringens spores and DDT in the sediments near the Hudson Canyon may be due to this process. A previous study (Battelle, 1987d) found that DDT could be traced from the 12-Mile Dumpsite down the Hudson Canyon. The 12-Mile Dumpsite is also the most likely source of C. perfringens spores.

Discernible differences between shelf and slope water seen during these surveys suggests that contaminants may also be introduced to the 106-Mile Site during overruns of the more contaminated shelf waters. Shelf water contained significantly higher levels of the fecal tracers, C. perfringens and coprostanol, and contained higher levels of total iron than slope water. Levels of most contaminants in seawater at the 106-Mile Site are at or near detection levels. Because of the lack of any organic contaminants found in seawater particulates in these background samples, and because of the association of sludge contaminants with particulate matter, particulate sampling may have great utility for monitoring the fate of sludge at the site.

Monitoring must address the fact that environmental conditions in the water column at this site are dependent on the water mass present at the time of sampling. The highly variable nature of the water column and the potential transport of sediments into the 106-Mile Site emphasize the importance of farfield monitoring. The occurrence of long-term environmental degradation may be due to transport of contaminants into the 106-Mile Site, rather than due to ocean dumping.

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