FINAL

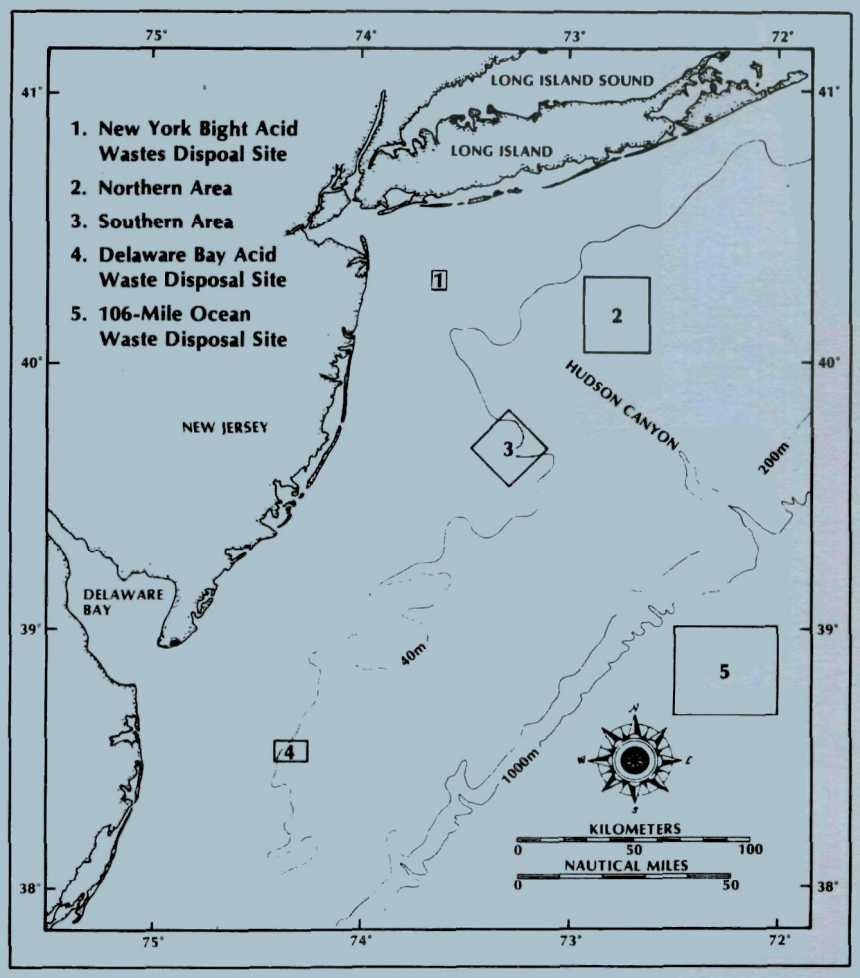
ENVIRONMENTAL IMPACT STATEMENT (EIS)

for

106-MILE OCEAN WASTE DISPOSAL SITE DESIGNATION

December 1979

EPA



Prepared for
U.S. ENVIRONMENTAL PROTECTION AGENCY
Oil and Special Materials Control Division
Marine Protection Branch
Washington, D.C. 20460

FINAL

ENVIRONMENTAL IMPACT STATEMENT (EIS)

for

106-MILE OCEAN WASTE DISPOSAL SITE DESIGNATION

December 1979

EPA

Prepared Under Contract 68-01-4610
T. A. Wastler, Project Officer
for
U.S. ENVIRONMENTAL PROTECTION AGENCY
Oil and Special Materials Control Division
Marine Protection Branch
Washington, D.C. 20460

ENVIRONMENTAL PROTECTION AGENCY

FINAL
ENVIRONMENTAL IMPACT STATEMENT ON THE 106-MILE OCEAN WASTE DISPOSAL SITE DESIGNATION

Prepared by: U.S. Environmental Protection Agency
Oil and Special Materials Control Division
Marine Protection Branch
Washington, D.C. 20460

Approved by: _____ _____

T. A. Wastler
Project Officer

Date

SUMMARY SHEET

ENVIRONMENTAL IMPACT STATEMENT
FOR
106-MILE OCEAN WASTE DISPOSAL SITE DESIGNATION

( ) Draft

(X) Final

( ) Supplement to Draft

ENVIRONMENTAL PROTECTION AGENCY

OFFICE OF WATER PROGRAM OPERATIONS

MARINE PROTECTION BRANCH

1. Type of Action

(X) Administrative/Regulatory action

( ) Legislative action

2. **Brief description of background of action and its purpose indicating what States (and counties) are particularly affected.**

The proposed action is the designation of the 106-Mile Ocean Waste Disposal Site for continuing use. The site is approximately 130 nmi (240 km) east of Cape Henlopen, New Jersey, and is primarily used by industries in the New York-New Jersey-Delaware area. The purpose of the action is to provide an environmentally acceptable area for the disposal of wastes which (1) comply with EPA's rigid marine environmental impact criteria, or (2) must be ocean-disposed until a suitable land-based disposal method is available.

3. **Summary of major beneficial and adverse environmental and other impacts.**

The 106-Mile Site has been used for ocean disposal since 1961. Since that time, it has received a wide variety of waste materials with no apparent long-term adverse impact. Short-term impacts of current dumping are known to occur - primarily on the plankton in the barge wake. Other impacts are still subjects of research studies underway at the site. EPA's site management policies mitigate adverse impacts by regulating amounts and kinds of wastes, and discharge frequencies and rates. None of the environmental impacts of waste disposal at the 106-Mile Site is known to cause irreversible damage to the site environment.

4. **Major alternatives considered.**

The alternatives considered in this EIS are (1) no action, which would require the use of land-based methods or the shutdown of the waste producing manufacturing processes, and (2) use of another ocean site for these wastes - the New York Bight Acid Wastes Site, the Delaware Bay Acid Waste Site, or the Northern and Southern Areas near the Hudson Canyon.

5. **Comments have been requested from the following:**

<u>Federal Agencies and Offices</u>

Council on Environmental Quality
Department of Commerce
    National Oceanic and Atmospheric Administration
    Maritime Administration
Department of Defense
    Army Corps of Engineers
    Office of the Oceanographer of the Navy
    Department of the Air Force
Department of Health, Education, and Welfare

Department of the Interior

- Fish and Wildlife Service
- Bureau of Outdoor Recreation
- Bureau of Land Management
- Geological Survey

Department of Transportation

- Coast Guard

National Aeronautics and Space Administration

Water Resources Council

National Science Foundation

States and Municipalities

Connecticut, Delaware, Maryland, Massachusetts, New Jersey, New York, Pennsylvania, Rhode Island, Virginia

New York City, N.Y.; Camden, N.J.; Office of the Public Advocate, Trenton, N.J.; Philadelphia, Pa.

Private Organizations

National Wildlife Federation

American Eagle Foundation

Sierra Club

Environmental Defense Fund, Inc.

Resources for the Future

Water Pollution Control Federation

National Academy of Sciences

American Littoral Society

Center for Law and Social Policy

American Chemical Society

Manufacturing Chemists Association

Academic/Research Institutions

Lamont-Doherty Geological Observatory
University of Rhode Island
Woods Hole Oceanographic Institute
University of Delaware
New York State University
Rutgers University

6. **The draft statement was officially filed with the Director, Office of Environmental Review, EPA, on or about June 22, 1979.**

7. **The 45-day review period for comments on the Draft EIS began on June 29, 1979.**

Comments on the Final EIS should be addressed to:

Mr. T.A. Wastler
Chief, Marine Protection Branch (WH-548)
Environmental Protection Agency
Washington, D.C. 20460

Copies of the Final EIS may be obtained from:

Environmental Protection Agency
Marine Protection Branch (WH-548)
Washington, D.C. 20460

Environmental Protection Agency
Region II
Surveillance and Analysis Division
Edison, N.J. 08817

The final statement may be reviewed at the following locations:

Environmental Protection Agency
Library
401 M Street, SW
Washington, D.C.

Environmental Protection Agency
Region II
Library, Room 1002
26 Federal Plaza
New York, N.Y.

Environmental Protection Agency
Region II
Woodbridge Ave.
GSA Raritan Depot
Edison, N.J.

NOAA/MESA NY Bight Project
Old Biology Bldg.
State University of New York
Stony Brook, N.Y.

SUMMARY

This Environmental Impact Statement (EIS) provides documentation of data and analyses supporting the formal designation of the 106-Mile Ocean Waste Disposal Site for continued ocean waste disposal. It evaluates the types of industrial materials which may be disposed of at the site, presents rationale for consideration of the site as an alternate site for the emergency disposal of sewage sludge, and provides guidance for EPA management of the site through the ocean dumping permit program.

ORGANIZATION OF THE ENVIRONMENTAL IMPACT STATEMENT

The EIS has three levels of detail: This summary highlights significant points of the chapters, thereby permitting readers to understand major points without reading the entire text. The main text contains additional technical information, with full discussions of the options and decisions. The Appendices contain supplemental technical data and information which amplify and support the decisions. It is not necessary to read the Appendices to understand the rest of the document.

Five chapters comprise the main body of the EIS:

- Chapter 1 specifies the purpose of and need for the proposed action and presents background material relevant to ocean waste disposal. The legal framework by which EPA selects, designates, and manages ocean waste disposal sites is described.
- Chapter 2 presents alternatives to designating the 106-Mile Site, outlines procedures by which alternatives were chosen and evaluated, and summarizes the relevant comparisons of all alternatives.
- Chapter 3 describes the environmental features of the 106-Mile Site and the alternative sites. The history of waste disposal and other activities in the site vicinities is fully described.
- Chapter 4 discusses the environmental consequences of waste disposal at the alternative sites and at the proposed site.
- Chapter 5 discusses the feasibility of sewage sludge disposal at the 106-Mile Site.

Five Appendices are included to support the text:

- Appendix A is a compendium of environmental data and information on the 106-Mile Site.
- Appendix B discusses in detail current and historical waste disposal practices at the 106-Mile Site.
- Appendix C provides information on present monitoring practices at the site, and defines general guidelines for future site monitoring.
- Appendix D presents Chapter III of the Final Environmental Impact Statement on the Ocean Dumping of Sewage Sludge in the New York Bight (EPA, 1978), describing alternatives to ocean dumping of sewage sludge.
- Appendix E contains public comments received on the draft EIS and EPA's responses.

PROPOSED ACTION

EPA proposes to designate the 106-Mile Ocean Waste Disposal Site (Figure S-1) for continuing use. This action will satisfy the need for a suitable location off the Middle Atlantic States for the disposal of certain wastes which satisfy the criteria for ocean disposal under EPA's ocean dumping permit program. The criteria are based on a demonstrated need for ocean disposal in preference to land-based alternatives, and an evaluation of the potential impact on the marine environment.

As this EIS demonstrates, there is a present need for ocean disposal of some industrial chemical wastes and municipal sewage sludge in the northeastern United States. This need comprises four categories of materials:

(1) Materials which comply with the marine environmental impact criteria and for which land-based disposal alternatives are less acceptable than ocean disposal

(2) Materials which comply with the impact criteria and for which land-based alternatives are under development

(3) Materials which do not comply with the impact criteria but for which land-based alternatives will be imposed by 1981

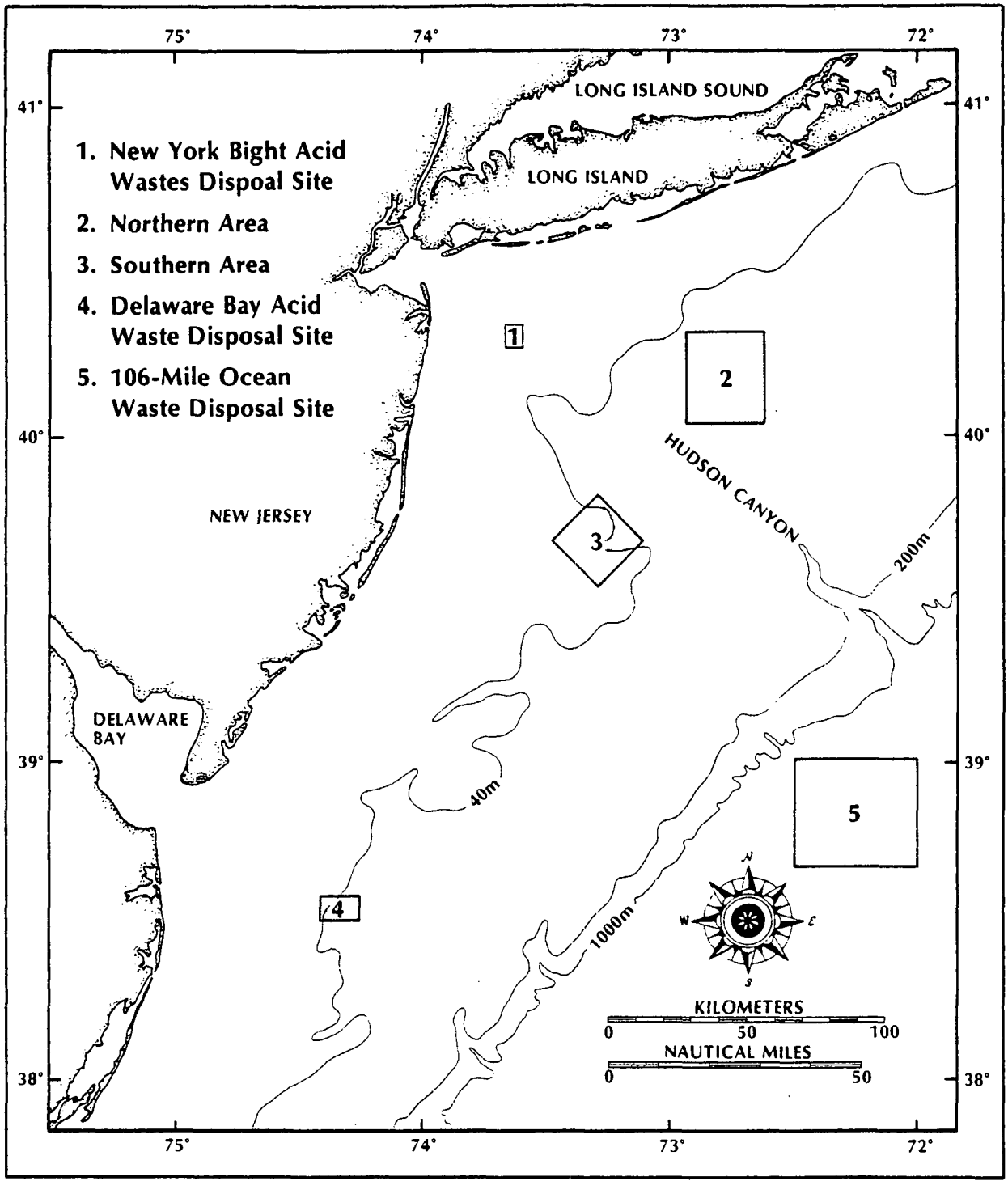


Figure S-1. Proposed Site and All Alternative Sites

(4) Materials which must be ocean-dumped under emergency conditions, either because they represent a health hazard, or because no feasible alternative is available at the time of the emergency.

The 106-Mile Site was first used for waste disposal in 1961. In 1973, the site was designated by EPA for disposal of industrial wastes on an interim basis, pending completion of trend assessment surveys. Designation of the site for continuing use will permit approved disposal of industrial wastes presently dumped there and will provide for a disposal site for new wastes judged acceptable for disposal.

More than 100 industries previously dumped wastes at the 106-Mile Site, but only four industrial permittees now remain: E.I. du Pont de Nemours and Co. (Edge Moor and Grasselli plants), Merck and Co., and American Cyanamid Co. Of the four, Du Pont-Edge Moor, Merck, and American Cyanamid are scheduled to cease ocean disposal by the end of 1981, when they will complete implementation of land-based alternatives. Du Pont-Grasselli, the remaining permittee, will continue ocean disposal, since no viable land-based alternatives to ocean disposal are presently available which are environmentally acceptable, and the waste presently complies with EPA's marine environmental impact criteria.

Municipal sewage sludge has been dumped at the 106-Mile Site. The City of Camden, New Jersey, used the site during 1977 and 1978; digester clean-out sludges from New York/New Jersey metropolitan area wastewater treatment plants have also been dumped there. Future use of the site for additional sewage sludge disposal will be considered only if it is determined by EPA that the New York Bight ("12-Mile") Sewage Sludge Disposal Site cannot safely accommodate any more sewage sludge without endangering public health or degrading coastal water quality.

OVERVIEW

Ocean dumping, particularly in the heavily populated northeast, has been used as an ultimate means of waste disposal for generations in the United States. Before the early 1970's, there was very little regulation of ocean waste disposal. Limited regulation was provided primarily by the New York Harbor Act of 1888, which empowered the Secretary of the Army to prohibit disposal of wastes, except from streets and sewers, into the harbors of New York, Hampton Roads, and Baltimore. The Refuse Act of 1899 prohibited the disposing of materials into navigable waters when disposal impeded safe navigation. Under these Acts, selection of disposal locations by the U.S. Army Corps of Engineers (CE) and the issuance of permits for ocean disposal were based primarily on transportation and navigation factors rather than on environmental concerns.

Public interest in the effects of ocean disposal was aroused in 1969 and 1970 by a number of incidents involving the disposal of warfare agents in the ocean. Simultaneously, studies by the National Oceanic and Atmospheric Administration (NOAA), and several universities, identified potentially adverse effects of sewage sludge and industrial waste disposal in the New York Bight. The Council on Environmental Quality (CEQ) 1970 report to the President identified poorly regulated waste disposal in the marine environment as a potential environmental danger.

CEQ's report, and the increasing public awareness of the potential undesirable effects of poorly regulated ocean waste disposal, were primarily responsible for the enactment of the Marine Protection, Research, and Sanctuaries Act (MPRSA) of 1972, the primary U.S. legislation now regulating barged waste disposal in the ocean. In the fall of 1972, when it became apparent that Congress would promulgate an act to regulate ocean disposal, EPA began developing criteria to provide an effective technical base for the regulatory program. During the development of the technical criteria, EPA sought advice and counsel from EPA marine scientists, and from marine specialists in universities, industries, environmental groups, and Federal and State agencies. The criteria were published in May 1973, finalized in

October 1973, and revised in January 1977. The criteria are used in evaluating the need for ocean waste disposal and potential impact on the marine environment.

Ocean disposal became an international topic of concern and discussion in this same period. An intergovernmental conference, held in London in the fall of 1972, developed the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter. This Convention regulates ocean waste disposal at the international level with provisions for prohibited materials and regulation of dumping by participating nations. The MPRSA was amended in March 1974 to bring the national legislation into full compliance with the International Convention.

The EPA Ocean Dumping Regulations and Criteria contain provisions for selecting, designating, and managing ocean disposal sites, and for issuing permits to use the sites for waste disposal. Thirteen interim municipal and industrial waste disposal sites (most of them located in the U.S. mid-Atlantic) were listed in EPA's Final Ocean Dumping Regulations and Criteria published in January 1977. Existing sites will continue to be used for the disposal of specific materials on an interim basis, pending completion of baseline or trend assessment surveys, and ultimate designation for continuing use or termination of use. EPA and NOAA are presently conducting trend assessment surveys to support preparation of Environmental Impact Statements (EIS's) on most sites proposed for continuing use. The subject of this EIS is the proposed designation of the 106-Mile Ocean Waste Disposal Site for continuing use and a determination of the types and quantities of wastes which can be disposed of at the site in an environmentally acceptable manner.

MAJOR ALTERNATIVES

The major alternatives to designation of the 106-Mile Site for continuing use are: (1) no action, thereby requiring current permittees to use other disposal methods (primarily land-based), or, in the absence of non-ocean

alternatives, forcing shutdown of activities which generate wastes presently dumped at the site; and (2) use of an alternative ocean disposal site for 106-Mile Site wastes - either an existing site or a new one. The mid-Atlantic Continental Shelf and Slope were evaluated for potential alternative disposal sites. As a result of this evaluation, four locations were selected for detailed evaluation as possible alternative sites: the New York Bight Acid Wastes Disposal Site, the Delaware Bay (formerly Du Pont) Acid Waste Disposal Site, the New York Bight Southern Area, and the New York Bight Northern Area (Figure S-1). Each alternative was evaluated for environmental acceptability, monitoring and surveillance requirements, associated economic burden, and logistics, and compared to use of the 106-Mile Site. As a result of this evaluation, the 106-Mile Site was judged the best location.

Of the eight existing waste disposal sites in the mid-Atlantic, two were considered viable alternatives to the 106-Mile Site - the New York Bight and Delaware Bay Acid Waste Sites. The remaining sites are used only for disposal of non-industrial wastes, are small, and are in heavily utilized areas.

Two other alternative locations on the mid-Atlantic Continental Shelf were also examined in detail: the so-called Northern and Southern Areas, located mid-way between the nearshore alternative sites and the 106-Mile Site. Although not previously designated disposal sites, these areas were surveyed by NOAA and EPA to provide background environmental data for assessing the advisability of using one of the locations for sewage sludge disposal. As a result of this analysis, a small portion of the Northern Area is now a designated alternate sewage sludge disposal site.

AFFECTED ENVIRONMENT

The 106-Mile Site is in the mid-Atlantic just beyond the edge of the Continental Shelf. The site is oceanic in nature; it is deep (1,400 m to 2,800 m) and the water masses and biology of the area are more like the open ocean to the east than the coastal environment to the west. Typical of surrounding waters, the site does not appear to be highly productive. The bottom terrain is a vast plain sloping to the east, punctuated by several submarine canyons. The site is currently used primarily for ocean disposal of industrial chemical wastes and its use is managed by EPA Region II. From 1961 to 1978, approximately 5.1 million metric tons of chemical wastes, 102 thousand metric tons of sewage sludge, and 287 thousand metric tons of digester residue were dumped at the site. An inactive munitions disposal site is located within the boundaries of the 106-Mile Site and an inactive radioactive waste disposal site is 10 nmi (18 km) south of the southern edge of the 106-Mile Site. Results of surveys conducted at the site are summarized later in this section.

The New York Bight Acid Wastes Site and the Northern and Southern Areas are in the New York Bight, over the Continental Shelf. The sites are shallow (25 to 53 m), and the water and biota are characteristic of the Shelf region. The Hudson Canyon separates the Southern and Northern Areas and terminates near the Acid Site. Potentially valuable biological resources exist near the Acid Site and Southern Area. Mineral resource development is occurring near the Southern Area. Waste disposal in the Acid Site and Southern Area could conflict with these other uses. Activities which could conflict with waste disposal operations are not expected to occur in the Northern Area.

Only the New York Bight Acid Wastes Site, 15 nmi (28 km) offshore, has been used for ocean waste disposal. From 1958 to 1978, 45.2 million metric tons of acid and caustic wastes were released at the site. After numerous special studies and a continuing environmental monitoring program, only short-term

adverse effects from waste disposal have been observed. Long-term adverse effects of waste disposal at the Acid Site may be masked by the presence of many more significant sources of contamination in the Bight. Because of the difficulty of differentiating the effects of the different pollutants, no long-term effects unique to the acid waste have been identified, nor is it known if any significant long-term effects of this waste exist. Waste disposal has not occurred in either the Southern or Northern Areas, although the Alternate New York Sewage Sludge Site has been designated for use, if required, and comprises a small section on the eastern edge of the Northern Area.

The Delaware Bay Acid Waste Site is just south of the New York Bight, approximately 30 nmi (55 km) off the Delaware coast. The site is located on the Continental Shelf and is shallow (38 to 45 m). Water and biota in the site vicinity are typical of other mid-Atlantic Shelf regions. Bottom sediments are medium to fine sands; the relatively smooth topography is punctuated with sand ridges and swales. Valuable shellfish resources exist in and near the site, however, their exploitation is currently restricted because the area is closed to shellfishing due to the Philadelphia Sewage Sludge Site, located only 5 nmi (9 km)south. From 1973 to 1977, 2.3 million metric tons of Du Pont-Edge Moor acid wastes were released at the site; it has been inactive since March 1977 when Du Pont's dumping was transferred to the 106-Mile Site. Environmental studies and monitoring for impacts of acid disposal on the environment have been inconclusive. Preliminary studies identified elevated vanadium concentrations in shellfish from the site vicinity; however, no direct link has been established between these observations and the acid waste disposal.

ENVIRONMENTAL CONSEQUENCES

Environmental consequences of industrial waste disposal at the proposed site and alternative sites were assessed. The total environmental consequences of industrial waste disposal at the 106-Mile Site are uncertain despite several years of study; however, continuing to use this site for waste

disposal is judged acceptable, given the alternatives. Two characteristics of the 106-Mile Site make it the best ocean location for disposing of industrial wastes: extreme depth and low biological productivity.

The depth of the 106-Mile Site is its greatest advantage over all alternative sites, which are shallower. This permits materials dumped at the site to disperse widely and dilute rapidly. As long as a waste resides in the water column, it is subject to horizontal dispersion. Once the waste reaches the seafloor, it may persist in one location and perhaps accumulate there. Studies at the site have shown that the wastes are generally restricted to the water column above the seasonal or permanent thermocline and do not reach the seafloor in measureable quantities.

The standing crop of organisms at the 106-Mile Site is often less than the standing crop on the Continental Shelf, therefore the total damage to organisms from dumping will be less at the 106-Mile Site than at alternative sites. However, studies show that some oceanic organisms are more sensitive to wastes than similar organisms taken from heavily used coastal areas. Therefore, while waste dilutions are sufficient to minimize adverse effects in the water, effects on indigenous organisms are more likely at the 106-Mile Site than at alternative sites. Although less total damage will occur at the 106-Mile Site than at alternative coastal sites, the potential for localized damage is probably greater.

Known negative consequences of ocean disposal are expected at the 106-Mile Site; however, these negative factors (primarily economic), do not outweigh the potential negative environmental consequences of using alternative sites:

- The distance of the 106-Mile Site from ports requires (for disposal and monitoring) the use of vessels with extended sea-going capability. Increased wages, fuel costs, and other operating expenses, make waste disposal at a distant site economically disadvantageous to waste generators, compared to disposal at nearshore sites.

- Unless automatic surveillance is developed and implemented, surveillance at the 106-Mile Site will usually require the use of shipriders.

- Laboratory and field studies indicate that acute short-term mortality of sensitive plankton will occur immediately upon discharge of wastes; however, mortality will be mitigated by the rapid dilution and dispersion of wastes in seawater within the site. Short-term plankton mortality would be expected at any ocean disposal site, however, oceanic organisms may be more sensitive to stress than coastal organisms.

The state of knowledge on adverse dumping effects at this site, especially long-term effects, is incomplete. Several years of background work were necessary before studies of specific long-term effects could be initiated. During that time, successful techniques for tracking and sampling the waste plume were developed. These refined sampling techniques and the past data on background environmental conditions at the site, will permit future studies at the site to concentrate on effects of the waste on the biota in the waste plume. Does [illegible]

SEWAGE SLUDGE DISPOSAL

The feasibility of using the 106-Mile Site for municipal sewage sludge disposal is addressed as a special case. It is acknowledged that the only reasonable long-term solution for disposal of harmful sewage sludge is by means of land-based processes; however, adverse conditions at the existing New York Bight Sewage Sludge Site could require moving sludge disposal to another site. Effects of past sludge disposal at the 106-Mile Site and at other sludge disposal sites were evaluated to provide a basis for determining impacts from future sludge disposal at the 106-Mile Site. On this basis, use of the site for sludge disposal is determined to be feasible, provided that monitoring of short- and long-term effects is instigated concurrent with sludge dumping and that chemical wastes and sewage sludge are separated. Other conditions are treated in Chapter 5.

CONCLUSIONS

After carefully evaluating all reasonable alternatives, EPA proposes that the 106-Mile Ocean Waste Disposal Site receive final designation for continuing industrial waste disposal, in accordance with the EPA Ocean Dumping Regulations and Criteria. However, in keeping with the MPRSA, exploration of alternatives to ocean disposal should continue, and such research and development should be conditions imposed on waste generators receiving ocean disposal permits.

Industrial wastes permitted for disposal at the site should have the following characteristics:

- Aqueous, with concentrations of solids sufficiently low, so that waste materials are dispersed within the upper water column
- Neutrally buoyant or slightly denser than seawater such that, upon mixing with seawater, the material does not float
- Demonstrate low toxicity and low bioaccumulation potential to representative marine organisms
- Contain no materials prohibited by the MPRSA or the London Ocean Dumping Convention
- Contain constituents in concentrations which are diluted such that the limiting permissible concentration for each constituent is not exceeded beyond the disposal site boundaries during initial mixing (4 hours) and not exceeded inside or outside of the site after initial mixing
- Dischargeable from a moving vessel, to enable rapid and immediate dilution.

Each waste load should be sufficiently small to permit adequate dispersal of the waste constituents before disposal of the next load, and to prevent accumulation of waste materials due to successive dumps. Vessels releasing wastes simultaneously should be located in different quadrants of the site, to provide for maximum dilution of wastes within the site boundaries.

All future permits should contain the following conditions:

(1) Independent shiprider surveillance of disposal operations will be conducted by the USCG or an objective observer (the latter at permittee's expense) with a program goal of 75% surveillance.

(2) Comprehensive monitoring for long-term impacts will be accomplished by Federal agencies and for short-term impacts by permittees or by environmental contractors (the latter at permittee's expense). All permittee monitoring studies are subject to EPA approval. Short-term monitoring should include laboratory studies of waste characteristics and toxicity, and field studies of waste behavior following discharge and the effect of wastes on local organisms. Long-term monitoring should include studies of chronic toxicity of the waste at low concentrations and field studies of the fate of materials, especially any particulates formed after discharge.

(3) EPA will enforce a discharge rate based on the limiting permissible concentration, disposal in specified quadrants of the site, and maintenance of a 0.5 nmi (0.9 km) separation distance between vessels.

(4) Key constituents will be analyzed routinely in waste samples, at frequencies to be determined by EPA on a case-by-case basis, but sufficient to evaluate accurately mass loading at the site.

(5) Routine bioassays will be performed on waste samples using appropriate sensitive marine organisms.

It is further proposed that use of the site for sewage sludge disposal be decided by EPA case-by-case, and on the basis of severity of need. Any permit issued should include provisions for adequate monitoring and surveillance to ensure that no significant adverse impacts result from disposal. Sludge disposal should be allowed at the site only under the following conditions:

- Provided the existing New York Bight Sewage Sludge Site cannot safely accommodate more sludge disposal without endangering public health, severely degrading the marine environment, or degrading coastal water quality.

- Independent surveillance by the U.S. Coast Guard or an unbiased observer (the latter at the permittee's expense) will be conducted.

- Monitoring for short- and long-term impacts will be accomplished by Federal agencies and environmental contractors (the latter at the permittee's expense). This monitoring must include studies of the fate of solids and sludge micro-organisms, inside and outside of the site, and a comprehensive analysis of environmental effects.

- Vessels will discharge the sludge into the wake so that maximum turbulent dispersion occurs.

- Vessels discharging sludge will be sufficiently separated from vessels discharging chemical wastes to prevent the two types of wastes from mixing.

- Key constituents of the sludge will be routinely analyzed in barge samples at a frequency to be determined by EPA on a case-by-case basis, but sufficient to evaluate accurately mass loading at the site.

- Routine bioassays will be performed on sludge samples using appropriate sensitive marine organisms.

TABLE OF CONTENTS

Chapter	Title	Page
	SUMMARY	xi
	ORGANIZATION OF THE ENVIRONMENTAL IMPACT STATEMENT	xi
	PROPOSED ACTION	xii
	OVERVIEW	xv
	MAJOR ALTERNATIVES	xvi
	AFFECTED ENVIRONMENT	xviii
	ENVIRONMENTAL CONSEQUENCES	xix
	SEWAGE SLUDGE DISPOSAL	xxi
	CONCLUSIONS	xxii
1	**PURPOSE OF AND NEED FOR ACTION**	1-1
	FEDERAL LEGISLATION AND CONTROL PROGRAMS	1-3
	Marine Protection, Research, and Sanctuaries Act	1-5
	Ocean Disposal Site Designation	1-9
	Ocean Dumping Permit Program	1-13
	INTERNATIONAL CONSIDERATIONS	1-15
2	**ALTERNATIVES INCLUDING THE PROPOSED ACTION**	2-1
	NO-ACTION ALTERNATIVE	2-2
	CONTINUED USE OF THE 106-MILE SITE	2-3
	Environmental Acceptability	2-4
	Environmental Monitoring	2-7
	Surveillance	2-8
	Economics	2-8
	Logistics	2-10
	USE OF ALTERNATIVE EXISTING SITES	2-10
	New York Bight Acid Wastes Disposal Site	2-12
	Delaware Bay Acid Waste Disposal Site	2-18
	USE OF NEW SITES	2-22
	Locations on the Continental Shelf	2-22
	Locations Off the Continental Shelf	2-28
	SUMMARY	2-29

TABLE OF CONTENTS (continued)

Chapter	Title	Page
	BASES FOR SELECTION OF THE PROPOSED SITE	2-34
	Geographical Position, Depth of Water Bottom Topography and Distance from Coast	2-34
	Location in Relation to Breeding, Spawning, Nursery, Feeding, or Passage Areas of Living Resources in Adult or Juvenile Phases	2-35
	Location in Relation to Beaches and Other Amenity Areas	2-35
	Types and Quantities of Wastes Proposed to be Disposed of, and Proposed Methods of Release, Including Methods of Packing the Waste, if Any	2-35
	Feasibility of Surveillance and Monitoring	2-36
	Dispersal, Horizontal Transport and Vertical Mixing Characteristics of the Area, Including Prevailing Current Direction and Velocity	2-36
	Existence and Effects of Current and Previous Discharges and Dumping in the Area (Including Cumulative Effects)	2-36
	Interference with Shipping, Fishing, Recreation, Mineral Extraction, Desalination, Fish and Shellfish Culture, Areas of Special Scientific Importance, and Other Legitimate Uses of the Ocean	2-37
	The Existing Water Quality and Ecology of the Site as Determined by Available Data or By Trend Assessment or Baseline Surveys	2-37
	Potentiality for the Development or Recruitment of Nuisance Species in the Disposal Site	2-38
	Existence at or in Close Proximity to the Site of any Significant Natural or Cultural Features of Historical Importance	2-38
	CONCLUSIONS AND PROPOSED ACTION	2-38
	Types of Wastes	2-38
	Waste Loadings	2-39
	Disposal Methods	2-40
	Dumping Schedules	2-40
	Permit Conditions	2-41
3	AFFECTED ENVIRONMENT	3-1
	THE 106-MILE SITE	3-1
	Physical Conditions	3-1
	Geological Conditions	3-4
	Chemical Conditions	3-5
	Biological Conditions	3-6
	Waste Disposal at the Site	3-7
	Concurrent and Future Studies	3-7
	Other Activities in the Site Vicinity	3-8

TABLE OF CONTENTS (continued)

Chapter	Title	Page
	ALTERNATIVE SITES IN THE NEW YORK BIGHT	3-11
	Physical Conditions	3-12
	Geological Conditions	3-12
	Chemical Conditions	3-13
	Biological Conditions	3-15
	Waste Disposal at the New York Bight Acid Wastes Site	3-16
	Concurrent and Future Studies	3-24
	Other Activities in the Site Vicinity	3-25
	DELAWARE BAY ACID WASTE DISPOSAL SITE	3-36
	Physical Conditions	3-36
	Geological Conditions	3-36
	Chemical Conditions	3-36
	Biological Conditions	3-36
	Waste Disposal at the Site	3-37
	Concurrent and Future Studies	3-40
	Other Activities in the Site Vicinity	3-40
4	**ENVIRONMENTAL CONSEQUENCES**	4-1
	EFFECTS ON PUBLIC HEALTH AND SAFETY	4-2
	Commercial and Recreational Fish and Shellfish	4-2
	Navigational Hazards	4-7
	EFFECTS ON THE ECOSYSTEM	4-9
	Plankton	4-12
	Nekton	4-16
	Benthos	4-17
	Water and Sediment Quality	4-19
	Short Dumping	4-28
	UNAVOIDABLE ADVERSE ENVIRONMENTAL EFFECTS AND MITIGATING MEASURES	4-30
	RELATIONSHIP BETWEEN USE OF THE SITE AND LONG-TERM PRODUCTIVITY	4-31
	IRREVERSIBLE OR IRRETRIEVABLE COMMITMENTS OF RESOURCES	4-31
5	**SEWAGE SLUDGE DISPOSAL AT THE 106-MILE SITE**	5-1
	AMOUNTS OF SLUDGE DUMPED	5-6
	ENVIRONMENTAL ACCEPTABILITY	5-6
	Fate of Sewage Sludge	5-9
	Effects upon Water Chemistry	5-12
	Interactions with Industrial Waste	5-16
	Effects upon Organisms	5-17
	Survival of Pathogens	5-18
	ENVIRONMENTAL MONITORING	5-22
	SURVEILLANCE	5-23
	ECONOMICS	5-23

TABLE OF CONTENTS (continued)

Chapter	Title	Page
	LOGISTICS	5-24
	SUMMARY	5-24
	CONCLUSIONS	5-25
6	**LIST OF PREPARERS**	6-1
7	**GLOSSARY AND REFERENCES**	7-1
	GLOSSARY	7-1
	UNITS OF MEASURE	7-18
	REFERENCES	7-19

APPENDICES

A	ENVIRONMENTAL CHARACTERISTICS OF THE 106-MILE OCEAN WASTE DISPOSAL SITE	A-1
B	CONTAMINANT INPUTS TO THE 106-MILE OCEAN WASTE DISPOSAL SITE	B-1
C	MONITORING	C-1
D	CHAPTER III, FINAL EIS ON OCEAN DUMPING OF SEWAGE SLUDGE IN THE NEW YORK BIGHT	D-1
E	COMMENTS ON THE DRAFT EIS	E-1

ILLUSTRATIONS

Number	Title	Page
S-1	Proposed Site and All Alternative Sites	xiii
2-1	Proposed Site and All Alternative Sites	2-5
2-2	Existing Disposal Sites in the Mid-Atlantic	2-11
3-1	Alternative Disposal Sites	3-2
3-2	Location of the 106-Mile Site	3-3
3-3	Oil and Gas Leases in the New York Bight	3-9
3-4	Benthic Faunal Types in the Mid-Atlantic Bight	3-10
3-5	Distribution of Surf Clams, Ocean Quahogs, and Sea Scallops in the Mid-Atlantic	3-17
3-6	Total Commercial Landings of Marine Finfishes in the New York Bight Area, 1880-1975	3-26
3-7	Total Landings of Commercial Marine Shellfish in the New York Bight Area, 1880-1975	3-27
3-8	Location of Foreign Fishing off the U.S. East Coast	3-28
3-9	Gravel Distribution in the New York Bight	3-31
3-10	Navigational Lanes in the Mid-Atlantic	3-32
3-11	Ocean Disposal Sites in the New York Bight Apex	3-34
3-12	Oil and Gas Leases Near Delaware Bay	3-42
5-1	Alternative Sewage Sludge Disposal Sites	5-2

TABLE OF CONTENTS (continued)

TABLES

Number	Title	Page
1-1	Responsibilities of Federal Departments and Agencies for Regulating Ocean Waste Disposal Under MPRSA	1-7
2-1	Comparison of Contaminant Inputs to the New York Bight, 1973	2-13
2-2	Summary Comparative Evaluation of Alternative Toxic Chemical Waste Disposal Sites	2-31
3-1	Disposal Volumes at the New York Bight Acid Wastes Disposal Site	3-18
3-2	Reported Dilution Values for Wastes Dumped at the Acid Site	3-20
3-3	Estimated Amounts of Trace Metals Released Annually at the New York Bight Acid Wastes Disposal Site	3-21
3-4	Mass Loads of Trace Metals Entering the New York Bight, 1960-1974	3-22
3-5	Total Landings in 1974 of Five Major Commercial Finfishes in the New York Bight	3-26
3-6	Total New York-New Jersey Commercial Landings in 1974 and 1976 of Important Shellfish Species in the New York Bight	3-27
3-7	Quantities of Waste Dumped Annually at the Delaware Bay Acid Waste Disposal Site	3-38
3-8	Estimated Quantities of Trace Metals Dumped Annually at the Delaware Bay Acid Waste Disposal Site	3-39
3-9	Commercial Landings of Three Major Species of Finfish for the Delaware Region, 1974	3-41
4-1	Characteristics of the Total Metal Analyses Used in Studies at the 106-Mile Site	4-21
4-2	Worst-Case Contribution of Waste Metal Input to the Total Metal Loading at the New York Bight Acid Waste Site	4-24
4-3	Round-Trip Transit Times to Alternative Sites (in Hours) Based on Varied Vessel Speeds	4-29
5-1	History of the Proposal to Relocate Sewage Sludge Disposal to the 106-Mile Site	5-4
5-2	Comparison of Typical Physical, Chemical, and Toxicological Characteristics of Sewage Sludge and Industrial Waste Dumped at the 106-Mile Site	5-7
5-3	Estimated Quantities of Sewage Sludge to be Dumped in the New York Bight 1979 to 1981	5-8
5-4	Worst-Case Projections of Metal Loading Due to Sewage Sludge Disposal in a Quadrant of the 106-Mile Site	5-15
5-5	Worst-Case Projections of Inorganic Nutrient Loading Due to Sewage Sludge Disposal in a Quadrant of the 106-Mile Site	5-16
5-6	Important Sludge-Associated Human Pathogens	5-19
5-7	Factors Identified as Contributing to the "Die-Off" or Decline of Sewage Pathogens	5-21

Chapter 1

PURPOSE OF AND NEED FOR ACTION

EPA proposes to designate the 106-Mile Ocean Waste Disposal Site for continuing use in accordance with the January 11, 1977 EPA Ocean Dumping Regulations and Criteria. The site is needed because land-based disposal methods for some industrial wastes are not presently available. Chapter 1 defines the action to be taken, discusses the history of the regulation of ocean disposal, and summarizes the legal regime for identifying and evaluating viable options.

Disposal of waste materials in the ocean has been practiced for generations on an international scale. Since enactment in the early 1970's of U.S. legislation and international agreements controlling ocean disposal, the numbers of industries and municipalities dumping wastes in the ocean have decreased dramatically due to development of land-based disposal alternatives. However, some industries and municipal waste treatment facilities produce wastes that cannot, using current technology, be treated or disposed of safely or economically on land, but can be disposed of in the ocean without seriously degrading the marine environment. Most of this waste-generating activity is centered around the heavily populated and industrialized East Coast. To help safely accommodate this need for ocean waste disposal, the U.S. Environmental Protection Agency (EPA) proposes to designate the 106-Mile Ocean Waste Disposal Site (hereafter 106-Mile Site*) for continued use.

The 106-Mile Site has been used intermittently for ocean disposal since 1961. A wide variety of waste materials has been released within and near the site. These included munitions, radioactive materials, acid,

---

*Also known elsewhere as Chemical Waste Site, Deepwater Dumpsite 106, Toxic Chemical Site, Industrial Waste Site.

nonspecific chemical wastes, sewage sludge, and residues from sewage sludge digesters. In 1973, EPA designated the site primarily for the interim disposal of industrial chemical wastes, while studies of the effects of waste disposal at the site were underway. These research studies have continued since the spring of 1974. After five years of intensive study, no significant adverse effects have been demonstrated from disposal of any of the waste materials.

More than 100 different dumpers have used the 106-Mile Site for waste disposal since 1961. At present only four permittees are using the site (E.I. du Pont de Nemours and Co. (Edge Moor and Grasselli plants), Merck and Company, Inc., and American Cyanamid Co.). Despite this large decrease in ocean disposal activity at the site, a present and future need exists for its continued use. The reasons for this continuing need are four-fold: (1) although three of the four current permittees (Du Pont-Edge Moor, American Cyanamid, and Merck) will cease ocean disposal within the next two years, they must continue to dispose of their wastes in the ocean while alternative land-based disposal methods are under development; (2) there are some Du Pont-Grasselli wastes which cannot be disposed of by land-based methods, but which can be dumped safely at the 106-Mile Site without degrading the environment; (3) some municipal permittees dumping sewage sludge at the New York Bight Sewage Sludge Site may be required to move ocean disposal operations to the 106-Mile Site if public health is endangered or marine water quality at the existing sludge site is severely degraded; and (4) a site of known environmental characteristics is required for disposal of some wastes under emergency conditions.

By January 1, 1982 only wastes that can be demonstrated to comply with EPA's environmental impact criteria and cannot be discarded on land, will be permitted to be dumped in the ocean. For the short term, however, while land-based disposal methods are being developed, some industrial chemicals and sewage sludge must continue to be disposed of in the ocean, even though these materials have not been demonstrated to meet the impact criteria. Neither Merck, American Cyanamid, nor the municipal sludge permittees have demonstrated compliance with the impact criteria; however, because they have

demonstrated an adequate need for ocean disposal, accompanied by a schedule for developing suitable land-based alternatives, these dumpers are permitted to use the ocean for waste disposal on interim bases.

As part of its decision-making process, EPA has investigated all reasonable alternatives to the continued use of the 106-Mile Site. Two broad categories of alternatives exist: (1) take no action, thereby requiring use of other disposal methods, or, if other disposal methods are unavailable, causing cessation of the waste-producing processes; or (2) designate and use another ocean location for disposing of these wastes. After a careful review of the alternatives, EPA has determined that designation of the 106-Mile Site for continued use is the most favorable course of action.

Therefore, based upon the continued need for ocean disposal, the lack of any significant adverse impact as determined by the research studies conducted at the site, and the lack of a better alternative to designating this particular site, EPA proposes to designate the 106-Mile Site for continued use. Continued use of the site will allow approved dumping of the wastes released there under current ocean dumping permits, and will provide for the disposal of new wastes which the EPA deems acceptable for ocean disposal. EPA Region II will manage the site; regulate times, rates, methods of disposal, and quantities and types of materials disposed; develop and maintain effective monitoring programs for the site; conduct disposal site evaluation studies; and recommend modifications in site use or designation as necessary.

FEDERAL LEGISLATION AND CONTROL PROGRAMS

Before the early 1970's, there was little regulation of ocean waste disposal. Limited regulation was provided primarily by the New York Harbor Act of 1888, which empowered the Secretary of the Army to prohibit disposal of wastes, except from streets and sewers, into the harbors of New York, Hampton Roads, and Baltimore. The Refuse Act of 1899 prohibited the disposal of

materials into navigable waters when disposal impeded safe navigation. Under these Acts, selection of disposal locations by the U.S. Army Corps of Engineers (CE) and the issuance of permits for ocean disposal were based primarily upon transportation and navigation factors rather than upon environmental concerns.

Public interest in the effects of ocean disposal was aroused in 1969 and 1970 by a number of incidents involving the disposal of warfare agents in the ocean. Simultaneous studies by the National Oceanic and Atmospheric Administration (NOAA), and several universities, identified potential adverse effects of sewage sludge and industrial waste disposal in the New York Bight. The Council on Environmental Quality (CEQ) 1970 report to the President, identified poorly regulated waste disposal in the marine environment as a potential environmental danger.

CEQ's report and the increasing public awareness of the potential undesirable effects of poorly regulated ocean waste disposal were primarily responsible for the enactment of the Marine Protection, Research, and Sanctuaries Act (MPRSA) of 1972, the primary U.S. legislation now regulating barged waste disposal in the ocean. In the fall of 1972, when it became apparent that the Congress would promulgate an act to regulate ocean disposal, EPA began to develop criteria which would provide effective technical bases for the regulatory program. During the development of the technical criteria, EPA sought advice and counsel from EPA marine scientists, and from marine specialists in universities, industries, environmental groups, and Federal and state agencies. The criteria were published in May 1973, finalized in October 1973, and revised in January 1977. The criteria are used to evaluate the need for ocean waste disposal, and the potential impact of disposal on the marine environment.

Legislation dates back almost 100 years for controlling waste disposal into rivers, harbors, and coastal waters; however, ocean waste disposal was not specifically regulated in the United States until passage, in October 1972, of the Marine Protection, Research, and Sanctuaries Act (MPRSA, PL 92-532, as amended). To enable better understanding of this important legislation, it is

discussed here in detail, together with other relevant Federal legislation, Federal control programs initiated by MPRSA, and EPA programs for ocean disposal site designation and issuance of ocean disposal permits.

The Clean Water Act (CWA) of 1977 (PL 95-217) amended and replaced earlier legislation which established a comprehensive regulatory program to control discharges of pollutants from outfalls into navigable waters of the United States, including ocean waters. The primary objective of the CWA is to restore and maintain the chemical, physical, and biological integrity of the nation's waters. CWA regulates discharges by the promulgation of criteria to prevent degradation of the marine environment (Section 403), and the application of the criteria in the issuance of permits (Section 402). Thus, CWA and MPRSA are the primary Federal legislative means which are used to control ocean waste disposal, via ocean outfalls or by dumping at offshore disposal sites.

MARINE PROTECTION, RESEARCH, AND SANCTUARIES ACT

The MPRSA regulates the transportation and ultimate dumping of waste materials in ocean waters. The Act is divided into three parts: Title I - Ocean Dumping, Title II - Comprehensive Research on Ocean Dumping, and Title III - Marine Sanctuaries. This EIS concentrates on Title I, specifically Section 102(c), which charges EPA with the responsibility for designating sites and times for dumping.

Title I, the primary regulatory section of the Act, establishes the permit program for the disposal of dredged and non-dredged materials, mandates determination of impacts, and provides for enforcement of permit conditions. Through Title I, the Act provides a procedure for regulating ocean disposal of waste originating from any country, into ocean waters under the jurisdiction or control of the United States. Any transport for dumping in U.S. waters requires a similar permit. Title I requires that a permit be obtained by any person of any nationality wishing to transport waste material from any U.S. port or under a U.S. flag with the intention of disposing of it anywhere in the world's oceans.

Title I prohibits the dumping in ocean waters of certain wastes, among them biological, radiological, and chemical warfare agents, and all high-level radioactive wastes. Title I was further amended in November 1977 (PL 95-153) to prohibit dumping of harmful sewage sludge* after December 31, 1981. The provisions of Title I include criminal fines of $50,000 maximum and jail sentences of up to one year for every unauthorized dump or violation of permit requirement, and a civil fine of $50,000 maximum. Any individual may seek an injunction against any unauthorized dumper with possible recovery of all costs of litigation.

Title II of MPRSA provides for comprehensive research and monitoring of ocean dumping effects on the marine environment. Under Title II, The National Oceanic and Atmospheric Administration's (NOAA's) ocean dumping program has conducted extensive survey and laboratory investigations over the past several years at ocean waste disposal sites in the North Atlantic Ocean. This work aids EPA in site management by providing data for site-use decisions.

Several Federal departments and agencies share responsibilities under the Act (Table 1-1). The major responsibilities are mandated to EPA to review, grant, and enforce dumping permits for all wastes except dredged materials, and to designate and manage all disposal sites. In October 1973, EPA implemented its responsibility for regulating ocean dumping under MPRSA by issuing final Ocean Dumping Regulations and Criteria (hereafter the "Ocean Dumping Regulations"), which were revised in January 1977 (40 CFR, Parts 220 to 229). These regulations established procedures and criteria for: designating and managing ocean disposal sites (Part 228), reviewing ocean disposal permit applications and assessing impacts of ocean disposal and

---

* Harmful sewage sludge is defined by PL 95-153 as sewage sludge that "may significantly degrade or endanger human health, welfare and amenities, the marine environment and ecological systems, or economic potential."

TABLE 1-1
RESPONSIBILITIES OF FEDERAL DEPARTMENTS AND AGENCIES
FOR REGULATING OCEAN WASTE DISPOSAL UNDER MPRSA

Department/Agency	Responsibility
U.S. Environmental Protection Agency	Issuance of waste disposal permits, other than for dredged material. Establishment of criteria for regulating waste disposal. Enforcement actions. Site designation and management. Overall ocean disposal program management.
U.S. Department of the Army Corps of Engineers	Issuance of dredged material disposal permits.
U.S. Department of Transportation Coast Guard	Surveillance, enforcement, issuance of regulations, review of permit applications.
U.S. Department of Commerce National Oceanic and Atmospheric Administration	Long-term monitoring and research. Comprehensive ocean dumping impact and short-term effect studies. Marine sanctuary designation.
U.S. Department of Justice	Court actions.
U.S. Department of State	International agreements.

(Part 227), and enforcing permits. Interim disposal sites were authorized pending final designation for continuing, or a decision to terminate use. The 106-Mile Site was one of 13 municipal and industrial sites approved for interim use.

The U.S. Army Corps of Engineers (CE) issues permits for disposal of dredged material after determining compliance of the material with EPA's environmental impact criteria (40 CFR 227). Compliance with the criteria is

alternative disposal methods subject to EPA's concurrence. The CE is responsible for evaluating disposal applications and granting permits to dumpers of dredged materials, whereas dredged material disposal sites are designated and managed by EPA.

Under MPRSA, the Commandant of the U.S. Coast Guard (USCG) is assigned responsibility by the Secretary of Transportation for conducting surveillance of disposal operations to ensure compliance with permit conditions and to discourage unauthorized disposal. Violations are referred to EPA for enforcement. Surveillance is accomplished by means of spot checks of disposal vessels for valid permits, interception or escorting of dump vessels, use of shipriders, aircraft overflights during dumping, and random surveillance missions at land facilities. An automated Ocean Dumping Surveillance System (ODSS) based on electronic navigation has been field-tested and evaluated by the USCG for future use in routine surveillance. For the present, shipriders are the primary means of surveillance at the 106-Mile Site.

Under Title II of MPRSA, NOAA conducts comprehensive monitoring and research programs on the effects of ocean dumping on the marine environment, including short-term effects and potential long-term effects of pollution, over-fishing, and other man-induced changes in oceanic ecosystems. Title III of MPRSA authorizes NOAA to designate coastal marine sanctuaries, after consultation with other affected federal agencies, and to regulate all activities within the sanctuaries.

The Department of Justice initiates relief actions in court, at EPA's request in response to violations of the terms of MPRSA. When necessary, injunctions to cease ocean dumping are sought. Criminal fines and jail sentences may be levied, based upon the magnitudes of the violations.

The Department of State seeks effective international action and cooperation in protection of the marine environment by negotiating international agreements which further the goals of MPRSA. The most significant international negotiation with respect to ocean dumping is the Convention on

the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (hereafter the "Convention" or the "Ocean Dumping Convention") which is discussed later in this chapter.

The MPRSA has been amended several times since its enactment in 1972. Most amendments provide for annual appropriations for administration of MPRSA. However, two of the amendments are noteworthy. First, passage of an amendment in March 1974 (PL 93-254), brought the Act into full compliance with the Convention. Second, an amendment (PL 95-153) passed in November 1977, prohibits disposal of harmful sewage sludge in ocean waters after December 31, 1981.

OCEAN DISPOSAL SITE DESIGNATION

Under Section 102(c) of the MPRSA, the EPA Administrator is authorized to designate sites and times for ocean disposal, provided that the waste does not contain prohibited materials, and will not significantly degrade, or endanger, human health, welfare, and amenities, the marine environment and ecological systems, or economic potential. In response to this mandate, EPA established criteria for designating sites in its Ocean Dumping Regulations and Criteria (Part 228). These include criteria for site selection and procedures for designating the sites for disposal. General criteria for selection of sites, as provided in the Regulations, are:

> (a) The dumping of materials into the ocean will be permitted only at sites or in areas selected to minimize the interference of disposal activities with other activities in the marine environment, particularly avoiding areas of existing fisheries or shellfisheries, and regions of heavy commercial or recreational navigation.
>
> (b) Locations and boundaries of disposal sites will be so chosen that temporary perturbations in water quality or other environmental conditions during initial mixing caused by disposal operations anywhere within the site can be expected to be reduced to normal ambient seawater levels or to undetectable contaminant concentrations or effects before reaching any beach, shoreline, marine sanctuary, or known geographically limited fishery or shellfishery.

(c) If at anytime during or after disposal site evaluation studies, it is determined that existing disposal sites presently approved on an interim basis do not meet the criteria for site selection set forth in [Sections] 228.5 to 228.6, the use of such sites will be terminated as soon as suitable alternate disposal sites can be designated.

(d) The sizes of ocean disposal sites will be limited in order to localize for identification and control any immediate adverse impacts and permit the implementation of effective monitoring and surveillance programs to prevent adverse long-term impacts. The size, configuration, and location of any disposal site will be determined as a part of the disposal site evaluation or designation study.

(e) EPA will, wherever feasible, designate ocean dumping sites beyond the edge of the continental shelf, and other such sites that have been historically used. [Section 228.5]

Factors considered under the specific criteria for site selection relate more closely to conditions at the proposed sites by treating the general criteria in additional detail. A proposed site which satisfies the specific criteria for site selection conforms to the broader general criteria. The factors to be considered are:

(1) Geographical position, depth of water, bottom topography and distance from coast;

(2) Location in relation to breeding, spawning, nursery, feeding, or passage areas of living resources in adult or juvenile phases;

(3) Location in relation to beaches and other amenity areas;

(4) Types and quantities of wastes proposed to be disposed of and proposed methods of release, including methods of packing the waste, if any;

(5) Feasibility of surveillance and monitoring;

(6) Dispersal, horizontal transport and vertical mixing characteristics of the area, including prevailing current direction and velocity, if any;

(7) Existence and effects of current and previous discharges and dumping in the area (including cumulative effects);

(8) Interference with shipping, fishing, recreation, mineral extraction, desalination, fish and shellfish culture, areas of special scientific importance, and other legitimate uses of the ocean;

(9) The existing water quality and ecology of the site as determined by available data or by trend assessment or baseline surveys;

(10) Potentiality for the development or recruitment of nuisance species in the disposal site;

(11) Existence at or in close proximity to the site of any significant natural or cultural features of historical importance [Section 228.6].

These factors are addressed relative to the 106-Mile Site in Chapter 2.

Once designated, the site must be monitored for adverse impacts of waste disposal. EPA monitors the following types of effects to determine the extent of marine environmental impacts due to material released at the site:

- Movement of materials into estuaries or marine sanctuaries, or onto oceanfront beaches, or shorelines;
- Movement of materials toward productive fishery or shellfishery areas;
- Absence from the disposal site of pollution-sensitive biota characteristic of the general area;
- Progressive, non-seasonal, changes in water quality or sediment composition at the disposal site, when these changes are attributable to materials disposed of at the site;
- Progressive, non-seasonal, changes in composition or numbers of pelagic, demersal, or benthic biota at or near the disposal site, when these changes can be attributed to the effects of materials disposed of at the site;
- Accumulation of material constituents (including without limitation, human pathogens) in marine biota at or near the site [Section 228.10b].

EPA has established impact categories in its Ocean Dumping Regulations (Section 228.10) which specify impacts, detected by means of site monitoring, which require modifications in disposal site usage:

> (1) IMPACT CATEGORY I: The effects of activities at the disposal site shall be categorized in Impact Category I when one or more of the following conditions is present and can reasonably be attributed to ocean dumping activities:
>
> (i) There is identifiable progressive movement or accumulation, in detectable concentrations above normal ambient values, of any waste or waste constituent from the disposal site within 12 nautical miles of any shoreline, marine sanctuary designated under Title III of the Act, or critical area designated under Section 102 (c) of the Act; or
>
> (ii) The biota, sediments, or water column of the disposal site, or any area outside the disposal site where any waste or waste constituent from the disposal site is present in detectable concentrations above normal ambient values, are adversely affected by the toxicity of such waste or waste constituent to the extent that there are statistically significant decreases in the populations of valuable commercial or recreational species, or of specific species of biota essential to the propagation of such species, within the disposal site and such other area as compared to populations of the same organisms in comparable locations outside such site and area; or
>
> (iii) Solid waste material disposed of at the site has accumulated at the site or in areas adjacent to it, to such an extent that major uses of the site or of adjacent areas are significantly impaired and the Federal or State agency responsible for regulating such uses certifies that such significant impairment has occurred and states in its certificate the basis for its determination of such impairment; or
>
> (iv) There are adverse effects on the taste or odor of valuable commercial or recreational species as a result of disposal activities; or
>
> (v) When any toxic waste, toxic waste constituent, or toxic byproduct of waste interaction, is consistently identified in toxic concentrations above normal ambient values outside the disposal site more than four hours after disposal.
>
> (2) IMPACT CATEGORY II: The effects of activities at the disposal site which are not categorized in Impact Category I shall be categorized in Impact Category II [Section 228.10c].

OCEAN DUMPING PERMIT PROGRAM

EPA's Ocean Dumping Regulations establish a program for the application, evaluation, and issuance of ocean dumping permits. When a site is selected and duly designated, permits for the use of the site can be issued by CE for dredged material dumping and by EPA for other dumping. The Ocean Dumping Regulations are specific about the procedures used to evaluate permit applications, and the granting or denial of such applications. EPA and the CE evaluate permit applications principally to determine whether there are (1) a demonstrated need for ocean disposal and proof that no other reasonable alternatives exist (40 CFR 227 Subpart C), and (2) compliance with the environmental impact criteria (40 CFR 227 Subparts B, D, and E).

Compliance with EPA's environmental impact criteria ensures that the proposed waste disposal will not "unduly degrade or endanger the marine environment," and will not cause unacceptable adverse effects on human health, the marine ecosystem, or other uses of the ocean. The criteria are too lengthy to include here; however, the relevant points are briefly summarized below.

- Prohibited Materials: High-level radioactive wastes; materials produced for radiological, chemical, or biological warfare; unknown materials; persistent floatable materials which interfere with other uses of the ocean

- Materials present as trace contaminants only except on an emergency basis: Organohalogens; mercury and mercury compounds; cadmium and cadmium compounds; oil; known or suspected carcinogens, mutagens, or teratogens

- Trace contaminants in the liquid fraction must neither exceed the marine water quality criteria, nor exist in toxic and bioaccumulative forms after initial mixing

- Bioassays on the suspended particulate or solid fractions must not indicate occurrence of significant mortality or significant adverse sublethal effects, including bioaccumulation due to waste dumping

- When bioassay methods are unavailable: Maximum concentrations of mercury and cadmium apply; organohalogen concentrations must be less than is known to be toxic to organisms; oils in the waste must not produce a visible sheen on the water

- Trace contaminants must neither render edible marine organisms unpalatable nor endanger health of humans, domestic animals, shellfish, or wildlife.

Six types of ocean dumping permits may be issued: Interim, Special, General, Emergency, Research, and Incineration-at-Sea. With few exceptions, EPA has issued only Interim Permits. These permits are valid for one year maximum. They are issued when the permittee cannot demonstrate compliance of the waste with the environmental impact criteria, but can demonstrate that the need for ocean disposal is of greater significance to the public interest than possible adverse environmental impacts. Moreover, Interim Permits cannot be issued to applicants who were not issued dumping permits before April 23, 1978. Holders of present Interim Permits must have a compliance schedule which will ensure either the complete phaseout of ocean dumping or compliance with the environmental impact criteria by December 31, 1981. After that date, EPA will not issue Interim Permits and ocean disposal of harmful wastes will cease. At the 106-Mile Site, American Cyanamid and Merck are dumping under Interim Permits.

Special Permits, which are issued when the applicant can adequately demonstrate compliance of the wastes with the environmental impact criteria and can demonstrate a need for ocean disposal, may be issued for a maximum of three years. Holders of Special Permits are not subject to the 1981 deadline for cessation of the ocean disposal of harmful wastes. Some industrial permittees have been granted Special Permits. Specifically, at the 106-Mile Site, Du Pont-Edge Moor and Du Pont-Grasselli are holders of Special Permits.

General Permits may be issued for ocean disposal of small amounts of materials which will have minimal adverse effects upon the environment. Examples of materials which warrant a General Permit include human remains or ashes for burial at sea, target vessels for ordnance testing, and derelict vessels transported for scuttling.

Emergency Permits may be issued for ocean disposal of materials which pose an unacceptable risk to human health, and for which there is no other

reasonable disposal technique. Emergency Permit requests are considered case-by-case by EPA on the basis of the waste's characteristics and the safest means for its disposal.

Research Permits may be issued for dumping material into the ocean as part of a research project, when the scientific merit of the project outweighs the potential adverse impacts of the dumping. EPA designates the disposal site(s) to be used by Research Permit holders on the basis of the nature of the study project.

Incineration-at-Sea Permits are either Research, Interim, or Special permits. Current Incineration-at-Sea permits are Special Permits, issued for disposal at the New York Bight Wood Incineration Site. As Special Permits, they are issued for a maximum of three years. Burning is conducted under controlled weather conditions; the ash is transported back to shore and used as landfill. Research and Interim Permits have been issued for the incineration of organochlorine wastes.

INTERNATIONAL CONSIDERATIONS

The principal international agreement governing ocean dumping is the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (Ocean Dumping Convention), which became effective in August 1975, upon ratification by 15 contracting countries. Designed to control dumping of wastes in the oceans, the Convention specifies that contracting nations will regulate disposal in the marine environment within their jurisdiction, disallowing all disposal without permits. Certain other hazardous materials are prohibited, such as biological, radiological, and chemical warfare agents and high-level radioactive matter. Certain other materials (e.g., cadmium, mercury, organohalogens and their compounds, oil, and persistent synthetic materials which float) are prohibited, except when present as trace contaminants. Other materials - arsenic, lead, copper, zinc, cyanide, fluoride, organosilicon, and pesticides - while not prohibited from ocean disposal, require special care. Permits are required for at-sea

disposal of materials not specifically prohibited. The nature and quantities of all waste material, and the circumstances of disposal, must be periodically reported to the Intergovernmental Maritime Consultative Organization (IMCO) which is responsible for administration of the Convention. Effective in March 1979, the Convention was amended to incorporate regulations for control of incineration of wastes at sea to be enforced nationally.

Chapter 2

ALTERNATIVES INCLUDING THE PROPOSED ACTION

Some industrial waste products, which cannot be disposed of using land-based methods, can be safely dumped in the ocean until other disposal alternatives are developed. To meet the need for a suitable oceanic location for waste disposal, EPA evaluated five sites for environmental acceptability, feasibility and ease of monitoring and surveillance, economic burden, and logistics. Based upon this evaluation, the 106-Mile Site was determined to be the best location for disposal of the industrial wastes under consideration. As a special case, EPA evaluated the feasibility of using the 106-Mile Site for sludge disposal. It was determined that, under suitable conditions, the site could provide an alternative location for short-term sewage sludge disposal.

After reviewing the alternatives, EPA proposes that the 106-Mile Ocean Waste Disposal Site be designated for continuing use. The following alternatives were considered:

- No Action.
- Proposed Action: Designate the 106-Mile Site for continuing use.
- Use of Other Sites: Designate a site other than the 106-Mile Site.

Evaluation of the alternatives was based upon several factors:

- Environmental acceptability
- Feasibility and ease of monitoring
- Feasibility and ease of surveillance
- Economic burden
- Logistics

This EIS does not specifically address land-based alternatives to ocean disposal because feasibility of using land-based disposal processes is assessed on a case-by-case basis as part of EPA's ocean dumping permit

process. For example, Merck, American Cyanamid, and Du Pont-Edge Moor, presently authorized to dump wastes at the 106-Mile Site, are only using ocean disposal pending development of land-based processes which will permit reclamation or disposal of the wastes. However, present-day technology is inadequate to supply land-based disposal alternatives for Du Pont-Grasselli's waste. Du Pont-Grasselli has demonstrated that its waste satisfies EPA's environmental impact criteria, thus EPA has authorized disposal of this waste at the 106-Mile Site, with the stipulation that Du Pont continue to seek land-based alternatives for the waste.

Use of the 106-Mile Site as an alternate site for sewage sludge disposal was addressed in the Final EIS on the Ocean Dumping of Sewage Sludge in the New York Bight (EPA, 1978). This EIS presents additional considerations about the environmental acceptability of sewage sludge at the 106-Mile Site (Chapter 5) and includes Chapter III - Alternatives to the Proposed Action - of the earlier EIS as Appendix D. Land-based alternatives are discussed in Appendix D.

NO-ACTION ALTERNATIVE

The No-Action alternative would result in canceling or postponing the designation of an industrial waste disposal site off the Middle Atlantic States, thus requiring disposal of industrial wastes by other means; or, if other means of disposal were unavailable, would require termination of the waste-producing processes. This alternative would be feasible under certain conditions: (1) existence of technologically, environmentally, and economically feasible land-based disposal methods; or (2) evidence that ocean disposal causes sufficiently adverse environmental consequences to preclude it from consideration. Neither of these No-Action conditions applies to the proposed use of the 106-Mile Site for waste disposal.

In Chapter 1, a need was established for designating the 106-Mile Site for continued use. EPA evaluates the feasibility of land-based disposal methods when evaluating applications for ocean dumping permits, and permits are not issued if a waste can be disposed of safely on land. Therefore, the present

106-Mile Site permittees have adequately demonstrated that land-based disposal is currently unfeasible for their wastes. The consequences of terminating the waste generation, because no disposal methods were available, would be dramatic. In the case of American Cyanamid, for example, shut-down of the Warners plant would result in the direct loss of 850 jobs, valued at $14,000,000 annually (Reid, 1978). The impact would have other effects. American Cyanamid is the sole U.S. producer of malathion, a nonpersistent insecticide, which is widely used for protection of crops and eradication of several disease-causing insects. Termination of malathion production would be felt around the world. Shut-down of any of the other permittees could have negative consequences.

Most important, past dumping at the 106-Mile Site has not appeared to cause sufficiently severe adverse effects to preclude use of the site for waste disposal. This subject is treated more fully in Chapter 4. The short-term dumping effects on organisms at the site are generally known. In the initial stages of waste dilution, acute plankton mortality occurs as the pH of the receiving water changes. But this effect is mitigated by the subsequent rapid dilution and neutralization which occurs as the waste is dispersed throughout the mixing zone. After dumping, levels of trace elements in the water are elevated for a period of time; however, barge speeds and waste discharge rates, which are stipulated in the dumping permit, ensure that waste concentrations do not exceed the limiting permissible concentration at any time. Studies are still underway investigating the subtle and long-range effects of dumping at the site.

CONTINUED USE OF THE 106-MILE SITE

The proposed action is to continue use of the 106-Mile Site for waste disposal. This section summarizes anticipated impacts, forming the basis for comparison with the other alternatives (discussed later in this chapter).

The 106-Mile Site was established in 1965 for the disposal of industrial wastes not suitable for land disposal. It is located approximately 110 nmi (200 km) southeast of Ambrose Light, New York, and approximately 130 nmi

(240 km) east of Cape Henlopen, Delaware (Figure 2-1). The site covers almost 500 nmi^2 (1,700 km^2) on the Continental Slope and Continental Rise, and its latitudes and longitudes are 38°40'N to 39°00'N, and 72°00'W to 72°30'W, respectively. Water depths at the site range from 1,440 m (in the topographically rugged northwest corner) to 2,750 m (in the relatively flat southeast corner). An inactive munitions waste disposal site is within the site boundaries, and an inactive radioactive waste disposal area is 10 nmi (18 km) due south.

NOAA, assisted by other government agencies and academic institutions, has been surveying this site for many years, and has published its observations in two summary reports (NOAA, 1975, 1977), several memoranda, public hearing testimony, and in its annual report to Congress (NOAA, 1978). A private contractor, acting on behalf of the permittees, has been monitoring the site for two years.

ENVIRONMENTAL ACCEPTABILITY

Continued use of the 106-Mile Site for waste disposal will not directly endanger public health. The site is not in a commercially or recreationally important fishing or shellfishing area. Most mid-Atlantic fishing is on the Continental Shelf or along the Shelf/Slope break. Infrequent domestic and foreign fishing occurs at or near the site, but usage is variable and dependent on occurrence of water masses or eddies which affect fish abundance and distribution. There is a slight potential that some of the nekton caught at or near the site may have accumulated low levels of trace contaminants from wastes dumped at the site. However, the low level of fishing activity in the area, in combination with the extreme conditions necessary for bioaccumulation of contaminants in amounts which are unhealthy to man, make the potential threat to human health from dumping at this site slight.

Thus far, no studies have shown long-term adverse effects on water and sediment quality or on the site biota. The natural variability of the water at the site, resulting from the interaction of three major water masses, causes much greater changes in the biotal assemblages of the site and vicinity than waste disposal.

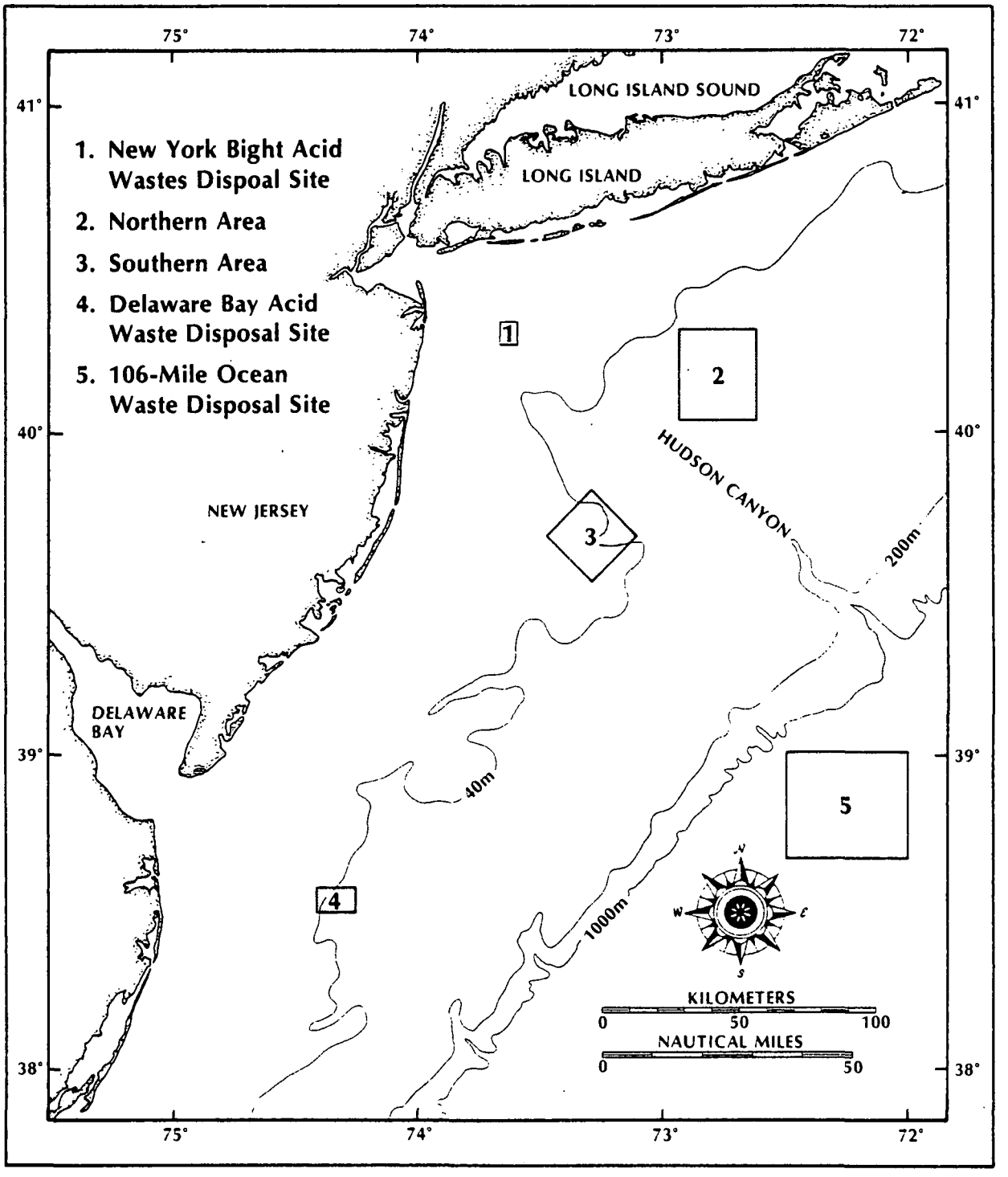


Figure 2-1. Proposed Site and All Alternative Sites

Routine laboratory bioassay tests performed on the waste, together with field dispersion data, indicate that levels of contaminants in the waste are rapidly diluted upon discharge, and concentrations of the waste contaminants do not remain elevated long enough to cause significant mortality in organisms. Field monitoring by NOAA (1975, 1977) has confirmed these observations. Laboratory studies on wastes currently being released at the site have shown adverse effects only at concentrations much higher than those occurring in the site. Although laboratory studies cannot be directly extrapolated to the ocean environment, the differences between the concentrations found at the site and the very high concentrations required for measurable effects in the laboratory, provide safety factors for short-term and long-term adverse impacts. Detailed discussions of environmental consequences of waste disposal at the site appear in Chapter 4.

The wastes presently permitted to be dumped at the site are primarily aqueous solutions and are discharged relatively slowly over a large area, thus there is extensive dilution and dispersion of disposed wastes. Monitoring by acoustic means has shown that pycnoclines act as barriers to downward movement of waste materials. Consequently, adverse bottom impacts are highly unlikely. This conclusion has been corroborated by benthic investigations at the site. Future wastes, with chemical and physical properties similar to present wastes, are expected to behave in the same manner, thus causing no adverse impacts.

Sewage sludge disposal at the 106-Mile Site will be considered only upon a finding by EPA that the New York Bight (12-Mile) Sewage Sludge Site cannot safely accommodate additional sludge release without endangering public health or unacceptably degrading coastal water quality. The alternative sites discussed later in this chapter would be designated for industrial wastes, not sewage sludge. Chapter 5 discusses in more detail the environmental acceptability of releasing sewage sludge at the site; the major findings are summarized here:

- Volumes of sludge requiring ocean disposal will increase 150% from 1978 to 1981.

- Settling of sludge particles would be strongly inhibited by the seasonal and permanent pycnoclines at about 10 to 50 m and 100 to 150 m depth, respectively.

- Horizontal dispersion would probably exceed vertical settling by at least two orders of magnitude.

- Sludge would add only 1% additional nitrogen to the site. Therefore, excessive phytoplankton blooms are not expected.

ENVIRONMENTAL MONITORING

The purpose of monitoring a waste disposal site is to ensure that long-term adverse impacts do not develop unnoticed, especially adverse impacts which are irreversible or irretrievable. As NOAA has observed in its baseline report on effects of dumping at the 106-Mile Site, monitoring is more difficult at sites beyond the Continental Shelf:

> This is due to factors such as greater depths of water and distances from shore and also to the general paucity of environmental and biological information in off-the-shelf areas. In the case of [the 106-Mile Site], this situation is further complicated by the interactions of major water masses, Shelf Water, Slope Water, and Gulf Stream eddies. The [site] is a complex oceanographic area in which to assess natural environmental conditions and the impact of man's activities upon those conditions (NOAA, 1977).

Another problem in monitoring involves assessing the interaction of liquid wastes with the surrounding water and marine life. Under the dynamic conditions at the 106-Mile Site, long-term impacts will be nearly impossible to measure because affected plants and animals will most likely have moved out of the area, either by swimming or drifting with the water. The difficulty of monitoring long-term impacts in the water column is inherent in aqueous waste disposal at any oceanic site. Monitoring at the site is further complicated by the presence of sunken munitions within the site boundaries and radioactive waste barrels just outside the southern site boundary. Any benthic sampling near these locations must be carefully conducted.

SURVEILLANCE

Nearshore sites permit use of patrol vessels and helicopters for surveillance; however, until other techniques are developed, surveillance at the 106-Mile Site will require use of observers (shipriders) because the site is located outside the range of other means of surveillance. The USCG has stated that the program goal for surveillance at industrial waste sites is 75% coverage of all industrial dumping operations.

ECONOMICS

TRANSPORTATION COSTS

The cost of barging chemical wastes to the 106-Mile Site is estimated to be in the range of $8.80 to $11.00 per metric ton ($8.00 to $10.00 per ton). Therefore, the total cost of industrial waste disposal at the site in 1978 (730,000 metric tons) was about $6.4 to $8.0 million for all permittees. The port of departure affects the costs somewhat because vessels transiting from ports in Delaware Bay must travel a greater distance to the site than vessels coming from New York Harbor. The total cost of disposal at the site will drop as some permittees phase out ocean dumping; however, the costs to individual permittees will rise as a result of inflation and increased fuel prices.

MONITORING COSTS

The costs of monitoring at the 106-Mile Site are high compared to other areas, because of the complexity of the environment and distance from shore. NOAA is responsible for comprehensive and continuing monitoring. A cost to NOAA of $1 million per year has been estimated to conduct seasonal monitoring surveys, based on a cost ranging from $200,000 to $300,000 for EPA or NOAA baseline surveys (Breidenbach, 1977). The cost to permittees for monitoring is high, primarily due to the site's great distance from shore.

If new materials, industrial and/or municipal sludge for example, were permitted to be released at the site, monitoring costs would increase substantially. The new permittees would be required to perform dispersion

studies and other investigations concerned with short-term effects of waste discharges, which would augment the existing monitoring program. NOAA would have to intensify its monitoring to determine if the biota is affected by interactions between waste types, and to assess long-term trends.

SURVEILLANCE COSTS

The current U.S. Coast Guard Instruction regarding surveillance and enforcement of ocean disposal sites establishes a goal of observing 75% of all industrial waste disposal operations (USCG, 1976). Surveillance activities include stationing a shiprider onboard the vessel to observe the disposal operation, conducting random spot checks before the barge leaves port, and checking vessel logs for departure and arrival times. The USCG presently assigns several full-time people to the surveillance of disposal activities in the Bight, including the 106-Mile Site.

LOSS OF BIOTIC OR MINERAL RESOURCES

Almost all U.S. fishing activities are located over the Continental Shelf. Wastes dumped at the site would be extremely dilute, when and if they reached the Continental Shelf. It is unlikely that stocks would be adversely affected by disposal operations.

Red crabs on the Continental Shelf/Slope break near the site represent a potentially valuable resource which may be further exploited in the future. However, no crabs of commercial size occur in the site, and the adult crabs are taken sufficiently far from the site, so that wastes released at the site are not likely to reach them.

Foreign ships fish along the edge of the entire Continental Shelf from Georges Bank to Cape Hatteras, especially during the late winter and early spring. However, the site is not a unique location for foreign fishermen, nor does it obstruct migration routes of species valuable to foreign fishermen. Therefore, the probability of foreign fish stocks being affected by disposal operations at the site is extremely remote.

Future oil and gas development is possible near the site, although virtually no mid-Atlantic oil exploration occurs presently off the U.S. Outer Continental Shelf. Waste disposal would not interfere with petroleum exploration or production activities. The only potential navigational hazard would result from barge traffic to and from the site.

LOGISTICS

Use of the 106-Mile Site presents some logistics problems. A distant disposal site requires careful transport operation planning. Weather conditions in the mid-Atlantic are subject to rapid change, and must be carefully monitored for adequate passages to permit a barge or tanker to complete transits in safety. Emergency discharge of wastes prior to reaching the legal site (called "short dumping") becomes more likely in transit to a distant site, as the length of time spent at sea increases.

The site is outside the heavily used transit lanes to New York Harbor, and is convenient to the ports of New York, Philadelphia, and Baltimore. This location has advantages over several existing nearshore New York Bight sites which are near the entrance to New York Harbor, an area congested with ship traffic of all types. Therefore, the dumping operation (which can take 5 to 6 hours) at the 106-Mile Site is less likely to impact other ship traffic adversely.

USE OF ALTERNATIVE EXISTING SITES

Eight municipal and industrial waste disposal sites (aside from dredged material sites and the proposed site) exist presently in the mid-Atlantic (Figure 2-2): six in the New York Bight, and two near Delaware Bay. Two of the sites discussed in this section have been used for industrial chemical waste disposal (the New York Bight and Delaware Bay Acid Wastes Sites) and were considered viable alternatives. The other existing sites were eliminated from further consideration for several reasons:

- None of the sites has ever been used for industrial waste disposal.

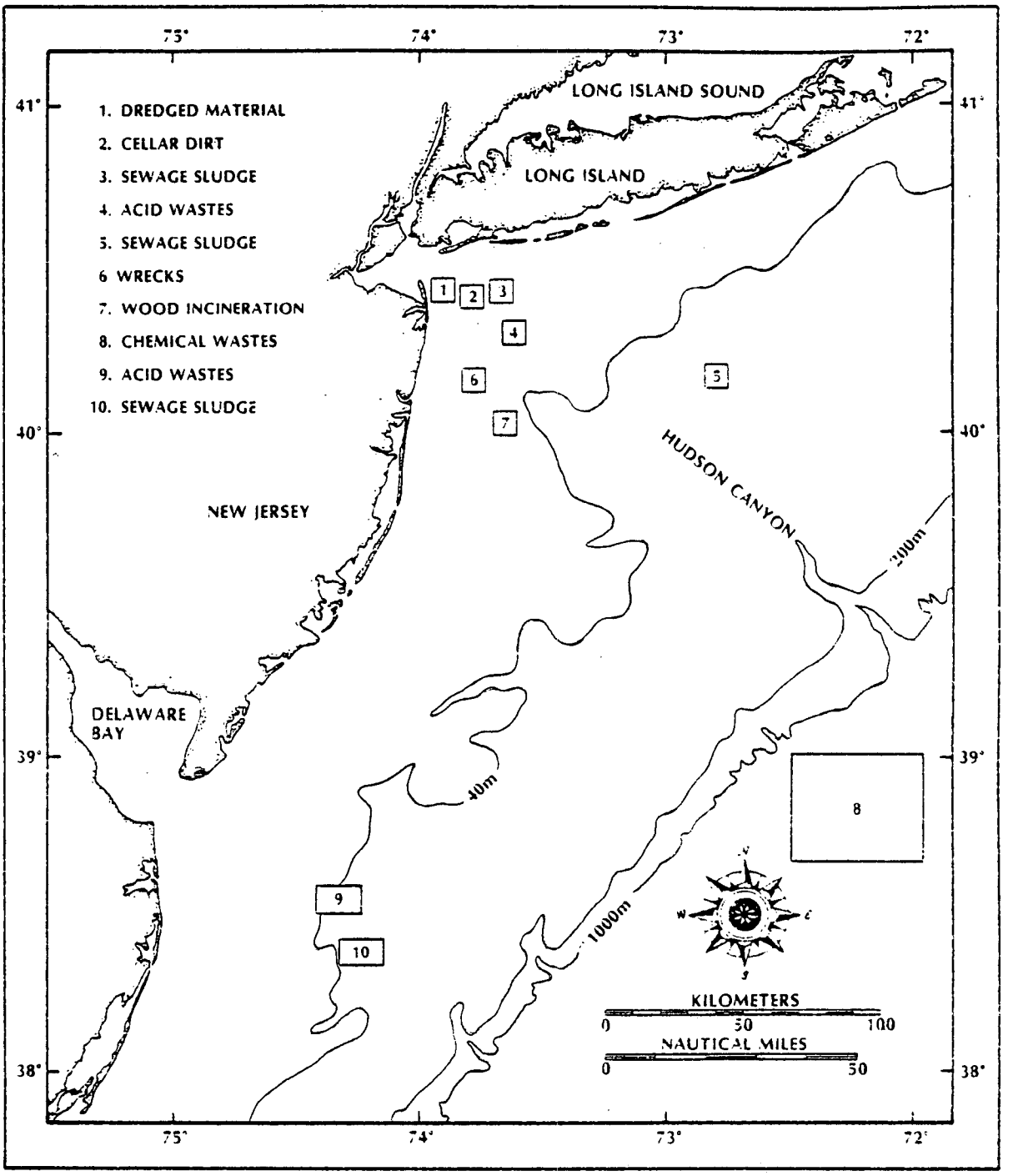


Figure 2-2. Existing Disposal Sites in the Mid-Atlantic

- All of the sites are small and additional activity would create logistics problems.
- The small size of the sites might preclude safe accommodation of more waste material.
- The sites are all located close to shore in areas which are heavily used for a wide variety of activities.

Consequently, most of the existing sites were eliminated from consideration for dumping the industrial wastes presently permitted at the 106-Mile Site.

A discussion of the New York Bight and Delaware Bay Acid Wastes Disposal Sites follows; these sites are individually compared with the 106-Mile Site.

NEW YORK BIGHT ACID WASTES DISPOSAL SITE

This disposal site was established in 1948 for the disposal of acid wastes generated by industries in the New Jersey-New York areas (Figure 2-1). The site is situated on the Continental Shelf 14.5 nmi (27 km) from the New Jersey and Long Island coasts, and covers 12 nmi^2 (41.2 km^2). The site boundaries are latitudes 40°16'N to 40°20'N, and longitudes 73°36'W to 73°40'W. The site bottom is relatively flat, with an average depth of 25.6 m (84 ft).

The primary waste dumper since the site was first established has been NL Industries, Inc., which presently dumps about 95% of the site's total annual volume. The only other active permittee is Allied Chemical Corporation. Du Pont-Grasselli released some caustic wastes at this site until 1975, when the disposal operation was moved to the 106-Mile Site.

The effects of waste disposal on the Bight Apex, including those at the Acid Site, have been investigated extensively by the NOAA-Marine Ecosystems Analysis Program (MESA) New York Bight Project, the NFMS-Sandy Hook Laboratory, and the permittees. The site environment, the history of waste disposal at the site, and the primary waste constituents presently dumped there are described in Chapter 3. Chapter 4 includes a description of the environmental consequences of acid wastes disposal at this site.

ENVIRONMENTAL ACCEPTABILITY

Several materials are present in wastes currently barged to the 106-Mile Site which are not presently released at the Acid Site or at any other location in the New York Bight Apex. These include nonpersistent organophosphate pesticides; surfactants; and by-products from the manufacture of rubber, mining, and papers, chemicals. Since such waste materials are not known to be entering the Apex from other sources, if released at the Acid Site they would represent an additional contaminant load on the environment of that area.

Several waste constituents dumped at the 106-Mile Site are present in wastes discharged at the Acid Site. Compared to the present mass loading of wastes at the Acid Site, significant amounts of cadmium, mercury, oil and grease, and petroleum hydrocarbons would be added by dumping 106-Mile Site wastes at the Acid Site. However, additional loading of these contaminants at the Acid Site would be a small fraction of the total amount of material already flowing into the area from rivers and land discharges (Table 2-1).

The Acid Wastes Site is in relatively shallow water. Hence, the potential for accumulation of waste constituents in shellfish and other organisms marketed for human consumption exists, and would be aggravated by further

TABLE 2-1
COMPARISON OF CONTAMINANT INPUTS TO THE NEW YORK BIGHT, 1973

Contaminant	(Metric Tons/Day)		
	All Sources	Acid Site Permittees	106-Mile Site Permittees
Cadmium	2.4	0.001	0.0003
Mercury	0.52	0.02	0.0002
Oil and Grease	782.7	0.1	0.09
Petroleum Hydrocarbons	No Data	0.08	0.2

Source: Adapted from Mueller et al., 1976.

waste discharges in the area. However, to date, benthic populations at the Acid Site have not shown evidence of uptake as the site is presently used. Additional discussion of this subject appears in Chapter 4.

Considering environmental acceptability, disposal at the New York Bight Acid Wastes Site of wastes from the 106-Mile Site must be discouraged for several reasons:

- Materials not presently entering the Bight Apex would be introduced, thus possibly placing greater strain on a system which is already impacted by man's wastes.
- Significantly greater amounts of waste constituents, which are presently disposed of at the site, would be introduced.
- Some constituents of the wastes presently dumped at the deepwater 106-Mile Site, could adversely affect the bottom dwelling organisms at the shallow Acid Site.

ENVIRONMENTAL MONITORING

The Bight Apex, including the Acid Site, is one of the most intensively studied regions in the world. Beginning in 1973, the NOAA-MESA New York Bight project has coordinated the study of all oceanographic disciplines within the Bight and has provided data and guidance for environmental management decisions (NOAA-MESA, 1977). Numerous other studies of the Acid Site environment and the effects of waste disposal have continued since 1948 (Redfield and Walford, 1951; Ketchum and Ford, 1948; Ketchum et al., 1958b, 1958c; Vaccaro et al., 1972). The current permittees, in compliance with condition of their permits, are sponsoring a monitoring program to evaluate the short-term effects of their waste discharges.

Relocating wastes from the 106-Mile Site to the New York Bight Acid Site would cause difficulty in monitoring waste effects at the site. The three decades of studies of the Acid Site provide an excellent historical baseline for acid dumping, particularly by NL Industries. If subtle long-term changes are taking place as a result of acid waste disposal, other waste discharges

would complicate the use of the data base for detecting such changes. Long-term environmental changes caused by acid dumping would be difficult, if not impossible, to differentiate from impacts caused by the new waste materials.

SURVEILLANCE

The Acid Site is adaptable to surveillance. The proximity of the site to shore permits use of patrol vessels and aircraft to conduct surveillance and record dumping vessel sightings, activities, and positions. Shipriders, although effective as a means of surveillance, are rarely used at this site because of the significant commitment of manpower and the adequacy of other surveillance methods. Any additional surveillance, however, would require additional operating hours, fuel, and man-hours.

ECONOMICS

Transportation Costs

The costs of barging wastes to the Acid Site are estimated to be in the range of $0.90 to $2.50 per metric ton ($0.80 to $2.25 per ton). The total cost of ocean disposal in 1978 for 106-Mile Site permittees leaving New York Harbor (360,000 metric tons), would therefore have ranged from $324,000 to $900,000 at the Acid Site. For permittees leaving Delaware Bay, the Acid Site is about the same distance as the 106-Mile Site, and the barging costs would not be significantly reduced by using the Acid Site instead of the 106-Mile Site. Using the previously calculated costs for disposal at the 106-Mile Site ($8.80 to $11.00 per metric ton), the 1978 barging cost from Delaware Bay to the Acid Site would have been in the range of $3.3 to $4.1 million. Thus, the total annual transportation cost to the permittees barging from Delaware Bay and New York Harbor would range from $3.6 to $5.0 million at the Acid Site. In the future, this total cost would drop as some permittees phased out ocean disposal; however, the cost to individual permittees would rise as a result of inflation and increased fuel prices.

Monitoring Costs

As previously noted, several groups are presently studying the effects of waste disposal in the New York Bight Apex. Unlike the permittees' programs, the other monitoring programs are not specifically oriented to evaluating the effects of acid waste disposal. However, if new wastes were released at the site, NOAA and EPA programs would probably conduct special studies at the site. New permittees would be required to conduct dispersion studies and participate in an existing monitoring program to evaluate short-term effects of waste. Since other types of wastes are released at the site, a rigorous monitoring program would be required to distinguish the effects of the new chemical wastes from the effects of acid wastes presently permitted at the site.

The cost of monitoring at this site cannot be reliably estimated. Although the site is shallow and located close to shore, the costs would still probably be substantial. The Bight Apex has numerous sources of contaminants, and other waste types are released at the site; consequently, a substantial effort would be required to evaluate the effects of new wastes. The cost would be borne by the permittees, in determining waste dispersion and short-term effects, and the Federal government, in investigating trends and chronic, long-term effects.

Surveillance Costs

The cost of surveillance for additional waste disposal operations in the Bight Apex would be relatively low. The site is well within the normal range of Coast Guard ships and aircraft, and surveillance is routinely carried out for the permittees now using disposal sites in the Bight; however, additional surveillance would require additional operating hours, fuel, and man-hours.

Loss of Biotic and Mineral Resources

Except for whiting, the most valuable commercial fish and shellfish taken in the New York Bight are either not present near the site, would not be affected by the chemical waste, or have been contaminated by other pollutants.

Disposal of additional chemical wastes at this site would threaten the commercial whiting fishery near the site during the late autumn and winter. No dollar value can be estimated accurately on these resources since the magnitude of the fishing effort near the site is unknown.

More important, the Bight Apex is a highly stressed ecosystem (NOAA-MESA, 1978), and adding new contaminants would increase the stress. Since other disposal sites are nearby, interactions between different waste types could cause unpredictable adverse effects on the ecosystem. It does not appear that fishery resources, in addition to these already mentioned, would be threatened; however, the possibility of a significant, deleterious change in the total Bight environment would exist with additional waste loading at the site.

Acid-iron wastes released presently at the Acid Site have been reported to attract bluefish (a popular sport fish) and, during spring and summer, the area is a popular fishing ground (Westman, 1958). If bluefish are, in fact, attracted to the site, the release of additional wastes could cause several problems: (1) fishermen might avoid the area because of the increased barge traffic and the presence of wastes which are perceived as more toxic than those currently permitted at the site; (2) the fish might no longer concentrate in the area; or (3) the fish might accumulate contaminants from the new wastes, causing the area to be closed to fishing to protect public health. The loss of this fishing area would cause significant economic impact on the charter and party fishing boats which presently use the area. Potential mineral resources in the Bight Apex have been contaminated by other pollutant sources, therefore there would probably be no additional loss from additional industrial wastes.

LOGISTICS

The present permittees using the New York Bight Acid Wastes Site and the 106-Mile Site barge wastes approximately once daily. Use of the Acid Site for the wastes presently being dumped at the 106-Mile Site would double the disposal activity at the Acid Site, thereby increasing the navigational

hazards to waste disposal vessels and other shipping, since the site is situated across the outbound lane and separation zone of the Ambrose-Hudson Canyon Traffic Lane. (See Chapter 3, Figure 3-10.)

OVERALL COMPARISON WITH THE 106-MILE SITE

Permitting 106-Mile Site industrial permittees to use the New York Bight Acid Wastes Site instead of the 106-Mile Site would result in decreased transportation costs for most dumpers, easier surveillance of the disposal operations, and, possibly, a greater ease of monitoring total impacts. However, the ability to monitor the specific impacts of the existing wastes released at the site would be degraded, and there would be a significantly increased shipping hazard. Most important, contaminants not presently dumped in the Bight Apex would be discharged, and these wastes could cause additional damage to an already highly stressed ecosystem. Therefore, this alternative is rejected in favor of the 106-Mile Site.

DELAWARE BAY ACID WASTE DISPOSAL SITE

This interim disposal site, centered approximately 35 nmi (65 km) southeast of Cape Henlopen, Delaware, is bounded by latitudes 38°30'N and 38°35'N, and longitudes 75°15'W and 74°25'W (Figure 2-1). It encompasses a rectangular area of about 51 nmi^2 (175 km^2), with depths of water ranging from 38 to 45 m (125 to 150 ft). The Philadelphia Sewage Sludge Site is 5 nmi (9 km) southeast of the site.

Du Pont-Edge Moor dumped acid-iron waste at this site from 1969 to 1977, when the operation was moved, at Du Pont's request, to the 106-Mile Site. During this period, the Edge Moor plant's titanium dioxide manufacturing process changed from a sulfate process to a chloride process, producing different acid wastes.

Du Pont sponsored several monitoring surveys at the site between 1969 and 1971. In 1973, EPA Region III initiated a monitoring program at the site and the nearby sewage sludge site. EPA still maintains historical stations in and around the site which are sampled twice yearly to monitor the site's recovery

towards natural conditions. Since September 1979, EPA and NOAA jointly monitor the acid waste and sewage sludge disposal sites.

ENVIRONMENTAL ACCEPTABILITY

Use of the Delaware Bay Acid Waste Site for disposal of wastes presently dumped at the 106-Mile Site would not be environmentally acceptable. Industrial wastes dumped at this shallow site could reach the seafloor which is inhabited by potentially valuable fishery resources (primarily surf clams, ocean quahogs, and scallops). However, the area is presently closed to some shellfishing because of the threat of bacterial contamination from the nearby sewage sludge disposal site. Past studies on benthic organisms from the vicinity of the Acid Site reported uptake of vanadium in scallops from the area. The acid waste dumped at the time of the study contained large amounts of vanadium, whereas the sewage sludge dumped nearby contained significantly lesser amounts of this metal. A link between the elevated vanadium concentrations in tissues and the acid waste was not clearly established; however, renewed industrial waste disposal at the site is not prudent in light of this observation.

Use of the Acid Site for industrial waste disposal, instead of the 106-Mile Site, would require transit by dump vessels from New York Harbor along the coast of New Jersey. Any emergency short dumping along this route could cause health hazards to beaches, coastal industry, or the extensive commercial and recreational fishing along this coast.

ENVIRONMENTAL MONITORING

Several years of background environmental data exist at the Delaware Bay Acid Waste Site. Pre-dumping surveys provide a marginal basis for comparison with post-dumping surveys, primarily because the latter work was much more extensive and more quantitative. However, there are enough data from the area to provide the basis for comparison.

Monitoring of the Delaware Bay Acid Waste Site would be complicated by the proximity of the Philadelphia Sewage Sludge Site. The primary net water

movement in the area is to the southwest; however, storms may affect the direction of water movement, causing water from the vicinity of the sewage sludge site to migrate northward. Therefore, it would be difficult to differentiate the effects of proposed industrial waste disposal, and previous acid waste disposal, from that of municipal waste disposal.

SURVEILLANCE

Since the Delaware Bay Acid Waste Site is presently inactive, USCG surveillance activities in the vicinity involve only the nearby sewage sludge site. The current USCG policy is to monitor 10% of the sludge disposal operations, and 75% of the industrial waste discharges. Therefore, a substantial increase in surveillance activities would be necessary if the Acid Site were reactivated for industrial waste disposal. However the increase in surveillance at the Acid Site would incur a decrease in surveillance at the 106-Mile Site.

ECONOMICS

Transportation Costs

The site is close to Delaware Bay, thus the hauling costs for vessels leaving New York Harbor will be significantly higher than for vessels from Delaware Bay. The site is about the same distance from New York as the 106-Mile Site, and the annual barging costs for dumpers in the New York area will probably be about the same - $8.80 to $11.00 per metric ton, or $3.2 to $4.0 million. The round trip would take between 54 and 72 hours (average speed 5 to 7 kn) through the coastal waters off New Jersey. The cost would be much less for vessels coming from Delaware Bay. Based upon the respective distances to the Acid Site and the 106-Mile Site, barging costs would be from $2.20 to $2.75 per metric ton, or $0.8 to $1.0 million annually. Thus, the annual total transport cost for this site would be about $4.0 to $5.0 million. The total cost of disposal at the site would decrease as some permittees phased out ocean dumping; however, the costs to individual permittees would rise as a result of inflation and increased fuel prices.

Monitoring Costs

The monitoring cost for the Delaware Bay Acid Waste Site is difficult to estimate, but would probably be lower than the cost of monitoring the 106-Mile Site. Effects of industrial wastes on the environment would have to be separated from the effects of nearby sewage sludge disposal and from the effects of water flowing out of Delaware Bay. EPA Region III and NOAA are currently jointly monitoring the sewage sludge site, and these surveys could be expanded at an additional cost to evaluate long-term effects of industrial waste disposal. Since the site was used until 1977, and was surveyed several times, sufficient data exist to recognize long-term environmental changes; extensive additional surveys would not be required.

Surveillance Costs

The Delaware Bay Acid Waste Site is near the limits of the range for Coast Guard ships and aircraft normally used for ocean dumping surveillance. Surveillance would require shipriders on some of the disposal vessels.

Loss of Biotic or Mineral Resources

Commercial surf clam beds exist in the vicinity of the Delaware Bay Acid Waste Site, but not close enough to be adversely affected by industrial waste disposal. Other shellfish, such as sea scallops and ocean quahogs, are abundant in the area, and scallops are presently being harvested. The site is sufficiently shallow, so that wastes could reach the bottom, perhaps contaminating these shellfish. At this time, the site is still closed to shellfishing by FDA because of the proximity of the sewage sludge site.

Mineral resources are not present at the site. Industrial waste disposal at this site would not interfere with oil and gas exploration and development east of the area.

LOGISTICS

The Delaware Bay Acid Waste Site is outside major shipping lanes, and daily use, if maintained at the level occurring presently at the 106-Mile Site, would present few, if any, navigational hazards to the dumping vessels within the site. However, the site's great distance from New York Harbor would necessitate careful planning and scheduling of trips.

OVERALL COMPARISON WITH THE 106-MILE SITE

The Delaware Bay Acid Waste Site is more convenient to one of the permittees using the 106-Mile Site, but little economic advantage would be gained by moving waste disposal operations from the 106-Mile Site to this location. The risks associated with renewed industrial waste discharges at the Acid Site and the possible adverse impact on potential fishery resources in the area make this alternative less preferable than continued use of the 106-Mile Site.

USE OF NEW SITES

New sites on or beyond the Continental Shelf (Figure 2-1) provide alternatives to disposal at the 106-Mile Site. Sites in the New York Bight and over the Continental Slope along the eastern edge of the Bight were considered. A new site for ocean dumping must meet the site selection criteria in Part 228 of the Ocean Dumping Regulations. The site must not conflict with other uses of the area, such as resource development or commercial fisheries, nor endanger human health or amenities, and should be located within the range of the current fleet of waste disposal vessels in order to make ocean disposal economically feasible.

LOCATIONS ON THE CONTINENTAL SHELF

The New York Bight is one of the busiest oceanic regions in the world; uses include extensive commercial shipping, fishing, shellfishing, recreation, resource development, and waste disposal. In selecting a site within the

Bight for ocean waste disposal, other conflicting activities in the area were evaluated for potential effects on disposal operations and vice versa. Additionally, adequate background environmental information on the area must presently exist to provide firm bases for projecting impacts of waste disposal.

Most of the survey work in the Bight has centered around existing disposal sites. However, two candidate areas for sewage sludge disposal have been studied extensively: the so-called Northern and Southern Areas (Figure 2-1). These areas were selected for study by NOAA, in part to avoid conflict with living marine resources (NOAA-MESA, 1976) and, therefore, were concluded to be the most reasonable new candidate locations for industrial waste disposal. Within the large areas suggested by NOAA for consideration, two smaller areas were studied in detail, the Northern and Southern Areas discussed below.

SOUTHERN AREA

The Southern Area (Figure 2-1) is square, centered at latitude 39°41'N and 73°18'W, with an area of 144 nmi^2 (484 km^2). The average water depth in the area is 40 m (130 ft).

Environmental Acceptability

The Southern Area contains presently and potentially valuable commercial fishery resources. The surf clam, sea scallop, and ocean quahog are often found in numbers suitable for commercial harvesting. Therefore, there exists significant risk in using the Southern Area to dispose of industrial wastes, since they contain elements which could be assimilated by organisms.

Environmental Monitoring

Due to the existence of the NOAA data base on predisposal conditions in the Southern Area, monitoring would be feasible. This site is outside the heavily contaminated Bight Apex, thus monitored waste disposal impacts at the site would not be confused with contaminants from other sources.

Surveillance

The Southern Area is outside the range of USCG patrol vessels and aircraft normally used for ocean dumping surveillance, therefore shipriders would be required. This would not result in a much shorter transit time and fewer shiprider hours per trip than surveillance at the 106-Mile Site.

Economics

Transportation Costs - The costs of transporting wastes to the Southern Area would be intermediate between those for a nearshore site and one beyond the Continental Shelf. The estimated barging costs for vessels leaving New York Harbor for the Southern Area would be $2.70 to $10.00 per metric ton, or $1.0 to $3.6 million annually. A round trip would take from 38 to 44 hours (average speed from 5 to 7 kn) through the coastal waters off New Jersey.

Permittees' barging costs from Delaware Bay would probably be about three-quarters of the cost of barging to the 106-Mile Site (based on the distances to the respective sites), i.e., $6.60 to $8.25 per metric ton, or from $2.4 to $3.1 million annually. The travel time would be 38 to 48 hours (average speed from 5 to 7 kn).

The total annual transportation cost for all waste disposal at the Southern Area would range from $3.4 to $6.7 million. The total cost of waste disposal at the site would decrease as some permittees phased out ocean dumping; however, the costs to individual permittees would rise as a result of inflation and increased fuel prices.

Monitoring Costs - Monitoring costs at the Southern Area would probably be lower than at either a nearshore or an off-Shelf site. Since NOAA has completed predisposal studies in the area (NOAA-MESA, 1976), and other contaminants are not present, monitoring would be fairly uncomplicated.

Surveillance Costs - The site is outside the range of Coast Guard ships and aircraft normally used for ocean dumping surveillance; therefore, surveillance

of actual ocean disposal operations would require shipriders. Surveillance of this site would require fewer man-hours, since the transit time is less than that required for the 106-Mile Site.

Loss of Biotic or Mineral Resources - Biological and mineral resources exist near the Southern Area. The potential loss of the former could be substantial. Economically important finfish (sculpin and whiting) and shellfish (lobster, surf clams, scallops, and ocean quahogs) inhabit the area. Since the area is in shallow water, wastes may reach the bottom and shellfish may be contaminated. Finfish may either avoid the area or accumulate contaminants from wastes. Thus, use of this location for industrial waste disposal could cause a significant adverse economic impact on living resources, although the impact could not be reliably estimated because the actual amount of fish and shellfish taken from the area is unknown.

Use of the Southern Area for industrial waste disposal would not be expected to affect nearby mineral resource development.

Logistics

Navigation of dump vessels in this location might be complicated by traffic (e.g., work boats, supply ships, oil tankers) associated with development of nearby oil and gas lease tracts (see Chapter 3, Figure 3-3). The likelihood of these hazards occurring would depend upon the speed and scope of oil and gas development in the area and upon the magnitude of ocean dumping at the site.

Overall Comparison with the 106-Mile Site

Waste disposal in the Southern Area would present some advantages over the 106-Mile Site, mainly in the ease of monitoring the site and in reduced transportation costs. However, the existence of a fishery resource in the area, the possibility of adversely affecting that resource, and the economic consequences of such an impact, make this alternative less favorable when compared to the 106-Mile Site.

NORTHERN AREA

The Northern Area (Figure 2-1) is a rectangle centered at approximately latitude 40°10'N and longitude 72°46.5'W, comprising 224 nmi^2 (770 km^2). Water depths in the area average 55 m (180 ft). The inactive Alternate Sewage Sludge Disposal Site is within the Northern Area at latitudes 40°10.5'N to 40°13.5'N, and longitudes 72°40.5'W to 72°43.5'W, comprising an area of 9 nmi^2 (31 km^2).

Environmental Acceptability

Although the Northern Area is not known to be fished, it contains sea scallops and ocean quahogs which may be caught in the future. The shallowness of the site makes bottom effects from waste disposal possible, and there are slight to moderate possibilities of modifying the benthic community of the area, and/or bioaccumulation of contaminants in benthic organisms.

Environmental Monitoring

An adequate data base on predisposal conditions at this site exists for monitoring. Possible sewage sludge dumping near one edge of the study area could complicate the differentiation of industrial waste effects from sludge effects.

Surveillance

The Northern Area is outside the range of USCG patrol vessels and aircraft normally used for ocean dumping surveillance, thus shipriders would be required for surveillance. Surveillance at the Northern Area would require fewer shiprider hours per trip than for surveillance of the 106-Mile Site since the transit time to the Northern Area is less.

Economics

Transportation Costs - Transportation costs for the Northern Area are similar to those for the Southern Area. The costs for hauling waste material

to this site would be intermediate between those for a nearshore site and those for an off-Shelf site. Estimated barging costs for vessels leaving New York Harbor are $3.60 to $7.50 per metric ton, or $1.3 to $2.7 million annually. A round trip would take between 38 and 44 hours (average speed 5 or 7 kn), through the coastal waters off Long Island.

The cost to permittees barging from Delaware Bay would be about the same as present transportation costs for ocean disposal at the 106-Mile Site, since the Northern Area is about the same distance from the mouth of the Bay as the existing site. Thus, the estimated cost per metric ton would be $8.80 to $11.00, or $3.3 to $4.1 million annually. A round trip would take 54 to 72 hours.

Total annual transportation costs of all waste disposal at this site would be from $4.6 to $6.8 million - slightly greater than costs for the Southern Area. Total cost would decrease as some permittees phased out ocean disposal, although the costs to individual permittees would rise as a result of inflation and increased fuel prices.

Monitoring Costs - Monitoring costs for the Northern Area would probably be similar to those for the Southern Area and less than those for a site off the Shelf or a nearshore site with other sources of contaminants nearby.

Surveillance Costs - The site is outside the range of Coast Guard ships and aircraft normally used in ocean dumping surveillance, thus surveillance of actual disposal operations would require shipriders. However, surveillance of this area would require fewer man-hours per mission than for the 106-Mile Site.

Loss of Biotic or Mineral Resources - The Northern Area is within the normal range of surf clams, but they are not abundant at the site. Ocean quahogs and sea scallops are abundant, and industrial waste disposal could possibly impact the development of these potentially valuable crops by affecting populations or by providing contaminants for uptake by the organisms.

Ocean disposal in the Northern Area would not interfere with the development of mineral resources. The site is approximately 60 nmi (110 km) northeast of the oil and gas lease tracts identified on the mid-Atlantic Shelf (see Chapter 3, Figure 3-3). Industrial waste disposal would not interfere with exploration or development of the oil and gas reserves which are presumed to occur in the vicinity of the Southern Area.

Logistics

No significant logistics problems would be expected in using the Northern Area for industrial waste disposal unless the Alternate Sewage Sludge Site was activated. The large volume of sludge that is presently dumped in the Bight requires a steady sequence of trips to the 12-Mile Site. If sewage sludge disposal operations were transferred to the Alternate Site, barge/vessel traffic in the Northern Area would increase. Thus use of this area for sludge disposal and industrial waste disposal would present problems in scheduling and navigation.

Overall Comparison to the 106-Mile Site

Use of the Northern Area for industrial waste disposal would have an economic advantage over the 106-Mile Site in transportation costs. However potential sludge disposal at the Alternative Sewage Sludge Site in addition to industrial waste disposal would create monitoring and logistics difficulties. Lastly, the Northern Area would not be environmentally favorable over the 106-Mile Site because of the presence of a potential shellfish resource which could be adversely affected by industrial waste disposal.

LOCATIONS OFF THE CONTINENTAL SHELF

Information on the mid-Atlantic Continental Slope and Continental Rise is generally lacking except for the vicinity of the 106-Mile Site (TRIGOM, 1976). The 106-Mile Site is the closest point to New York Harbor beyond the Continental Shelf (Figure 2-1). Hudson Canyon is immediately north of the site, and is believed to be a major migratory route for fish entering the New York Bight. Waste disposal near the Canyon would be environmentally

unacceptable primarily because migrating organisms could accumulate toxic constituents from the waste, presenting a potential health hazard to humans consuming the contaminated animals. The environment immediately southwest of the 106-Mile Site along the Continental Slope is unknown. Designating a site for waste disposal in that area would require extensive baseline survey work.

There are no data indicating that the 106-Mile Site is over or near a unique portion of the Slope or Rise. The same physical processes affect this entire region and the benthos is uniform over large horizontal distances at these depths. Other localities, farther northeast or south of the 106-Mile Site, would add considerably to round-trip distances to the site without any clear environmental benefit. The increased travel time raises the probability of emergencies occurring, which could result in short dumps.

OVERALL COMPARISON WITH THE 106-MILE SITE

The 106-Mile Site is clearly the best alternative for an ocean waste disposal site beyond the Continental Shelf for a number of reasons. Unlike other areas off the mid-Atlantic Continental Shelf, the 106-Mile Site has been studied extensively, so more information exists for projecting impacts of disposal activities. Use of any other Continental Slope area would require extensive survey work to produce the quantity of data presently available for the 106-Mile Site. The site is over that portion of the Continental Slope closest to New York Harbor (Figure 2-1), and thus is the Continental Slope location most convenient to potential users of an off-Shelf site. In conclusion, no advantage would be gained by favoring another off-Shelf location over the 106-Mile Site.

SUMMARY

Several alternative locations on and off the Continental Shelf were evaluated as potential industrial waste disposal sites. A number of features of the 106-Mile Site make it the best choice among the alternatives examined:

- The site is in deep water, so dilution and dispersion of introduced wastes are enhanced.
- The site is not in an area of significant commercial or recreational fishing or shellfishing.
- The site is convenient to the major ports in the Middle Atlantic states.
- The site conforms with the MPRSA directive to locate ocean disposal off the Continental Shelf whenever feasible.
- The site has been studied extensively for many years.
- Only limited adverse environmental impacts of waste disposal have been demonstrated at the site.

Thus, in considering all reasonable alternatives to the proposed action, the proposal of designating the 106-Mile Ocean Waste Disposal Site for continued use is the most favorable alternative for the foreseeable future.

There are risks involved in this action (discussed in detail in Chapter 4); however, the environmental risk of waste disposal at this site is judged to be less serious than the risk of disposing of these industrial wastes at locations on the Continental Shelf or at other locations the Continental Slope or Continental Rise. If subsequent monitoring at the site shows negative impacts resulting from waste disposal to be greater than anticipated, EPA may discontinue or modify use of the site, in accordance with Section 228.11 of the Ocean Dumping Regulations.

Table 2-2 presents the comparative evaluation of the possible effects of industrial wastes at the alternative sites discussed in this chapter. The effects on environmental acceptability, environmental monitoring, surveillance, economics, and logistics are summarized.

TABLE 2-2
SUMMARY COMPARATIVE EVALUATION OF ALTERNATIVE TOXIC CHEMICAL WASTE DISPOSAL SITES

CRITERIA	106-MILE SITE	NEW YORK BIGHT ACID WASTES SITE	DELAWARE BAY ACID WASTE SITE	NORTHERN AREA	SOUTHERN AREA
ENVIRONMENTAL ACCEPTABILITY	Extremely slight potential for adversely affecting public health from spills during transit to site. Very slight potential for long-term impacts on ecosystem at site.	Moderate to severe potential for adverse impacts on public health because the site is located in areas of commercial and recreational fishing and heavy ship traffic. Very slight to moderate potential for long-term impacts on the ecosystem.	Very slight to moderate potential for adversely affecting fishing from transit to the site, and from on-site disposal operations. Slight to moderate potential for long-term impacts on the ecosystem.	None to very slight potential for adverse impacts on fishing. Very slight to slight potential for long-term impacts on the ecosystem.	Very slight to moderate potential for adverse impacts on public health. Very slight to slight potential for adverse long-term impacts on the ecosystem.
IMPACTS ON PUBLIC HEALTH	None to very slight potential for adverse impacts.	Moderate to severe potential for adverse impacts.	Very slight to moderate potential for adverse impacts.	None to very slight potential for adverse impacts.	Very slight to moderate potential for adverse impacts.
Commercial Fish and Shellfish	No potential for consumption of contaminated fish or shellfish as commercial fishing is not concentrated in this region.	Moderate potential for consumption of contaminated fish or shellfish.	Moderate potential for consumption of contaminated fish or shellfish as commercially abundant resources exist near the site.	Low potential for consumption of contaminated fish or shellfish as the area does not have commercially abundant fish and shellfish.	Moderate potential for consumption of contaminated fish or shellfish as commercially exploitable shellfish exist in the area.
Recreational Fish and Shellfish	No potential adverse effects since the site is beyond the normal range of recreational fisherman.	Moderate potential for adverse short and long-term effects.	None to very slight potential for adverse effects as the area is beyond the normal range of most fishing.	None to very slight potential for adverse effects since the area is beyond the normal range of most recreational fishing.	None to very slight potential for adverse effects as the area is beyond the normal range of most recreational fishing.
Navigational Hazards	Very slight risk because of the great distance to the site.	Severe risk because the site is small, located close to shore, and located within the central traffic lane to New York Harbor.	Slight risk because barge traffic must travel down the coast of New Jersey and an accident could occur near fishing grounds.	No anticipated risk.	Slight risk because barges must transit through fishing areas.
IMPACTS ON THE ECOSYSTEM	Very slight potential for adverse impacts.	Very slight to moderate potental for adverse impacts.	Very slight to moderate potential for adverse impacts.	Very slight to slight potential for adverse impacts.	Very slight to slight potential for adverse impacts.
Plankton	Very slight short-term effects. None to very slight potential for accumulation of contaminants.	Slight short-term adverse effects when the wastes are released. No potential for detectable accumulation of contaminants due to numerous other waste sources.	Slight short-term adverse effects when the wastes are released, with potential of some accumulation of contaminants.	Slight short-term adverse effects when the wastes are released with potential of some accumulation of contaminants.	Slight short-term adverse effects when the wastes are released with potential of some accumulation of contaminants.

TABLE 2-2 (Continued)

CRITERIA	106-MILE SITE	NEW YORK BIGHT ACID WASTES SITE	DELAWARE BAY ACID WASTE SITE	NORTHERN AREA	SOUTHERN AREA
Nekton	Very slight potential for accumulation of contaminants.	Very slight potential for accumulation of contaminants.	Very slight potential for accumulation of contaminants.	Very slight potential for accumulation of contaminants.	Very slight potential for accumulation of contaminants.
Benthos	No potential for adverse effects because of adequate waste dilution.	Moderate potential for adverse effects. Difficult to differentiate from adverse effects of other nearby dumping.	Moderate potential for adverse effects.	Slight to moderate potential for adverse effects.	Slight to moderate potential for adverse effects.
Water Quality	Slight rise in concentration when wastes released, with very slight potential for longer term modification of ambient levels.	Slight rise in concentration when wastes released, with very slight potential for longer term modification of ambient levels.	Slight rise in concentration when wastes released, with very slight potential for longer term modification of ambient levels.	Slight rise in concentration when wastes released, with very slight potential for longer term modification of ambient levels.	Slight rise in concentration when wastes released, with very slight potential for longer term modification of ambient levels.
Sediment Quality	No potential for adverse effects.	Moderate potential for adverse effects. Difficult to differentiate from adverse effects of other nearby dumping.	Moderate potential for long-term accumulation.	Slight to moderate potential for long-term accumulation.	Slight to moderate potential for long-term accumulation.
Short Dumping	Slight potential for emergency because of extreme round-trip distance to site. No significant threat to commercial or recreational fisheries.	Very slight potential for emergency since site is so close to shore.	Slight potential for emergency because of extreme round-trip distance to site. Severe potential threat to commercial and recreational fisheries.	Slight potential for emergency.	Slight potential for emergency.
ENVIRONMENTAL MONITORING	Some difficulty in monitoring short-term effects of waste since the site is so far from shore. Moderate to severe difficulties in detecting long-term trends as site's environment is complex. Data base is large and expanding.	No difficulty in monitoring short-term effects of waste. Severe difficulties in detecting long-term trends as other permittees use the site and other contaminant inputs would mask this waste. Monitoring is complicated by close proximity of other disposal sites.	No difficulty in monitoring short-term effects of waste. Moderate difficulties in detecting long-term trends since the site was previously used and another disposal site is nearby.	No difficulty in monitoring short-term effects of waste. Slight difficulties in detecting long-term trends since existing data for area are few. Monitoring may be complicated if the alternate sewage sludge site is activated.	No difficulty in monitoring short-term effects of waste. Slight difficulties in detecting long-term trends since existing data for area are few.

TABLE 2-2 (Continued)

CRITERIA	106-MILE SITE	NEW YORK BIGHT ACID WASTES SITE	DELAWARE BAY ACID WASTE SITE	NORTHERN AREA	SOUTHERN AREA
SURVEILLANCE	Shipriders required.	Within the range of convential surveillance by aircraft and vessels.	Shipriders required.	Shipriders required.	Shipriders required.
ECONOMICS	High cost of transportation and monitoring. No conflict with other uses of the area.	Low cost of transportation and surveillance. Slight possibility of adversely affecting fishery resource.	High cost of transportation. Slight possibility of adversely affecting fishery resources.	Moderate transportation cost. Slight potential for adversely affecting future fishery resource.	Moderate transportation cost. Slight potential for adversely affecting present fishery resources.
Transportation Costs (Incl. energy costs)	Estimated to be $8.80 to $11.00 per metric ton.	Estimated to be $0.90 to $2.50 per metric ton.	Estimated to be $8.80 to $11.00 per metric ton for wastes transported from New York Harbor.	Estimated to be $3.60 to $7.50 per metric ton for wastes transported from New York Harbor.	Estimated to be $2.70 to $10.00 per metric ton for wastes transported from New York Harbor.
Monitoring Costs	Directly related to difficulty of monitoring. No dollar value available.	Directly related to difficulty of monitoring. No dollar value available.	Directly related to difficulty of monitoring. No dollar value available.	Directly related to difficulty of monitoring. No dollar value available.	Directly related to difficulty of monitoring. No dollar value available.
Surveillance Costs	Expensive unless ODSS is implemented since area is outside normal Coast Guard patrol ranges.	No exceptional expense as many disposal operations in the area undergo routine surveillance.	Expensive unless ODSS is implemented. Some mitigation of expense due to other site in area.	Expensive unless ODSS is implemented as area is outside normal Coast Guard patrol ranges.	Expensive unless ODSS is implemented as area is outside normal Coast Guard patrol ranges.
Loss of Biotic Resources	No potential for loss of resource since populations are not exploitable. No potential of interference with a lobster or red crab fishery.	Slight potential for loss of significant portion of recreational resources.	Slight potential for loss of future commercial shellfish resource.	None to very slight potential for loss of future resource.	Slight potential for adverse effects on resources and very slight potential for loss of significant portion of resources.
Loss of Mineral Resources	No conflict.	No conflict.	No conflict.	No conflict.	Possible very slight conflict.
LOGISTICS	Moderate scheduling and operational difficulties because of extreme distance to site. No conflicts with shipping.	Some conflict with other shipping because the site is located in a traffic zone.	Moderate scheduling and operational difficulties because of distance from New York Harbor. No conflicts with shipping near site.	No conflict with shipping.	Very slight potential conflict with oil and gas development.

BASES FOR SELECTION OF THE PROPOSED SITE

Part 228 of the Ocean Dumping Regulations and Criteria describes general and specific criteria for selection of sites to be used for ocean waste disposal. In brief, the general criteria state that site locations will be chosen:

- "...to minimize the interference of disposal activities with other activities in the marine environment..."
- "...[so] temporary perturbations in water quality or other environmental conditions during initial mixing...can be expected to be reduced to normal ambient seawater levels or to undetectable contaminant concentrations or effects before reaching any beach, shoreline, marine sanctuary, or known geographically limited fishery or shellfishery."
- "[site sizes] will be limited in order to localize for identification and control any immediate adverse impacts and permit the implementation of effective monitoring and surveillance programs to prevent adverse long-range impacts."
- "EPA will, whenever feasible, designate ocean dumping sites beyond the edge of the continental shelf and other such sites that have been historically used."

The 106-Mile Ocean Waste Disposal Site complies with all of the above criteria.

Eleven specific site selection criteria are presented in Section 228.6 of the Ocean Dumping Regulations. The following discussion consolidates the information for the 106-Mile Site, demonstrating the site's compliance with the site selection criteria. Additional information is provided in Chapter 3 (Affected Environment) and Chapter 4 (Environmental Consequences).

GEOGRAPHICAL POSITION, DEPTH OF WATER, BOTTOM TOPOGRAPHY AND DISTANCE FROM COAST

The 106-Mile Site is beyond the mid-Atlantic Continental Shelf, over portions of the Continental Slope and Continental Rise (Figure 2-1). Its

coordinates are latitudes 38°40'N to 39°00'N and longitudes 72°00'W to 72°30'W. Water depths at the site range from 1,440 m (in the topographically rugged northwest corner) to 2,750 m (in the relatively flat southeast corner). The nearest point of land is the New Jersey coast north of Cape May, located approximately 90 nmi (170 km) from the northwest corner of the site.

LOCATION IN RELATION TO BREEDING, SPAWNING, NURSERY, FEEDING, OR PASSAGE AREAS OF LIVING RESOURCES IN ADULT OR JUVENILE PHASES

All of these activities occur in some measure within the oceanic region along the Shelf break which contains the 106-Mile Site; however, no feature of the life history of valuable organisms is known to be unique to the 106-Mile Site or its vicinity.

Rare or endangered species may be present occasionally at the 106-Mile Site. However, the site is not a concentration point for these animals, which are migratory and would be present for only a few hours. Turtles (e.g., hawksbill and leatherback) and whales (e.g., sperm and right) may occasionally pass through the site. The possibility that these animals would be affected by a waste disposal operation is remote. Rare or endangered birds are not present at the site (Gusey, 1976).

LOCATION IN RELATION TO BEACHES AND OTHER AMENITY AREAS

The site is 90 nmi (170 km) from the nearest point of land, the coast of New Jersey. This distance is adequate to provide for extensive dilution and dispersion of wastes before reaching shore. Therefore, use of the site should not impinge on recreation, coastal development, or any other amenities along the shoreline.

TYPES AND QUANTITIES OF WASTES PROPOSED TO BE DISPOSED OF, AND PROPOSED METHODS OF RELEASE, INCLUDING METHODS OF PACKING THE WASTE, IF ANY

Wastes to be disposed of at the site must meet the EPA environmental impact criteria outlined in Part 227, Subparts B, D, and E of the Ocean Dumping Regulations, or, as in the cases of some of the present permittees using the

site, dumping of wastes not complying with the impact criteria must be phased out by December 31, 1981. In all cases, a need for ocean dumping must be demonstrated in accordance with Subpart C. Upon site designation, types and quantities of wastes presently dumped will apply. At this time, no new permit applications are anticipated. All wastes expected to be disposed of now, and following final site designation, will be aqueous industrial wastes (and possibly municipal sewage sludge) transported by vessels with subsurface release mechanisms. None of the wastes will be packaged in any way.

FEASIBILITY OF SURVEILLANCE AND MONITORING

Both activities are feasible at the 106-Mile Site, although costly. This subject was addressed earlier in Chapter 2.

DISPERSAL, HORIZONTAL TRANSPORT AND VERTICAL MIXING CHARACTERISTICS OF THE AREA, INCLUDING PREVAILING CURRENT DIRECTION AND VELOCITY

The physical oceanographic characteristics of the 106-Mile Site are described in detail in Appendix A. Waste dispersal is discussed in Chapter 4 and Appendix B.

EXISTENCE AND EFFECTS OF CURRENT AND PREVIOUS DISCHARGES AND DUMPING IN THE AREA (INCLUDING CUMULATIVE EFFECTS)

Chapter 4 and Appendices A and B provide additional details on effects of dumping at the site. This EIS is limited to discerning effects of industrial waste dumping. The effects of past munitions disposal within the site are unknown. Likewise, the effects of radioactive waste disposal outside of the site are unknown.

Based on survey work conducted at the 106-Mile Site and at other sites where acid-iron wastes are dumped, short-term adverse effects of waste dumping are generally known. These effects consist of plankton mortality in the waste plume immediately upon discharge from the barge, pH changes within the plume, increased concentrations of some waste constituents in the upper water column,

and possible avoidance of the area by fish. Short-term effects are mitigated by rapid dilution and dispersion of the wastes within the period of initial mixing.

Other investigations of dumping effects have been made, but the studies are still at a preliminary stage. Some observations include possible occurrence of abnormal fish eggs and embryos in the waste plume, ingestion of waste particulates by zooplankton, inhibition of organic carbon assimilation by bacteria, reduced feeding rates in copepods, stimulation of diatom growth in low waste concentrations and growth inhibition in elevated concentrations, and possible transport of waste materials by vertically migrating zooplankton. Most of this work has been hindered by the difficulty of tracking the plumes and performing time-series sampling within plumes. These effects and others are subjects for future research on waste disposal at the site.

INTERFERENCE WITH SHIPPING, FISHING, RECREATION, MINERAL EXTRACTION, DESALINATION, FISH AND SHELLFISH CULTURE, AREAS OF SPECIAL SCIENTIFIC IMPORTANCE, AND OTHER LEGITIMATE USES OF THE OCEAN

Present use of the 106-Mile Site interferes with none of the listed activities, nor is future use of the site for dumping likely to cause an obstruction. Most resource exploitation occurs on the Continental Shelf, so use of a site off the Continental Shelf is not likely to influence such activities adversely. The only relevant consideration is the effect, if any, of transit to and from the site. Emergency waste dumping could cause wastes being transported to the site to be short-dumped in an area where other activites are occurring; however, such a situation would be expected to cause only short-term interference and short-term adverse impacts, if any.

THE EXISTING WATER QUALITY AND ECOLOGY OF THE SITE AS DETERMINED BY AVAILABLE DATA OR BY TREND ASSESSMENT OR BASELINE SURVEYS

No known pre-disposal baseline data from the site vicinity exist; however, trend assessment surveys and limited laboratory studies have been conducted since waste disposal began at the site. This work is detailed in Chapter 4 and Appendix A.

POTENTIALITY FOR THE DEVELOPMENT OR RECRUITMENT OF NUISANCE SPECIES IN THE DISPOSAL SITE

In several years of site survey work, since waste discharging began, no development or recruitment of nuisance species has been observed.

EXISTENCE AT OR IN CLOSE PROXIMITY TO THE SITE OF ANY SIGNIFICANT NATURAL OR CULTURAL FEATURES OF HISTORICAL IMPORTANCE

No such features are known to exist at or near the site. The site is sufficiently distant from shore, so that wastes will not affect national or state parks or beaches.

CONCLUSIONS AND PROPOSED ACTION

All future use of the 106-Mile Site for ocean waste disposal must comply with the EPA Ocean Dumping Regulations and Criteria - a requirement which also brings prospective dumping into compliance with the MPRSA and the London Ocean Dumping Convention. EPA determines compliance with the Ocean Dumping Regulations on a case-by-case basis as applications for disposal permits are evaluated. This section offers general guidelines for determining acceptability of applicant wastes when a clear need for ocean disposal has been demonstrated, due to a lack of land-based disposal methods.

TYPES OF WASTES

Waste materials similar to those presently dumped at the site (see Appendix B) will be provisionally acceptable, since no significant adverse environmental effects have yet been demonstrated from dumping these wastes. If adverse effects are observed in later monitoring, dumping must be altered (reduced or stopped) according to Section 228.11 of the Ocean Dumping

Regulations until such effects do not occur. For the present, however, industrial wastes having the following characteristics may be released at the site:

- Aqueous, with solids concentrations sufficiently low, so that waste materials are dispersed within the upper water column
- Neutrally buoyant or slightly denser than seawater, such that, upon mixing with seawater, the material does not float
- Demonstrate low toxicity and low bioaccumulation potential to representative marine organisms
- Contain no materials prohibited by the MPRSA or the London Ocean Dumping Convention
- Contain constituents in concentrations that are diluted, such that the limiting permissible concentration for each constituent is not exceeded beyond the disposal site boundaries during initial mixing (4 hours), and not exceeded inside or outside of the site after initial mixing

Sewage sludge represents a special category of waste being considered for dumping at the site and is discussed in additional detail in Chapter 5.

WASTE LOADINGS

Since cumulative effects of past waste loading have not been demonstrated at the site, no upper limit can be defined beyond which effects could occur. (See Appendix B.) The maximum historical input, roughly 800,000 metric tons of industrial wastes and sewage sludge in 1978, has not caused observable long-term adverse effects. However, the critical element for evaluating the effects of waste loading at the site, is not the total annual input, but rather the input of each individual dump. The rate of release of each waste load must not be greater than the ability of the water to dilute it to acceptable levels within a short time. Compliance with Section 227.8 of the Ocean Dumping Regulations (limiting permissible concentration) should ensure that the marine environment will not be adversely or irreversibly impacted.

The total assimilative capacity of the site is unknown because the physical conditions which cause waste dispersal there are still not well understood.

Therefore, making accurate predictions of maximum permissible waste loading is impossible at this time. However, the emphasis of future NOAA research at the site is to define the physical characteristics of the site and its action on the waste in more detail. Each waste proposed to be dumped must be evaluated individually, and in relation to other wastes being dumped, for dispersion characteristics and input of toxic elements to the environment of the area. In the absence of more accurate information, waste loadings increased above the present level may be permitted as long as the site is carefully monitored for adverse effects. However, the amount of material dumped in each barge load must not be greater than that amount which can be reduced to acceptable levels within the period of initial mixing (4 hours). EPA establishes the size of barge loads and rates of release of materials at the site to meet this objective.

DISPOSAL METHODS

Present disposal methods practiced by permittees at the site appear to be acceptable for future waste disposal. Wastes are transported to the site in specially constructed barges, or in self-propelled tankers, and discharged from underwater valves while the barge/vessel is underway within the disposal site boundaries. The turbulence created in the barge/vessel wakes causes immediate dilution of the waste. This method (or any other method that maximizes initial dilution upon discharge) is recommended for all future disposal.

DUMPING SCHEDULES

EPA presently manages the disposal operations, such that different quadrants of the site are used seasonally by each permittee. This plan minimizes contact of wastes being released within the site at the same time and maximizes the dilution of wastes by using the entire site for dumping. When two or more waste vessels are discharging wastes simultaneously, the vessels should be separated by the maximum possible distance (at least 0.5 nmi) within the quadrant to allow for adequate dilution of the wastes.

PERMIT CONDITIONS

EPA specifies special conditions for inclusion in individual permits as necessary. All future permits should minimally contain the following conditions:

(1) Independent shiprider surveillance of all disposal operation will be conducted by the USCG or an unbiased observer (the latter at permittee's expense).

(2) Comprehensive monitoring for long-term impacts will be accomplished by Federal agencies and monitoring for short-term impacts will be accomplished by NOAA and the permittees (or by environmental contractors at the permittee's expense). All monitoring studies of permittees are subject to EPA approval. Short-term monitoring should include laboratory studies of waste characteristics and toxicity, and field studies of waste behavior upon discharge and its effect on local organisms. Long-term monitoring should include studies of chronic toxicity of the waste at low concentrations and field studies of the fate of materials, especially any particulates formed after discharge.

(3) EPA will enforce a discharge rate based on the limiting permissible concentration, disposal in quadrants of the site, and maintenance of a 0.5 nmi separation distance between vessels.

(4) Key constituents of the waste will be routinely analyzed in waste samples at a frequency to be determined by EPA on a case-by-case basis, but sufficient to evaluate accurately mass loading at the site.

(5) Routine bioassays will be performed on waste samples using appropriate sensitive marine organisms.

Chapter 3

AFFECTED ENVIRONMENT

This Chapter describes the environments of the proposed site and the alternative sites. The 106-Mile Site is in deep water off the Continental Shelf, thus it exhibits environmental features different from the alternative sites, which are in shallow water over the Continental Shelf. These unique features of the 106-Mile Site make it a better location for industrial waste disposal than any of the alternative sites.

THE 106-MILE SITE

Detailed information on the 106-Mile Site (Figure 3-1) is given in Appendix A. The following discussion is excerpted from Appendix A.

PHYSICAL CONDITIONS

The site is beyond the edge of the Continental Shelf within the influence of the Gulf Stream (Figure 3-2), therefore surface water at the site may belong to any or all of three different water masses, each having distinct physical, chemical, and biological characteristics: Shelf Water, Slope Water, and Gulf Stream Water. Slope Water normally occupies the site; however, when the Shelf/Slope front migrates eastward, Shelf Water of equal or lower salinity and temperature spreads over Slope Water, forming a relatively thin surface layer. Occasionally, warm-core rings of water (eddies), break off the Gulf Stream and migrate through the site, entraining Shelf Water or Gulf Stream Water. The latter is of higher temperature and salinity than Slope Water. Such eddies do not pass through the site on a seasonal basis, but they have been observed to touch or completely occupy the site for about 70 days a year (Bisagni, 1976).

As the surface waters of the site warm in late spring, the water stratifies within 10 to 50 m of the surface, forming a seasonal thermocline. Stratification persists until mid or late fall, when cooling and storm activity

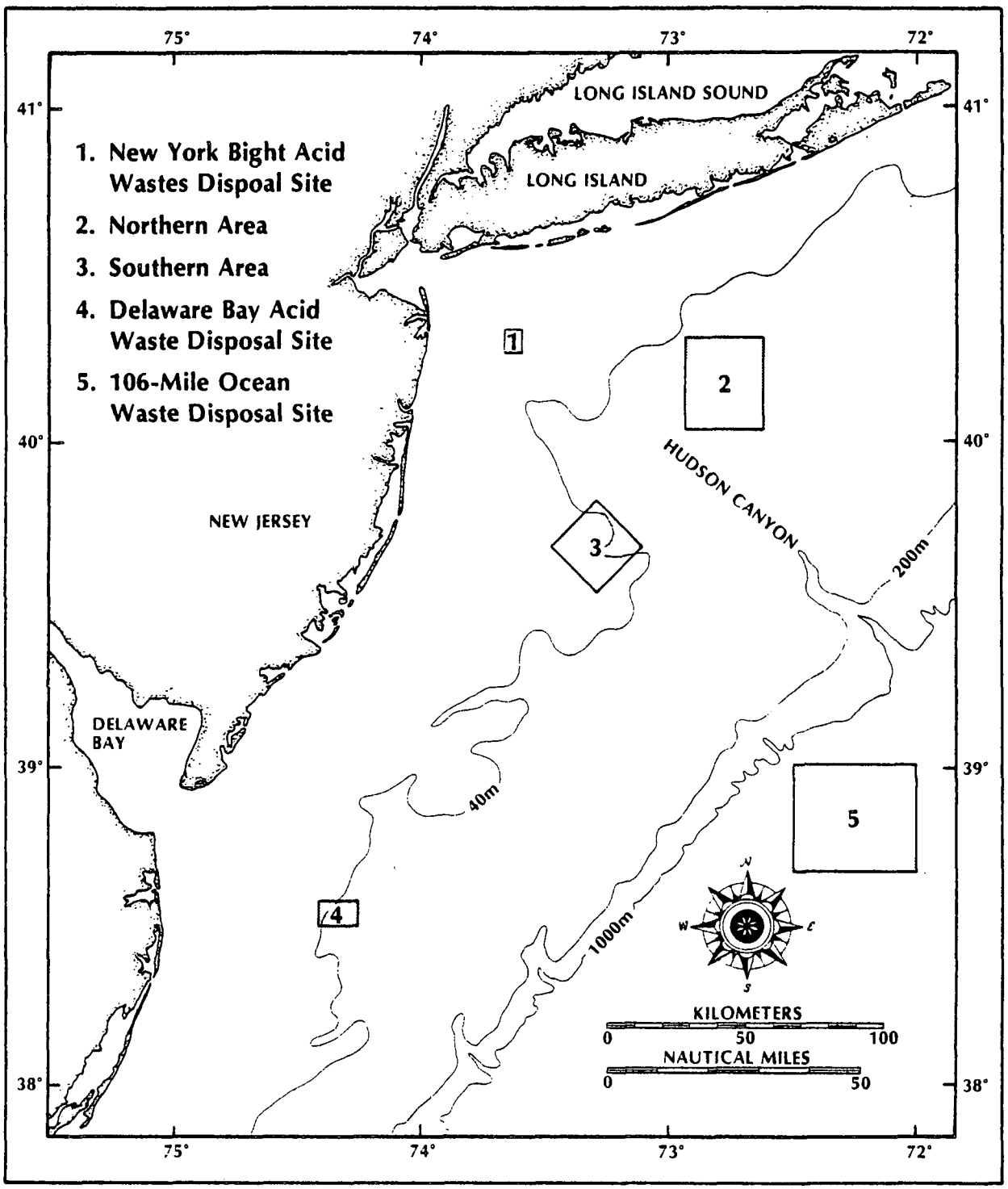


Figure 3-1. Alternative Disposal Sites

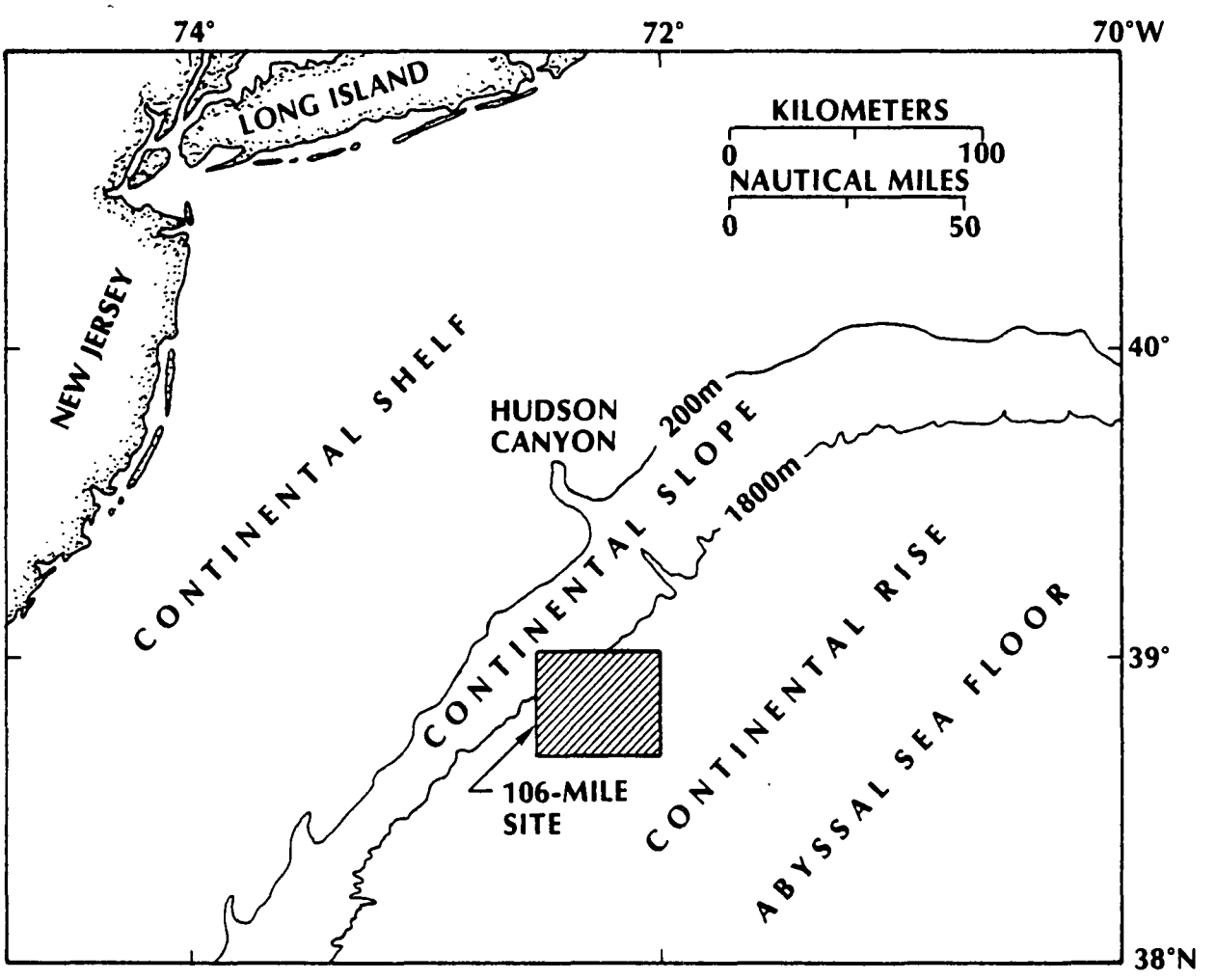


Figure 3-2. Location of the 106-Mile Site (Shaded)
Source: Adapted from Warsh, 1975b.

destroy it. From fall through winter and into early spring, the temperature of the water column is the same from the surface to a depth of approximately 100 m. At 100 to 150 m depth, however, a permanent thermocline exists, dividing the water column into upper and lower regimes. Water below the permanent thermocline is uniformly lower in temperature than water above the thermocline. The different water densities of these regimes (caused by the differences in temperatures) prevent large-scale mixing of the layers. Large storms passing through the area will only disrupt this feature temporarily, if at all. Physical characteristics of the site greatly influence the ultimate fate of aqueous wastes dumped there.

Few current measurements exist for the site; however, the literature indicates that water at all depths in this area tends to flow southwest at a speed of less than 0.2 kn, generally following the boundary of the Continental Shelf and Continental Slope (Warsh, 1975b). Occasionally, the water flow may change direction, particularly when Gulf Stream eddies pass through the area; this effect has been observed at great depths at the site.

Physical and chemical characteristics at the site introduce biological complexity because each water mass possesses unique associations of plants and animals.

GEOLOGICAL CONDITIONS

The Continental Slope within the disposal area has a gentle (4%) grade, which levels off (1%) outside the site in the region of the upper Continental Rise. Sediments within the site are principally sand and silt, with silts predominating (Pearce et al., 1975). Sediment composition is a major factor determining the amounts and kinds of animals capable of colonizing the bottom of the site. Generally, greater diversity and abundance of fauna are associated with fine sediments (e.g., silt) than with coarse sediments (e.g., sand), although unusual physical conditions may alter this. Fine-grained sediments are more likely to contain higher concentrations of heavy metals than coarse sediments. Sand, gravel, and rocky bottoms rarely contain these elements in high concentrations.

Continental Slope sediments in various parts of the site are subject to different dynamic forces. The Upper Continental Rise is an area of tranquil deposition, and the Lower Continental Rise is an area of shifting deposition. Erosional areas (caused by currents) lie between these two provinces. Depositional processes would determine the ultimate fate of any waste products which reached bottom (anticipated to be quite small). In areas swept by currents, waste products would be carried out of the disposal site by currents, and greatly diluted. In areas of erosion and shifting deposition, the same situation would exist, although the waste material could be temporarily deposited before movement. With tranquil or slow deposition, waste products would be buried slowly.

CHEMICAL CONDITIONS

The amount of oxygen dissolved in seawater is a general indicator of the life-supporting capacity of the water. Dissolved oxygen levels below 0.5 ml/liter stress some oceanic animals (Banse, 1964). Dissolved oxygen concentrations at the 106-Mile site range from 4.6 to almost 7.5 ml/liter in surface water.

Dissolved oxygen levels are minimum at depths of 200 to 300 m (averaging 3.2 ml/liter), and slowly increase vertically (shallower or deeper) from the stratification line. Summer and winter dissolved oxygen gradients at the site are similar, the main difference being the higher surface concentrations during winter. Any waste material which undergoes oxidation in seawater will consume oxygen, thus lowering the quantity of dissolved oxygen present in seawater.

Chemical research and monitoring surveys at the 106-Mile Site have analyzed trace metal levels in the sediments, water, and selected organisms. Metals in the sediments and water represent contaminants potentially available to site organisms, and could possibly be assimilated (bioaccumulated) and concentrated in toxic quantities within tissues.

Numerous metals are naturally present in seawater. Only concentrations of metals which exceed natural background levels and approach known or suspected toxicity levels would be expected to threaten marine organisms and man. The most recent studies of trace metal levels in the water of the 106-Mile Site found background levels typical of other uncontaminated Shelf-Slope regions (Kester et al., 1977; Hausknecht and Kester, 1976a, 1976b).

Concentrations of trace metals in sediments all along the Continental Slope and Continental Rise (including the site area) are generally elevated in comparison to Continental Shelf values (Greig et al., 1976; Pearce et al., 1975). This difference in concentrations is due partly to particle size

differences between Shelf and Slope sediments, since contaminants are usually more concentrated in finer grain sediments characteristic of the Slope region. Thus, elevated values appear to be ubiquitous off the Shelf, and therefore are not attributed to waste disposal activities at the site.

Analyses of trace metal concentrations in organisms at the site revealed high cadmium levels in three swordfish livers, mercury levels above the Food and Drug Administration action level ("unfit for human consumption") in most fish muscle samples, and low to moderate copper and manganese concentrations, similar to those in New York Bight finfish (Greig and Wenzloff, 1977; Greig et al., 1976). However, ocean waste disposal at the site was not linked by investigators to the metal concentrations found in any of the analyzed benthic and pelagic organisms because the organisms were transients and not confined to the site vicinity (Pearce et al., 1975).

BIOLOGICAL CONDITIONS

Plankton are microscopic plants and animals which drift passively with the current or swim weakly. Plankton are divided into plants - the phytoplankton, and animals - the zooplankton. Plankton are the primary source of food in the ocean, so their health and ability to reproduce are of crucial importance to all life in the ocean, including fish and shellfish of commercial importance.

Plankton at the 106-Mile Site are highly diverse due to the influence of the Shelf, Slope, and Gulf Stream water masses, as previously discussed in the section on physical conditions. High-nutrient Shelf Waters primarily contribute diatoms to the site, while the low-nutrient Slope Waters contribute coccolithophorids, diatoms, dinoflagellates, and other mixed flagellates (Hulburt and Jones, 1977). Mixed assemblages of zooplankters, common to the different water masses, occupy the site during winter, spring, and summer (Sherman et al., 1977; Austin, 1975).

Fish have been surveyed at various depths within the site. The diversity and abundance of fish found only in surface waters are similar inside and outside the disposal site (Haedrich, 1977). The fauna found primarily at

mid-depths (mesopelagic fish), are dominated by Slope Water species with Gulf Stream eddies contributing some north Sargasso Sea species (Krueger et al., 1975, 1977; Haedrich, 1977). At some depths, particularly in the lower water column, the density of mesopelagic fish has been lower at the site, compared with control areas (Krueger et al., 1977). Several migratory oceanic fish, usually associated with the Gulf Stream, are often found at midwater depths within the site. Benthic (bottom) fish in the site are similar to assemblages in other Slope areas (Musick et al., 1975; Cohen and Pawson, 1977).

Abundance and diversity of invertebrates at the 106-Mile Site are similar to those in most other mid-Atlantic Slope localities. As in similar areas, the invertebrates on the bottom (the epifauna) of the 106-Mile Site are dominated by echinoderms (e.g., brittle stars and sea urchins), while segmented worms (polychaetes) are the dominant burrowing organisms.

No mammal sightings have been reported at the site, although the site is within the distribution range of several species of whales and turtles, some of which are rare or endangered. However, disposal activities at the 106-Mile Site would not obstruct migrations nor harm these animals in any forseeable way since, as migrants, they would only be in the site a few hours, at most, and would tend to avoid dump vessels.

WASTE DISPOSAL AT THE SITE

Waste disposal at the 106-Mile Site is discussed in detail in Appendix B.

CONCURRENT AND FUTURE STUDIES

The NOAA Ocean Dumping and Monitoring Division and Ocean Pulse Program plan to continue monitoring the 106-Mile Site. All permittees are required to monitor waste discharges. Current permittees have contracted with a private company to conduct quarterly monitoring.

OTHER ACTIVITIES IN THE SITE VICINITY

Few activities occur in the site vicinity other than waste disposal operations at the site. A large area immediately south of the site has been proposed for ocean incineration. There are no other ocean disposal sites in the vicinity. Oil and gas lease tracts are west and north of the site, along the outer Continental Shelf (Figure 3-3). The Hudson Canyon Navigational Lane crosses the Continental Slope north of the site, but no major shipping lanes approach 106-Mile Site boundaries (Figure 3-4).

Limited fisheries resources occur at the 106-Mile Site and vicinity. Most commercially important species of finfishes in the mid-Atlantic prefer to live and spawn in Shelf areas and along the crest of the Continental Shelf-Slope break (NOAA-MESA, 1975; BLM, 1978; Chenoweth, 1976a). Consequently, most foreign and domestic fish trawling is conducted at depths shallower than 1,000 m - much shallower than the 106-Mile Site. Waters near the site have been used for the commercial longline fishing of marlin, swordfish, and tuna (Casey and Hoenig, 1977). However, only 1,264 fish of these species were reported caught between 1961 and 1974 in a large ocean area, of which the 106-Mile Site is a small part (Casey and Hoenig, 1977). Unknown additional quantities of these species were caught by foreign fishermen. The commercial longline effort is variable and dependent on the presence of eddies or other water masses near the site that create interfaces between water masses which are favorable to fishing (Casey, personal communication). In general, catch statistics for Continental Slope areas are incomplete because fishing vessels move from Shelf to Slope areas, mixing catches; landing records usually fail to separate Shelf species from Slope species.

The red crab (*Geryon quinquedens*) is among the several species of crabs collectively important to mid-Atlantic fisheries. The red crab is presently considered a feasible fishery only when simultaneously collected with other more commercially valuable species (Gusey, 1976). Adult red crabs have been found to depths of 4,000 m and juvenile red crabs have been found from depths of 500 to 1,000 m (Wigley, personal communication). Thus, the 106-Mile Site occurs within the depth range of the species.

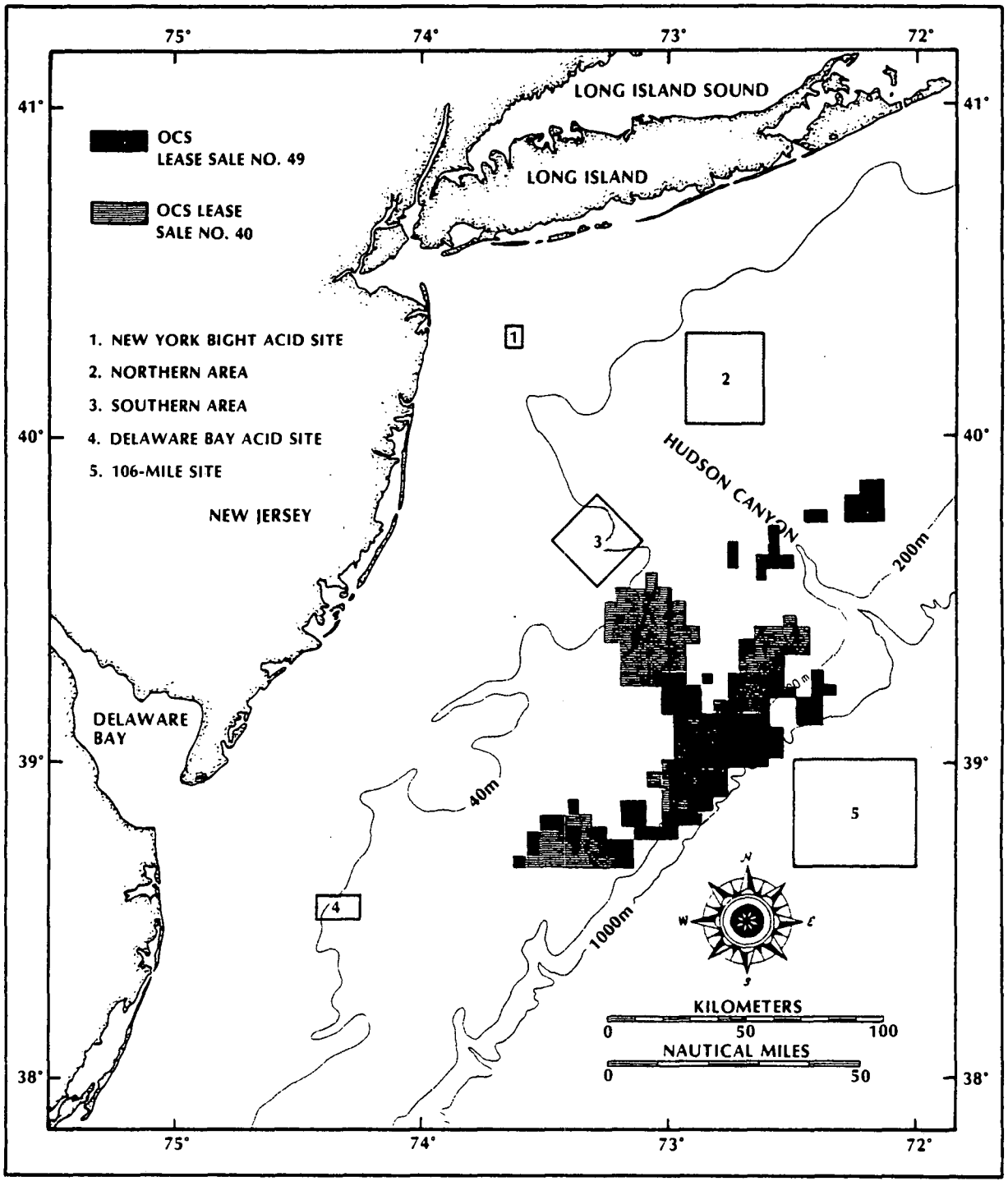


Figure 3-3. Oil and Gas Leases in the New York Bight
Source: Adapted from EPA, 1978.

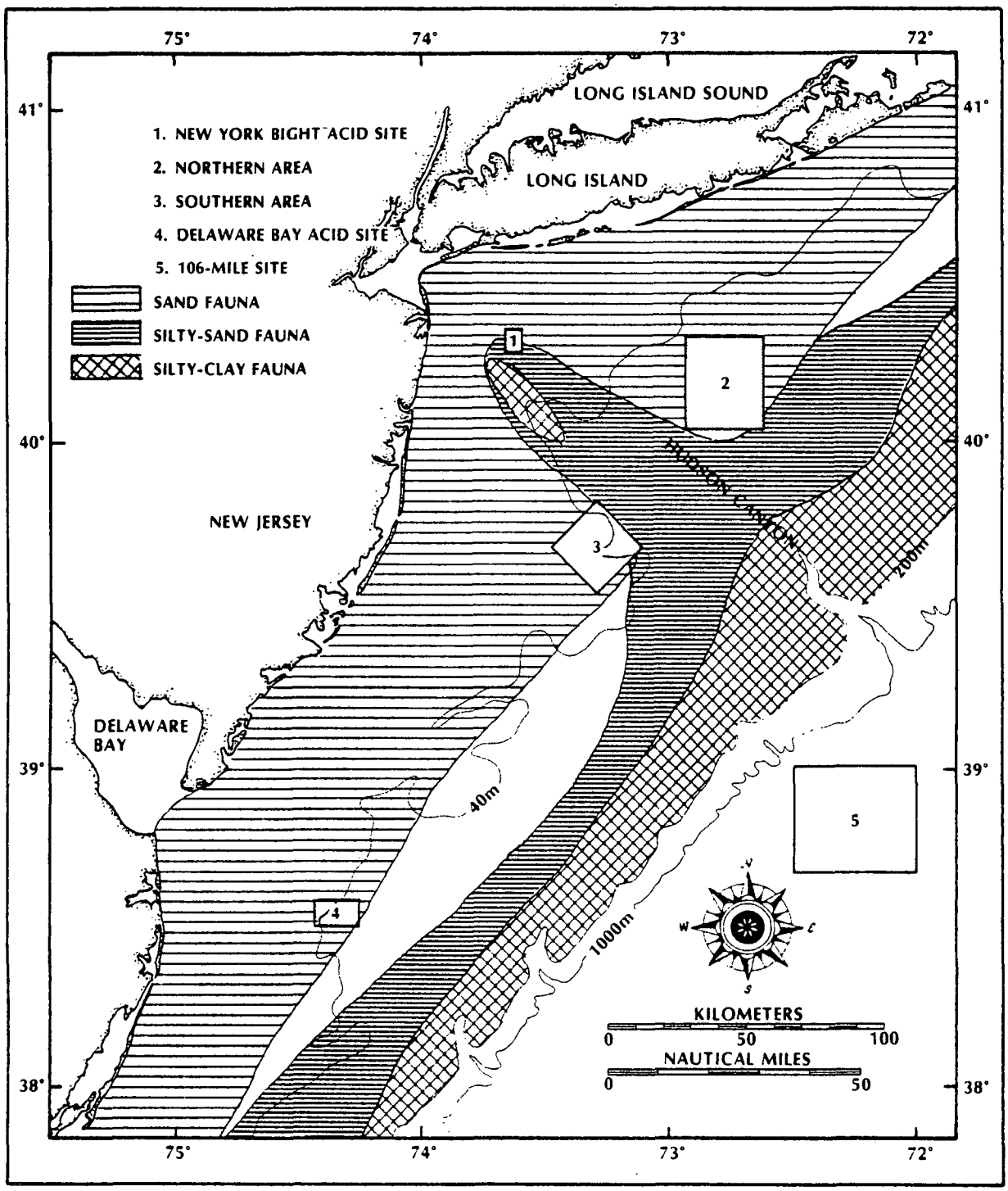


Figure 3-4. Benthic Faunal Types in the Mid-Atlantic Bight
Source: Adapted from Pratt, 1973.

The commercial fishing effort for red crabs is concentrated at depths of 300 to 500 m and does not presently occur at the 106-Mile Site or in water depths similar to those at the site (Wigley, personal communication). The greatest densities and biomass of red crabs occur at intermediate depths of 320 to 640 m (Wigley et al., 1975). Additional sampling is necessary to verify the depth relationship between adult and juvenile crabs; however, Wigley et al. (1975) found that some upslope migration of juvenile red crabs occurs with increased age (size). The presence of adults to at least 4,000 m depth suggests that downslope migration may occur. It is not known if recruitment of red crabs exploited by the commercial industry is solely dependent on individuals migrating from deeper water. Adequate abundance and size-class data for the red crab are not presently available and additional studies are needed (Wigley, personal communication). The effect of disposal operations on the planktonic larvae of red crabs is unknown, but is expected to be localized.

The commercial fishery for lobster (Homarus americanus) is one of the most important fisheries in the Northwest Atlantic. Offshore fishing occurs to at least 300 m depth and even with recent exploitation of lobsters on the Continental Shelf, domestic catches of lobster have been declining since 1970. Reported foreign catches are relatively small (Ginter, 1978). Lobsters occur from the low intertidal down to at least 700 m, with the potential resource occurring from 90 to 450 m depth (Larsen and Chenoweth, 1976; Gusey, 1976). Lobster fishing is not presently conducted at or near the 106-Mile Site or in water depths similar to those at the site (1,440 to 2,750 m). Lobsters prefer habitats ranging from rock crevices to sand and mud burrows. The substrate at the 106-Mile Site is predominantly silt, and therefore probably does not provide adequate shelter.

ALTERNATIVE SITES IN THE NEW YORK BIGHT

Three New York Bight Sites (Figure 3-1) - the existing New York Bight Acid Wastes Site, and the proposed alternative Northern and Southern Areas - were

evaluated as alternative sites for the disposal of industrial wastes. Overall conditions for the New York Bight are described below, emphasizing conditions which are unique to each site.

PHYSICAL CONDITIONS

The physical characteristics of the New York Bight are complex. Seasonal patterns of temperature, salinity, insolation, and river runoff are complicated by strong meteorological events and intrusions of Slope Water (Bowman and Wunderlich, 1977).

The hydrography of the New York Bight exhibits definite seasonal cycles in temperature and salinity (hence density) structures. Two distinct oceanographic regimes, with short transition periods, prevail during an annual cycle. Early winter storm mixing and rapid cooling at the surface create a well-mixed, unstratified water column. A moderate stratification develops in early spring, which intensifies during summer (Charnell and Hansen, 1974). The rapid formation of the seasonal thermocline divides the water column into upper and lower layers. Bottom waters remain stable until storms break up the thermocline in the late fall.

Conditions at the New York Bight Acid Wastes Site are more extreme than conditions at the Northern or Southern Areas because the site is close to shore and is affected by the fresh water outflow from New York Harbor. The site receives a greater influx of fresh water and suspended particulate matter (discussed below) than Shelf areas farther offshore, due to its proximity to Hudson River drainage. The site experiences colder winter water temperatures, since the site water lacks the tempering effect of deep waters and receives substantial cold-water runoff during the winter season.

GEOLOGICAL CONDITIONS

The New York Bight Continental Shelf is a vast sandy plain, underlain with clay (Emery and Schlee, 1963; Milliman et al., 1972). Sand is the most abundant textural component on the Shelf, and significant deposits of gravel and mud are also present. Surface sediments of the Acid Site and the Northern

Area contain small percentages of mud, while the latter contains some gravel. Surface sediments of the Southern Area are principally sand. The most prominent feature of the bottom sediment in this area is a band of coarse gravelly sand near the northeast rim of the Southern Area, parallel to the Hudson Shelf Valley.

Suspended particulate matter includes fine material from natural and man-made sources, which is suspended in seawater for long periods and may be transported for some distance by waves and currents before sinking to the bottom. After reaching the bottom, the material may be resuspended by bottom currents or wave action and transported to other areas. A number of potential environmental effects have been attributed to suspended particulate matter. Higher levels of this material can increase the turbidity of the water, thereby significantly limiting the depth at which plants can photosynthesize. Suspended particulates can have toxic effects, or can bind or adsorb toxic materials, which are eventually carried to bottom life. While suspended in water, or lying on the bottom, the toxic material can be consumed by marine organisms, or taken up by absorption.

The highest concentrations of suspended particulate matter in New York Bight waters occur near shore. The New York Bight Acid Wastes Site, in particular, has high levels of suspended particulate matter due to its closeness to the coast and Hudson River runoff, a major source of this material. Lower levels of suspended particulates are transported to and from the Northern and Southern Areas by means of currents moving to replace water which has moved out of the area.

CHEMICAL CONDITIONS

The coastal metropolitan area is the primary source of heavy metals entering the New York Bight (Benninger et al., 1975; Carmody et al., 1973). Concentrations of dissolved heavy metals in the water of the New York Bight vary seasonally; background (natural) concentrations, however, are generally higher than those reported for the open ocean (Brewer, 1975). Heavy metal concentrations in bottom sediments are not uniformly distributed throughout

the New York Bight, but vary according to sediment grain size, quality of organic material present, mineral composition, and proximity to the metropolitan area. In general, concentrations of dissolved heavy metals are highest in the Bight Apex, where man's influence is greatest.

Concentrations of heavy metals in sediments and water of the Northern and Southern Areas are low compared to those found in the Bight Apex, but all other chemical parameters are typical of the New York Bight. Higher levels of heavy metals have occasionally been found in the water of the New York Bight Acid Wastes Site (Segar and Cantillo, 1976), and metal concentrations in the sediments of the site are generally half as high as concentrations in Hudson Submarine Canyon sediments. Normally, waste material dumped at the site is confined to the water column; however an iron flocculent, which forms as the acid-iron waste reacts with seawater, has contributed to high sediment-iron concentrations in the site vicinity.

Surface waters of the New York Bight are saturated or nearly saturated with oxygen. Dissolved oxygen levels in bottom waters begin to decline in spring as the the surface mixing layer (thermocline) develops; by late summer, the oxygen levels reach the lowest values. Oxygen saturation increases in the fall, following breakup of the surface mixed layer, and continues to increase as greater mixing occurs (Segar et al., 1975). Dissolved oxygen concentrations in surface, mid-depth, and bottom waters in the Northern and Southern Areas are moderately to highly saturated during winter, spring, and critical summer conditions. The saturation value for oxygen at these sampling depths probably does not fall below 50% at any time of year, and is usually much higher (75% to 110%).

Suspended particulates which may trap and transport toxic susbtances, are found in highest concentrations near areas of wastewater discharge (outfalls) and sewage sludge, dredged material, and cellar dirt disposal sites. All three alternative sites display low levels of total organic carbon. No comprehensive studies of chlorinated hydrocarbons exist for the New York Bight, but dredged material and sewage sludge disposal are probably major sources of these materials in the Bight (EPA, 1975; Raytheon, 1975a, 1975b). Industrial chemical waste generally contains low levels of chlorinated hydrocarbons.

BIOLOGICAL CONDITIONS

During most of the year, the ranges of daily phytoplankton production for inshore and offshore areas of the New York Bight do not differ significantly from one another (Ryther and Yentsch, 1958; Yentsch, 1963). Total annual production, however, is higher in coastal waters. In broad terms, phytoplankton populations are dominated by diatoms during cold months and chlorophytes during warm months in the Hudson River estuary and Apex, and by diatoms in the outer Bight. Zooplankton populations are dominated by copepods and larvae of vertebrates and invertebrates during summer only in the estuary, and by copepods in the outer Bight.

The fish population in the New York Bight includes nonmigrating species, migrating species, and seasonal migrants (NYOSL, 1973). Many species of coastal fishes use the New York Bight as a spawning ground, although no specific location is used exclusively or consistently by any one species. The benthic fauna show a subtle gradient in the offshore direction, from sand fauna, to silty-sand fauna, to silty-clay fauna, as the sediments become more fine-grained (Figure 3-4).

At present, 21 species of finfish and 15 species of shellfish are commonly harvested in the New York Bight, and several other species are potentially important to future fishing. Fish exhibit unrestricted movement, thus locations where specific finfish are caught vary considerably from year to year. Fish mobility and the understandable lack of a requirement for fishermen to report specific fishing grounds, makes mapping of finfisheries nearly impossible.

Locations of specific shellfishing grounds in the mid-Atlantic are largely unknown. However, since shellfish movement is restricted, assessment surveys by NOAA's National Marine Fisheries Service (NMFS) are useful for locating areas inhabited by shellfish in marketable quantities. High densities of three of the most heavily utilized Bight shellfish resources - the surf clam,

sea scallop, and ocean quahog - are shown in Figure 3-5. The assessment surveys which provided these data were conducted in 1974 and 1975; actual locations and densities of the shellfish may have changed since that time. In addition, EPA (1978) reports that ocean quahogs are numerous around the Northern area. The Northern Area was not sampled in the NMFS assessment surveys.

Minor commercial fishing occurs around the New York Bight Acid Wastes Site. A seasonal whiting fishery exists along the edge of the Hudson Shelf Valley near the site during the winter, and lobster are taken inshore of the site. Most of the Bight Apex is closed to shellfishing because of contamination from the sewage sludge and dredged material sites, and the numerous effluent outfalls along the Long Island and New Jersey shore.

Surf clams, sea scallops, and ocean quahogs inhabit the Northern and Southern Areas on a nonexclusive basis for most (or all) life stages. Surf clams are more prevalent in the Southern Area and scallops are more prevalent in the Northern Area. However, neither area is known to be actively fished at this time.

WASTE DISPOSAL AT THE NEW YORK BIGHT ACID WASTES SITE

The New York Bight Acid Wastes Site was established in 1948 for the disposal of waste generated by industries in the New Jersey and New York areas. The present site, designated as an interim disposal site by EPA in 1973, is bounded by latitudes 40°16'N to 40°20'N and longitudes 73°36'W to 73°40'W.

RECENT DISPOSAL PRACTICES

Three permittees were using the New York Bight Acid Wastes Site when it came under EPA regulation in April 1973. In 1974, the Du Pont-Grasselli waste disposal operation was moved to the 106-Mile Site. Two permittees - NL

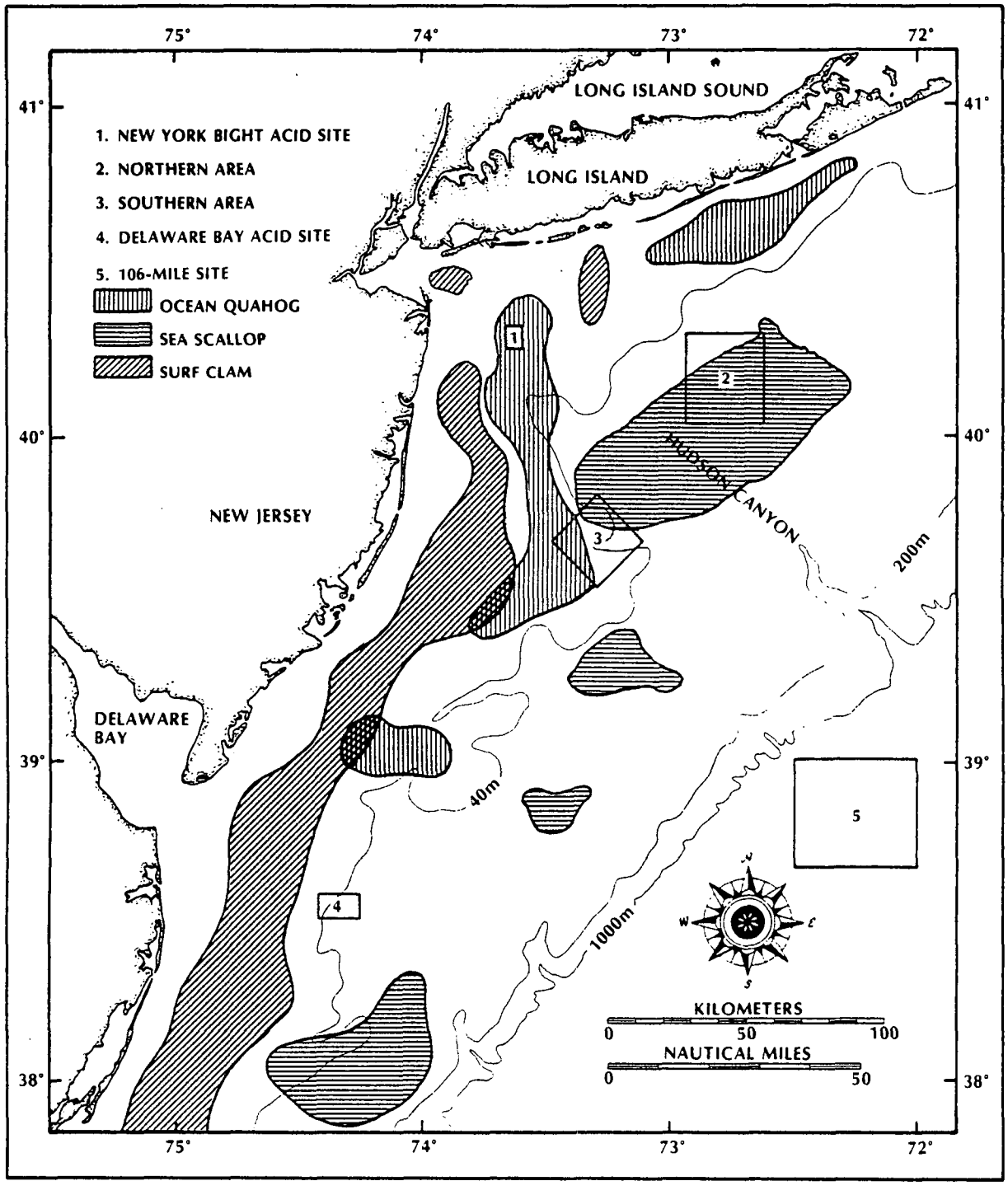


Figure 3-5 . Distribution of Surf Clams, Ocean Quahogs, and Sea Scallops in the Mid-Atlantic
Source: Adapted from NOAA-NMFS, 1974, 1975.

Industries, Inc., and Allied Chemical Corporation - are currently using the Acid Wastes Site. The volume of waste discharged at the site decreased 65% between 1973 and 1978 (Table 3-1), due to three factors:

(1) Du Pont-Grasselli abandoned the site in late 1974. Graselli waste accounted for 5% of the total quantity disposed in 1973 and 1974.

(2) Allied Chemical shut down certain manufacturing processes, causing the waste volume to decrease 74% between 1973 and 1978.

(3) NL Industries (the primary waste discharger) was either shut down or operating at a reduced capacity (due to a strike) for an extended period from 1976 to 1977. Normally, NL Industries contributes more than 90% of the waste volume.

TABLE 3-1
DISPOSAL VOLUMES AT THE NEW YORK BIGHT ACID WASTES DISPOSAL SITE
(Metric Tons)

Permittee	Year						
	1973	1974	1975	1976	1977	1978	Total
NL Industries	2,300,000	1,987,000	1,842,000	1,234,000	605,000	849,000	8,822,000
Allied Chemical	59,000	56,000	48,000	47,000	29,000	15,000	254,000
Du Pont-Grasselli	142,000	78,000	---	---	---	---	220,000
TOTAL	2,505,000	2,121,000	1,890,000	1,281,000	634,000	864,000	9,295,000

NL Industries

NL Industries, in Sayreville, New Jersey, disposes of wastes generated during the manufacture of titanium dioxide, an inert, nontoxic white pigment, prepared in various grades for use in the paint, paper, plastic, drug, and

ceramic industries. The waste consists of approximately 8.5% (by volume) sulfuric acid (H_2SO_4) and 10% (by volume) ferrous sulfate ($FeSO_4$) dissolved in fresh water. When the waste is dumped, the ferrous sulfate colors the water light green. Shortly thereafter the barge wake turns brown as the ferrous sulfate is oxidized to form ferric hydroxide (rust). Insoluble materials (e.g., silica and unrecovered titanium dioxide) are also present in the waste. NL Industries waste represented 97% of the total material dumped at the Acid Site between 1975 and 1978.

Allied Chemical Corporation

Allied Chemical, in Elizabeth, New Jersey, discharges wastes from the manufacture of fluorocarbons. The waste material consists of approximately 30% hydrochloric acid (HCl), 2% hydrofluoric acid (HF) - both by volume - and trace constituents in aqueous solution. The principal trace metals in the waste are chromium, copper, lead, nickel, and zinc. Allied Chemical wastes represented 3% of the total material dumped at the Acid Wastes Site between 1975 and 1978.

WASTE CHARACTERISTICS

Dispersion studies have been conducted periodically on NL Industries wastes since waste disposal began in 1948. Table 3-2 summarizes results of dispersion studies for NL Industries and Allied Chemical wastes, showing that the wastes are diluted rapidly after discharge. Redfield and Walford (1951) reported that the maximum volume of water having an acid reaction was 162,000 m^3 (640 m long, 23 m wide, and 11 m deep); the acid was neutralized within 3.5 minutes after discharge. Recent EG&G studies (1977a, 1977b) reported that the wastes did not penetrate the summer thermocline at 10 m, and initial mixing was rapid. A detailed description of the dumping operation is provided by Redfield and Walford (1951) and Peschiera and Freiberr (1968).

Trace Metals

The quantities of eight trace metals released at the Acid Site during the years 1973 to 1978 are summarized in Table 3-3. Only chromium, vanadium, and

TABLE 3-2
REPORTED DILUTION VALUES FOR WASTES DUMPED AT THE ACID SITE

	Dilution Seconds		Dilution Minutes												Dilution Hours	
Permittee/ Reference	15	30	1	2	3	4	5	12	22	30	39	55	66	180-200	4	18
Industries:																
Refs: Redfield and Walford 1951		250														
Ketchum and Ford, 1952	700			1,200		1,500	1,200	3,000		3,900		5,600		2,700		
Vaccaro et al., 1972*																
EG&G Inc. 1977a											9,400		40,000	82,000	90,000	116,000
Allied Chemical Corporation																
Ref: EG&G Inc. 1977b			2,700		6,500	1,500			23,000					83,000	143,000	

* Reported that the highest particulate iron concentration observed was equivalent to a dilution of 39,000. The time after discharge was unknown but the acid plume was still visible.

zinc are present in large quantities, and if the total contaminant inputs to the Bight are considered, inputs of these three metals from acid wastes are insignificant. The total mass loads of several trace metals released annually into the New York Bight from various sources are listed in Table 3-4. Wastes discharged at the Acid Site contribute significant amounts of vanadium, iron, and possibly nickel to the Bight. Redfield and Walford (1951) reported that the amount of iron barged to sea for disposal was about equal to the amount discharged in the Hudson River outflow. Recent work (NOAA-MESA, 1975) indicated that the Hudson estuary discharge is a major source of dissolved and suspended particulate metals, particularly iron and manganese. The Acid Wastes Site ranks fourth or fifth among the five possible sources of most metals introduced to the Bight; ocean dumping at other sites (principally dredged material and sewage sludge) and outflow from New York Harbor are the dominant sources of contaminants.

TABLE 3-3
ESTIMATED AMOUNTS OF TRACE METALS RELEASED ANNUALLY AT THE NEW YORK BIGHT ACID WASTES DISPOSAL SITE

Metal	Metric Tons/Year							
	1973	1974	1975	1976	1977	1978	Total	Average
Cadmium	0.9	0.9	0.1	0.3	0.1	0.2	2.5	0.4
Chromium	30.7	25.5	19.2	5.4	58.3	8.2	147.3	24.5
Copper	15.3	6.5	8.8	2.1	2.2	3.1	38.0	6.3
Lead	5.7	2.6	2.5	3.0	0.9	1.3	16.0	2.7
Mercury	0.0	0.1	0.0	0.005	0.003	0.004	0.1	0.02
Nickel	13.3	14.3	9.6	3.8	3.4	4.8	49.2	8.2
Vanadium	215.5	127.7	112.5	NA	NA	NA	NA	NA
Zinc	52.7	42.5	33.5	13.6	10.9	15.2	168.4	28.1

NA = Not analyzed

TABLE 3-4
MASS LOADS OF TRACE METALS ENTERING THE NEW YORK BIGHT, 1960-1974

Metal	Metric Tons					
	Ocean Dumping*	Atmosphere	Transect Zone†	New Jersey/ Long Island Coastal Zone	Acid Waste	Total
Cadmium	30	20	13	5	1	769
Chromium	880	27	803	81	31	1,822
Copper	2,573	146	2,263	54	15	5,051
Lead	1,993	2,154	2,117	32	6	6,302
Mercury	10	NR	94	7	0.01	111
Nickel	NR	NR	NR	NR	13	NR
Vanadium	NR	NR	NR	NR	216	NR

* Dredged Material and Sewage Sludge Sites
† Outflow from New York Harbor
NR = Not reported

Source: Adapted from Mueller et al., 1976.

Acid

The acid in NL Industries wastes is neutralized within a maximum of 40 minutes after discharge (EG&G, 1977a). Redfield and Walford (1951) calculated that upon discharge, the sulfuric acid would be immediately diluted to 2 parts in 10,000 and the seawater pH would not fall below 4.5. The actual pH depression observed two minutes after discharge was 6.9. The pH returned to normal level (8.2) within seven minutes. The EG&G (1977a) study found only two stations where the pH was depressed more than 0.1 units 40 minutes after the disposal of NL Industries waste.

In Allied Chemical waste dispersion studies, EG&G (1977b) reported a minimum pH of 5.95 four minutes after disposal began. The pH increased (6.6 at 22 minutes, 7.3 at 37 minutes) and returned to ambient levels within one to three hours.

EFFECT ON ORGANISMS

Before regulation of ocean dumping by EPA, numerous laboratory and field toxicity studies had been performed on the wastes dumped at the Acid Site. Observations of relatively slight effects have been reported by Redfield and Walford (1951), PHSSEC (1960), Ketchum et al. (1958b, 1958c), Vaccaro et al. (1972), Wiebe et al. (1973), Grice et al. (1973), and Gibson (1973). In contrast, NOAA-NMFS (1972) reported severe effects due to acid waste disposal. However, the NMFS methods and conclusions have been criticized (Buzas et al., 1972).

A variety of phytoplankters and zooplankters collected in the wake of an acid waste discharge have been analyzed. Animals may be immobilized immediately after disposal but recover quickly when the waste is diluted with an equal volume of seawater. Several investigators reported that the gastrointestinal tracts of copepods and ctenophores collected at the site after a discharge contained iron particles from the waste, but the animals did not exhibit any ill effects.

Laboratory work indicates that phytoplankton are unaffected by a concentration of acid waste four times higher than concentrations observed in the field. Zooplankton are chronically affected by concentrations of one part waste in 10,000 parts seawater, causing impaired reproduction and retarded development. However, this concentration of waste persists only for a few minutes after disposal, and is a strictly local phenomenon. Investigations have shown that the pH change causes the adverse effects rather than toxic elements in the waste. Neutralized acid waste is not toxic to the test organisms.

When the site was first established, there was controversy over possible adverse effects on the migratory fish in the New York Bight. Westman periodically surveyed the site and other fishing areas in the Bight (Westman, 1958, 1967 1969; Westman et al., 1961), and concluded that bluefish and yellowfin tuna are attracted to the site, and that an active pelagic fishery exists in the area; however, fish attraction was not demonstrated by

comparative sampling, and increased catches of fish in the site may be related to increased turbidity, consequent decreased recognition, and avoidance of fishing gear.

The acid waste does not appear to be toxic to bottom-dwelling animals. The site supports a typical sand-bottom community, with biomass and species diversity comparable to a control area (Vaccaro et al., 1972); however, the total numbers of individuals of all species are significantly less than at the control area. Other investigators (Westman, 1967, 1969; NOAA-NMFS, 1972) have reported variable benthic communities at the site. Recent samples (Pearce et al., 1976a, 1976b, 1977b) show that there is a wide natural variation at stations in and around the site, and that such variability is common for sand-bottom assemblages.

CONCURRENT AND FUTURE STUDIES

Several organizations are currently conducting research and survey activities in the New York Bight. The MESA-New York Bight Project is sponsoring work by a variety of Federal and academic investigators. This phase of the project is scheduled to end in 1981. After 1981, less intensive monitoring will continue under NOAA sponsorship.

The NOAA-National Marine Fisheries Service Laboratory at Sandy Hook, New Jersey, is periodically sampling and evaluating the Bight as part of the Ocean Pulse Program, designed to monitor and assess the health of the ocean's living resources on the Continental Shelf of the Northwest Atlantic Ocean. This program includes, as one of its objectives, the study of the effects of pollutants on important marine species.

EPA requires Acid Site permittees to perform waste dispersion studies and site monitoring surveys as permit conditions.

OTHER ACTIVITIES IN THE SITE VICINITY

COMMERCIAL FISHERIES

Extensive finfish and shellfish fishing occurs in the New York Bight. Most finfish fishing grounds are over the inner Continental Shelf or near the edge of the Shelf. Most indigenous Bight shellfish exist throughout the Bight, but certain species (e.g., lobster) are most abundant in Hudson Canyon or outer Continental Shelf Areas.

Domestic

Table 3-5 shows the 1974 total yield and dollar value for the five major species of commercial finfish in the New York Bight. The stock of most commercial species is still substantial, but there has been an overall decrease in annual yields of finfish over the last two decades (Figure 3-6), with commercial landings of certain over-fished species (e.g., menhaden) declining. The yield of the domestic shellfishery has increased greatly since 1960 (Figure 3-7). The once-important surf clam is becoming increasingly scarce, and other shellfish species have recently begun to be exploited (e.g., red crab and ocean quahog). Table 3-6 shows the total annual values in 1974 and 1976 for the more important shellfish species. The American lobster is the most important species fished along the Continental Shelf/Slope break, and is quickly becoming the most important fishery resource of the New York Bight (Chenoweth, 1976a).

Foreign

Nearly all foreign fishing in the north and mid-Atlantic regions of the United States is conducted on the Continental Shelf, with the majority of foreign vessels trawling in the outer Shelf region (Figure 3-8). Peak foreign fishing activity in the New York Bight occurs during spring and early summer, when the fleet moves south from its winter fishing grounds on the Georges Bank. The foreign fleet greatly increases in size during this period in order to harvest the greater numbers of fish which congregate at spawning grounds.

TABLE 3-5
TOTAL LANDINGS IN 1974 OF FIVE MAJOR COMMERCIAL FINFISHES IN THE NEW YORK BIGHT

Species	New York		New Jersey		Total	
	000 Lb	$000	000 Lb	$000	000 Lb	$000
Fluke	2,487	846	3,499	1,153	5,986	1,999
Menhaden	576	18	107,307	2,735	107,883	2,753
Scup	3,635	832	6,040	880	9,675	1,712
Striped Bass	1,409	533	714	177	2,123	710
Whiting	1,955	250	7,022	587	8,977	837

Source: Adapted from NOAA-NMFS, 1977a.

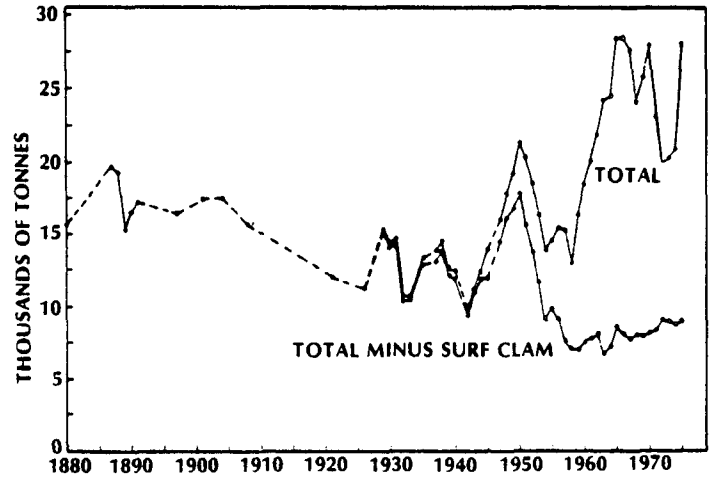


Figure 3-6. Total Landings of Commercial Marine Food Finfishes in the New York Bight Area, 1880-1975
Source: McHugh, 1978.

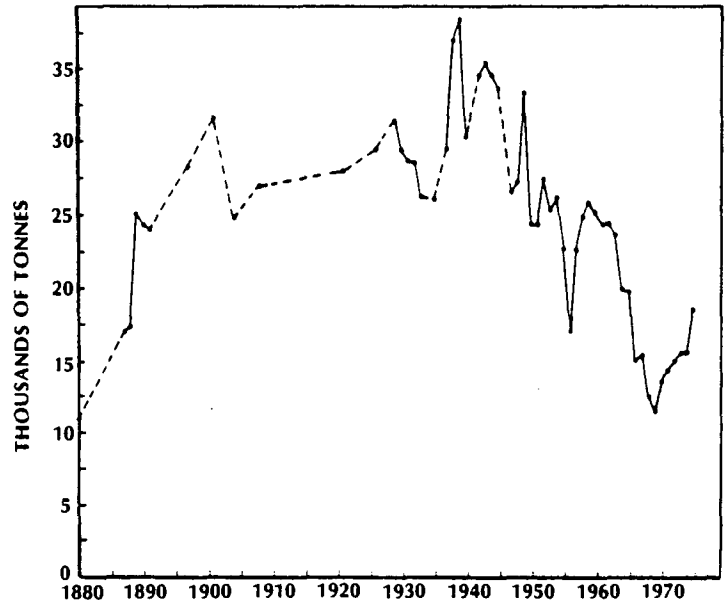


Figure 3-7. Total Commercial Landings of Marine Shellfish in the New York Bight Area, 1880-1975
Source: McHugh, 1978.

TABLE 3-6
TOTAL NEW YORK-NEW JERSEY COMMERCIAL LANDINGS IN 1974 AND 1976 OF IMPORTANT SHELLFISH SPECIES IN THE NEW YORK BIGHT

Species	1974		1976	
	000 Lb	$000	000 Lb	$000
American Lobster	1,922	3,312	1,117	2,368
Hard Clam	9,769	15,164	10,072	19,396
Surf Clam	26,608	3,667	9,493	3,299
Oyster	2,563	4,778	2,256	5,642
Sea Scallop	1,228	1,689	1,953	3,170
Blue Crab	2,864	725	407	123

Source: NOAA-NMFS, 1977a, 1977b.

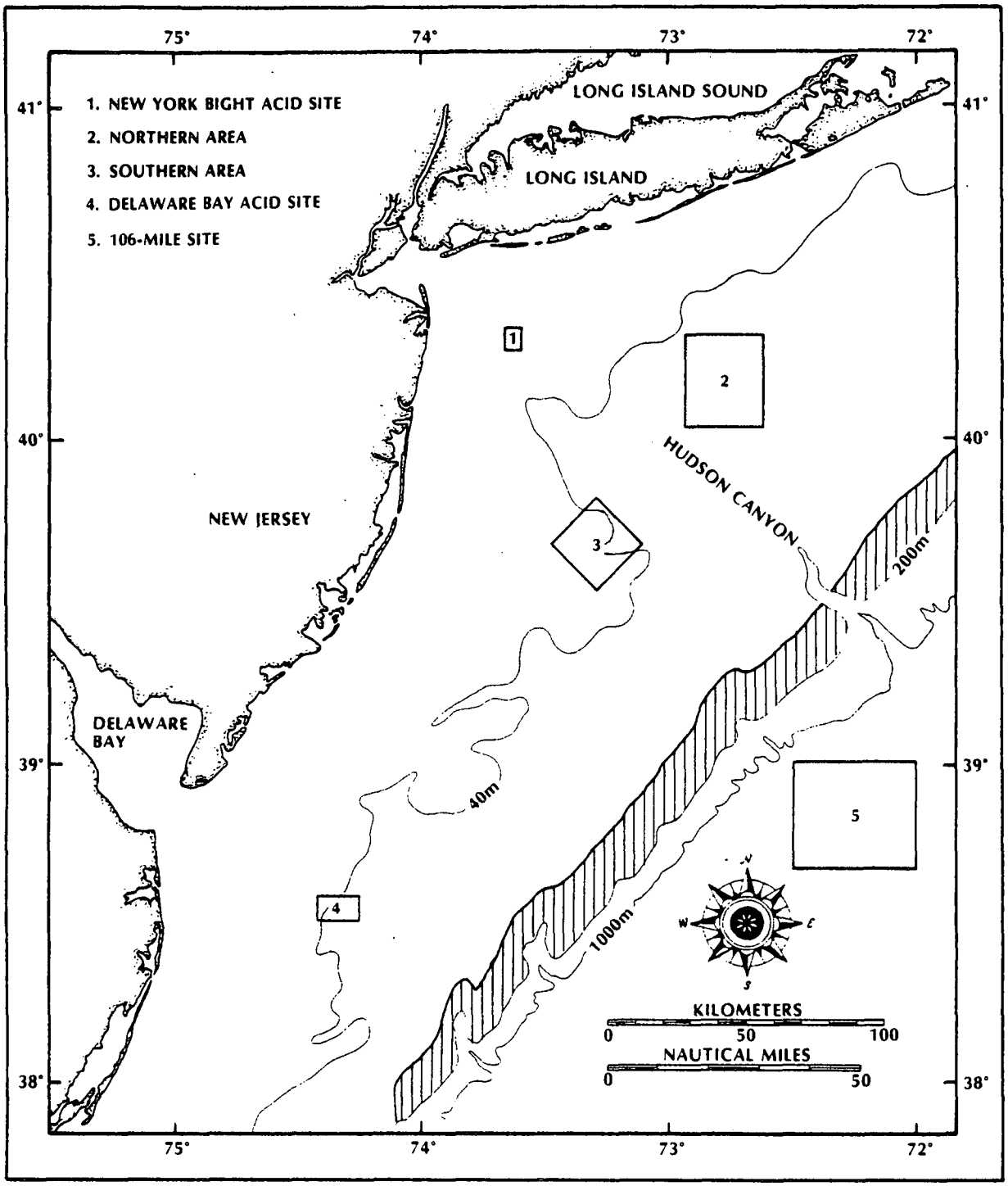


Figure 3-8. Location of Foreign Fishing off the U.S. East Coast
Source: Adapted from Ginter, 1978.

An annual average of 1,000 foreign vessels fish along the mid-Atlantic coast (Ginter, 1978). Foreign fishing in the New York Bight is dominated by the Soviet Union, followed by East Germany, Spain, and Japan. Major foreign fisheries are herring, silver and red hake, and mackerel. The seasonal migrations of these species account for the north-to-south movement of the foreign fleet throughout the year. New fishing efforts have been developed recently for squid, butterfish, tuna, and saury; this has moderated the strict north-south movement of foreign vessels.

Foreign vessels are prohibited from fishing such exclusive United States fishery resources as lobster, but are not required to report the magnitude of their annual harvest from United States waters. Consequently, no comprehensive foreign catch statistics are available.

RECREATIONAL FISHERIES

Most recreational fishing in the New York Bight is confined to inner Continental Shelf Waters, since this area is the most accessible to the public, and most sport species are found there (Chenoweth, 1976a). The important species are striped bass, weakfish, bluefish, and mackerel. The sport catch often equals or surpasses the commercial landings of certain species (e.g. striped bass), and has contributed significantly to the economics of several coastal areas. In 1970, for example, 1.7 million anglers caught 2.7 million pounds of fish from the North Atlantic coast. Recreational species fished further offshore are limited primarily to bluefin tuna, marlin, and swordfish. No accurate catch statistics exist for these species.

SAND AND GRAVEL MINING

Sanko (1975) states that since 1963 the largest single source of sand for New York City has been sand deposits in the Lower Bay of New York Harbor. This is the only area in the New York Bight where sand is presently mined; however, recent geological surveys show that sand could be mined nearly anywhere in the New York Bight, with current technology limiting the outer boundary to the 50-m (165-ft) isobath. There is an estimated area of over 780 nmi^2 (2,680 km^2) suitable for sand mining between the 50-m isobath and the

Long Island shoreline (Schlee, 1975). Most of this sand is of a uniform grain-size, and contains a low percentage of fine particles. Gravel deposits in the New York Bight have a much more limited distribution than sand. Potential mining areas for gravel are fewer and are principally off the northern coast of New Jersey (Figure 3-9).

OIL AND GAS EXPLORATION AND DEVELOPMENT

There are no present or future oil and gas lease tracts in any ocean disposal site (Figure 3-3). The U.S. Department of the Interior Bureau of Land Management (BLM) completed its first sale of oil and gas leases on the Mid-Atlantic Outer Continental Shelf in August 1976 (Outer Continental Shelf [OCS] Sale No. 40). Exploratory drilling at six of the 93 tracts leased in OCS Sale No. 40 began in the spring and summer of 1978. On May 19, 1978, BLM published a draft EIS on the proposed OCS Sale No. 49, which includes 136 tracts totalling 774,273 acres (313,344 hectares). Sale No. 49 is tentatively scheduled for spring of 1979. A third sale (No. 59) is under consideration, tentatively scheduled for August 1981 (BLM, 1978).

SHIPPING

The major trade routes charted by NOAA to serve the New York-New Jersey area coincide with three major shipping lanes designated by the USCG: the Nantucket, Hudson Canyon and Barnegat Navigational Lanes (Figure 3-10). Hudson Canyon Lane lies across the New York Bight Acid Wastes Site, and the other lanes straddle the Northern and Southern Areas. The trade routes within the navigational lanes are usually the safest routes for shipping traffic, and the Coast Guard recommends that they be used by all major shipping traffic.

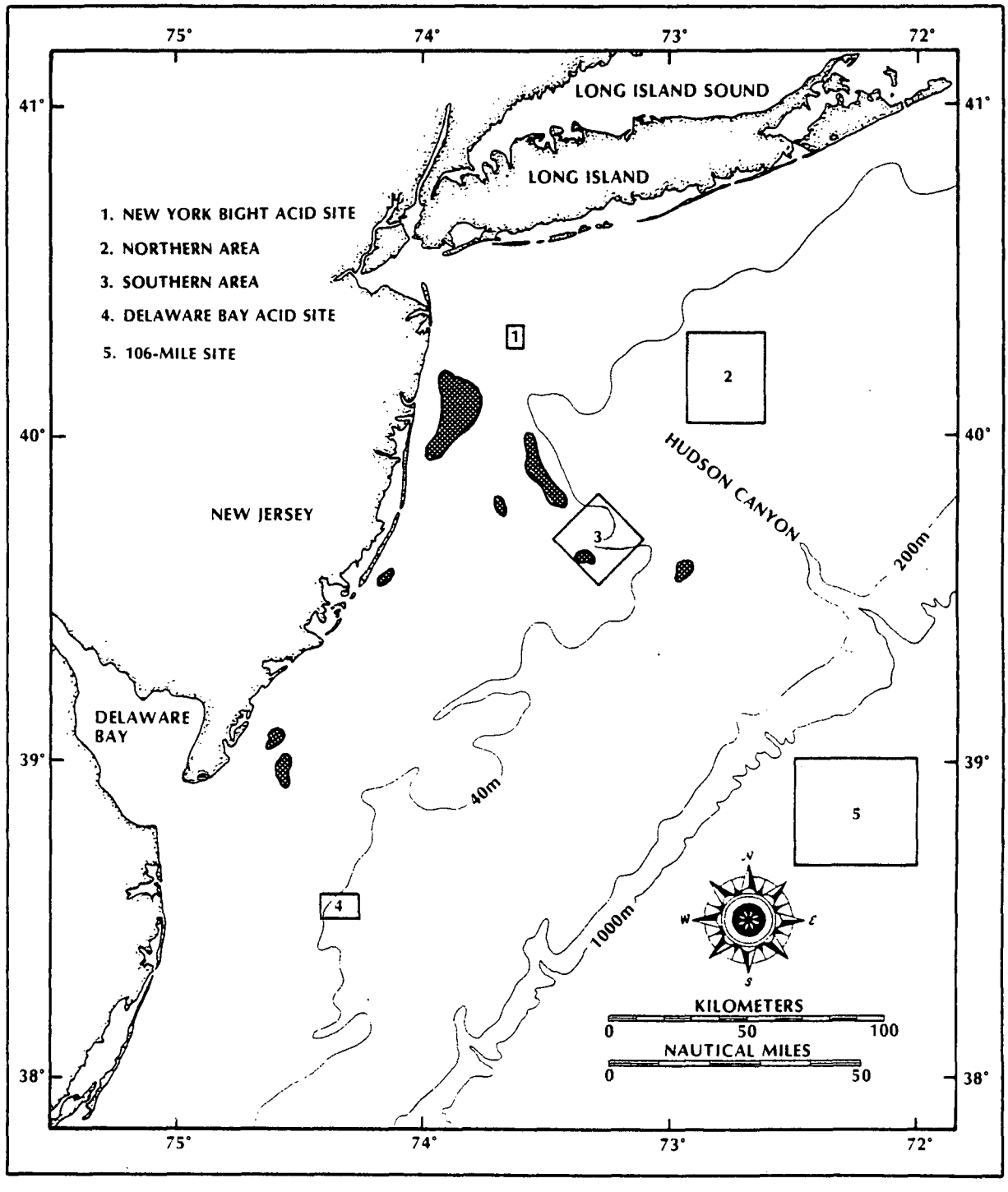


Figure 3-9. Gravel Distribution in the New York Bight
Source: Adapted from Schlee, 1975.

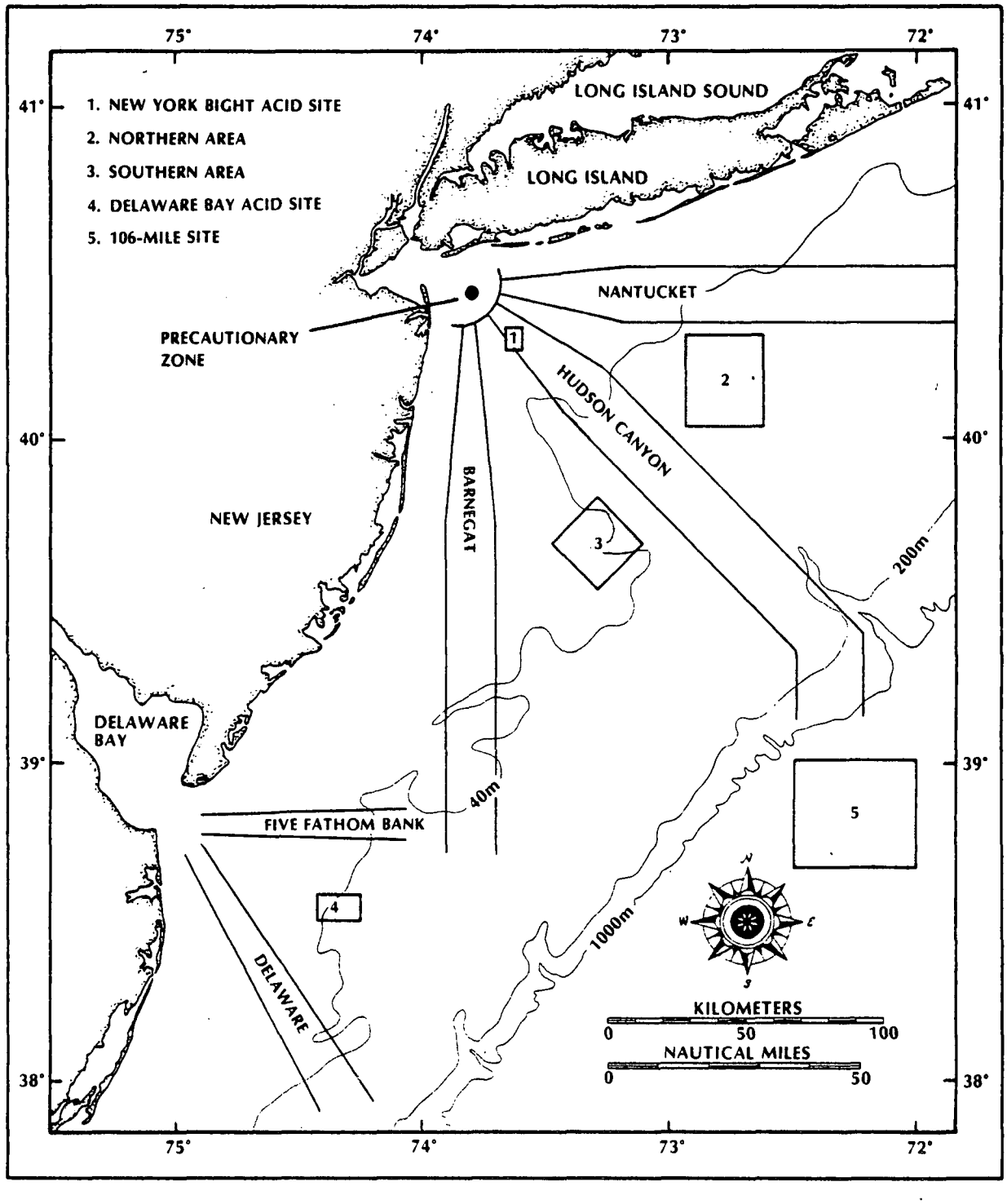


Figure 3-10. Navigational Lanes in the Mid-Atlantic

OCEAN WASTE DISPOSAL

The EPA permits ocean disposal at seven sites in the New York Bight (Figure 3-11). The Acid Wastes Site is considered in this EIS as a possible alternative site for the industrial wastes presently released at the 106-Mile Site.

12-Mile Sewage Sludge Site

There are 13 permittees dumping sewage sludge at this site, with the City of New York discharging the largest percentage of the waste. The total volume of sewage sludge to be disposed of by the 13 permittees in 1979 is estimated to be 7,772 m^3, and is expected to reach 9,895 m^3 by 1981. Sludge dumped at this site is composed of municipal sewage wastes resulting from primary and secondary treatment.

New York Bight Dredged Material Site

Several locations have been used historically as sites for the disposal of material dredged from navigable waterways in the New York-New Jersey metropolitan area. The present site was designated in 1940 as the exclusive disposal site for this material. Until 1973, ash residues from fossil-fueled power plants were also permitted to be dumped at the site.

Each year, the volume of dredged material dumped at this site exceeds that of material dumped at any other disposal site. The average annual volume of dredged material dumped at the site from 1960 to 1977 was approximately 6 million m^3. The annual volume is estimated to increase by 46,000 to 54,000 m^3. The dredged material dumped at this site is composed of particulate solids which, because of the proximity of the dredging sites to large metropolitan areas, contains higher levels of metals than any other material dumped in the Bight.

New York Bight Cellar Dirt Site

The history of this site is similar to the history of the Dredged Material site. The Cellar Dirt Disposal Site has been relocated several times to

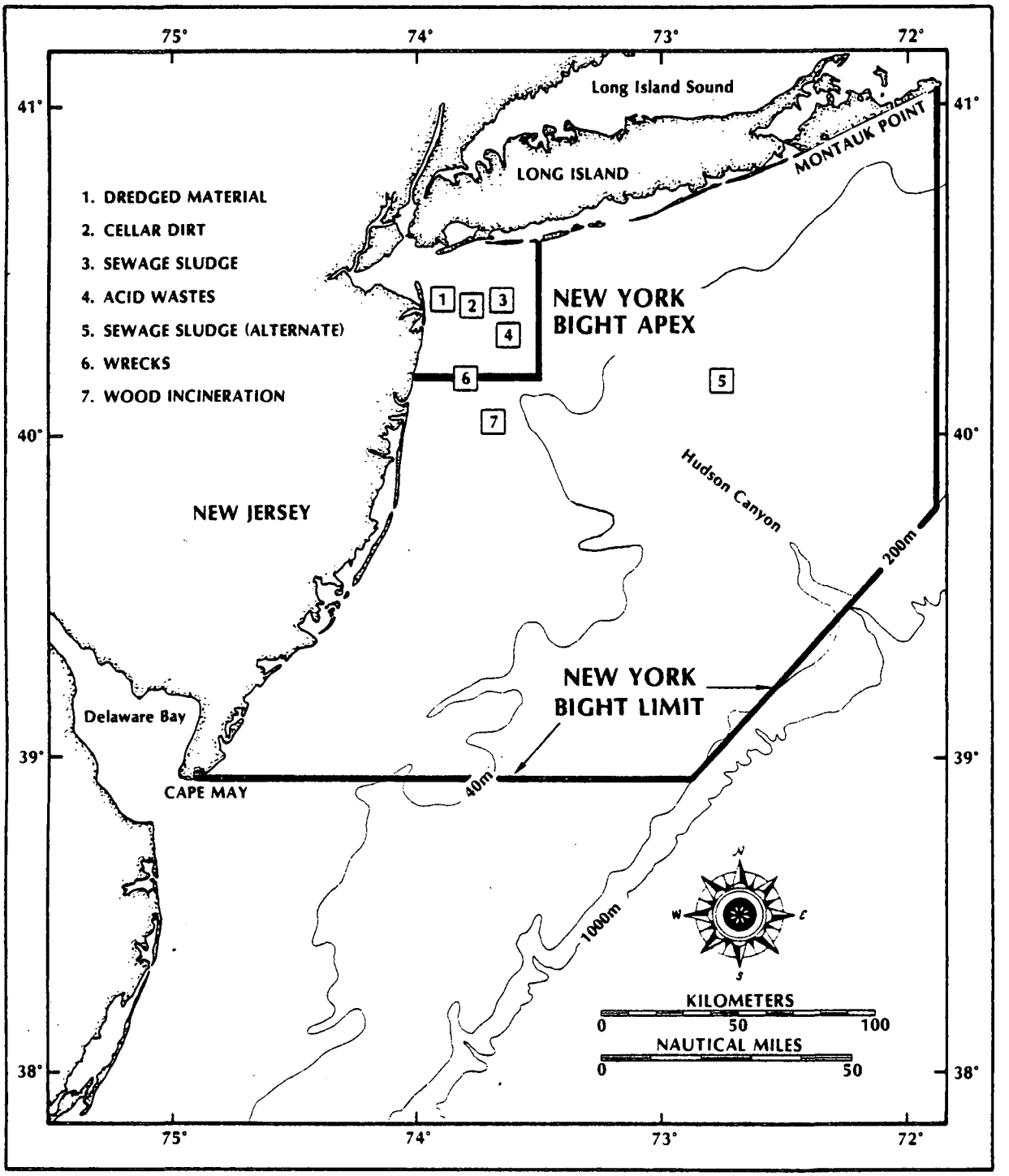


Figure 3-11. Ocean Disposal Sites in the New York Bight Apex (Boundary Shown by Dark Line)

prevent excessive local build-up of material; it has occupied the present location since 1940. Relatively inert materials from land-based construction projects (demolition wastes) are dumped at the site, including excavated earth, broken concrete, rock, and other solid materials. The average annual volume of cellar dirt dumped at the site from 1960 to 1977 was 450,000 m^3. The average annual volume will continue to fluctuate from year to year according to the activity of the construction industry.

Wreck Site

The Wreck Site was designated by EPA for disposal of derelict and wrecked vessels. The site has been used infrequently for the past 17 years, and was moved to a new location outside major navigational lanes in 1977.

Wood Incineration Site

The EPA designated this site for burning scrap wood from decaying structures and construction sites. The site is used as needed, and only the combustion products reach the ocean; the remaining ash is landfilled.

Alternative Sewage Sludge Site

This site was designated by EPA in May 1979 as an alternative to the 12-Mile Site for dumping sewage sludge. It has never been used.

MARINE RECREATION

The New York Bight encompasses many Federal and State beaches and wild life refuges, located on the coast and on offshore islands. Activities in these areas include swimming, hiking, and fishing.

DELAWARE BAY ACID WASTE DISPOSAL SITE

PHYSICAL CONDITIONS

Like the New York Bight, the physical environment offshore of Delaware Bay experiences marked changes with season. Warming of surface waters in late spring creates a strong thermocline which becomes more pronounced as summer progresses. Spring is associated with a flow of low-salinity water out of Delaware Bay, which lowers the salinity of the site water. In late autumn and winter, temperature and salinity values stabilize throughout the water column from surface to bottom. The net current flow at the site is to the southwest. Occasionally, strong summer winds reverse the surface flow.

GEOLOGICAL CONDITIONS

The Continental Shelf bottom off the Delaware coast is a gently sloping, relatively smooth plain superimposed with low elevation sand ridges and swales. Other small-scale relief is superimposed on the ridges, possibly due to the cumulative effects of seasonal storms or the effects of a particular storm. The sediments are composed of fine- and coarse-grained sands.

CHEMICAL CONDITIONS

Despite temporary, localized fluctuations, dissolved oxygen levels of waters off Delaware Bay show seasonal patterns and values typical of the Continental Shelf. Values near peak saturation are found throughout the water column during winter; the summer thermocline separates the saturated surface layer from a relatively depleted bottom layer.

Discussions of sediment and water column trace metal chemistry for the site appear in Chapter 4.

BIOLOGICAL CONDITIONS

The phytoplankton communities off Delaware Bay are dominated by dinoflagellates in the summer and by diatoms in the winter (Smith, 1973,

1974). Zooplankton communities off Delaware Bay are similarly characteristic of the New York Bight (Falk et al., 1974; Forns, 1973). Copepods are the most diverse and abundant taxon, with abundance peaking in summer and fall.

The benthic macrofauna in this area are characteristic of the firm sand-shell-gravel community existing elsewhere in the mid-Atlantic (Pratt, 1973; Falk et al., 1974; Lear et al., 1974). Annelid worms dominate in abundance and numbers of species. The offshore area probably serves as an incidental spawning ground for several commercially important species of fish found generally throughout the mid-Atlantic; however, the site supports no known finfishery at this time. Sea scallops have been harvested near the site, and the ocean quahog is abundant throughout the area.

WASTE DISPOSAL AT THE SITE

HISTORY

The E.I. du Pont de Nemours plant, Edge Moor, Delaware, was the only permittee using the so-called Du Pont Disposal Site after implementation of the ocean dumping permit program in 1973. Du Pont-Edge Moor began to discharge acid wastes at sea on a temporary basis in September 1968, in an area centered about 10 nmi (19 km) southeast of the more recently used site. This alternative site was used until July 1969, pending completion of the pre-disposal surveys in the primary area. Surveys were conducted in May and June of 1969, and barging began in the designated site in July 1969.

RECENT WASTE DISPOSAL PRACTICES

The volume of aqueous waste released at the Delaware Bay Acid Site decreased 92%, from 867,000 metric tons in 1973, to 69,000 metric tons in the first quarter of 1976. Actual amounts discharged by Du Pont from 1973 to 1976 are shown in Table 3-7. The waste disposal operation was relocated to the 106-Mile Site in March 1977.

TABLE 3-7
QUANTITIES OF WASTES DUMPED ANNUALLY AT THE DELAWARE BAY ACID WASTE DISPOSAL SITE

Year	Amount (Thousand Metric Tons)
1973	867
1974	614
1975	365
1976	430
1977	69

In 1973, Du Pont waste consisted of an aqueous solutions of iron and miscellaneous chlorides, sulfates, and sulfuric and hydrochloric acid. The waste was 17% to 23% sulfuric acid, and 4% to 10% ferrous sulfate. The waste was generated from the production of titanium dioxide (TiO_2) by the chloride, sulfate, and color pigment processses. The waste was modified as manufacturing changed from a sulfate process to a chloride process. By 1976, the waste consisted of an aqueous solution of iron, miscellaneous chlorides, and hydrochloric acid. The material at that time ranged between 7.3% and 16% hydrochloric acid, formed from the chlorine used in the manufacturing process. The process modification resulted in a decrease of waste production from 1,300 to 3,000 metric tons per day to 1,500 to 2,000 metric tons per day.

WASTE CHARACTERISTICS

Analyses of barge loads dumped from 1973 to 1976 indicated a range of specific gravity for Du Pont waste of 1.043 to 1.204; the specific gravity of seawater is 1.025.

The behavior of the Du Pont ferrous sulfate waste in situ was investigated at the site from spring 1969 to spring 1971 by Falk et al. (1974). The waste did not penetrate the thermocline during summer, spring, and fall, but during the winter a portion of the waste did reach the seafloor as a result of barging procedures used at that time. The water column pH was depressed following discharge, but returned to ambient levels within four hours. Iron was used to trace the waste up to 10 nmi (19 km) from the discharge point.

Falk and Phillips (1977) reported on a waste dispersion study conducted at the site in September 1976 by EG&G. Dispersion of the ferric chloride waste was similar to that of the ferrous sulfate waste previously tested.

Heavy metals were the most significant waste constituents, both in terms of amounts present and potential toxicity. From 1973 to 1977, the individual proportions of metals discharged to the total volume of discharged material, remained relatively constant (Table 3-8). The total mass loading of each metal decreased in a range from 28% to 76%. From 1973 to 1977, the most prevalent heavy metals in the waste, in order of decreasing mass load, were chromium, zinc, lead, nickel, copper, cadmium, and mercury.

TABLE 3-8
ESTIMATED QUANTITIES OF TRACE METALS DUMPED ANNUALLY AT THE DELAWARE BAY ACID WASTE DISPOSAL SITE

Metal	Metric Tons/Year				
	1973	1974	1975	1976	1977
Cadmium	0.1	0.3	0.001	0.001	0.001
Chromium	54.4	44.0	38.6	81.4	9.8
Copper	5.8	2.2	1.6	2.0	0.3
Lead	10.6	6.8	7.5	10.4	3.3
Mercury	0.035	0.01	0.001	0.001	0.001
Nickel	8.0	5.1	2.8	5.8	0.7
Zinc	34.2	21.4	15.6	41.0	4.0

EFFECT ON ORGANISMS

Routine 96-hr bioassays and special chronic toxicity studies were used to investigate the toxic effects of Du Pont waste on diatoms, opossum shrimp, grass shrimp, brine shrimp, copepods, sheepshead minnows, and hard clams (Falk

and Phillips, 1977). The waste concentrations which caused significant mortality, or other effects, were much higher than the concentrations occurred at the site after initial dilution. Long-term tests produced reduced growth and decreased hatching success in minnows and shrimp. However, these effects were believed to be caused by the presence of a waste flocculate in the test water which impeded feeding, rather than by toxic chemical constituents in the waste (Falk and Phillips, 1977).

Field studies at the site did not detect any effect of the waste on water column organisms or benthic communities. However, elevated vanadium values were observed in scallops collected in the site and southwest of the site (Pesch et al., 1977). Iron floc was believed to be observed overlying sediments in the vicinity, although the floc did not appear to harm organisms.

CONCURRENT AND FUTURE STUDIES

Intensive monitoring work at the Delaware Bay Acid Waste Site was concluded with cessation of dumping; however, EPA Region III still samples historical stations at the site with NOAA's assistance as part of the study program at the nearby Philadelphia Sewage Sludge Disposal Site.

OTHER ACTIVITIES IN THE SITE VICINITY

COMMERCIAL AND RECREATIONAL FISHERIES

The area of the north and middle Atlantic, from Georges Banks to Cape Hatteras, represents "one large...fish-producing unit", with few species of fish migrating into or out of this area (McHugh, 1978). Consequently, most of the species of finfish harvested in the New York Bight are caught near the Delaware Bay Acid Waste Disposal Site, although smaller domestic harvests are reported for the latter (Table 3-9).

The narrowness of the Continental Shelf in this region enables more recreational fishermen to reach the rich Shelf/Slope fishing grounds than in areas farther north. Fishermen in the Delaware region are known to travel great

TABLE 3-9
COMMERCIAL LANDINGS OF THREE MAJOR SPECIES OF FINFISH FOR THE DELAWARE REGION, 1974

Species	000 Lb	$000
Menhaden	13	0.5
Striped Bass	212	65
Whiting	8	1

Source: McHugh, 1978.

distances offshore in order to fish for large game fish, but no recreational fishing has been reported at the Delaware Bay Acid Waste Site. In 1976, 1.8 million anglers landed more than 246 million pounds of fish in the mid-Atlantic (Chenoweth, 1976a).

OIL AND GAS EXPLORATION AND DEVELOPMENT

Figure 3-12 shows the offshore oil and gas leases granted by OCS Sale No. 49.

SHIPPING

Delaware Bay is a major seaport, receiving nearly as much traffic as New York Harbor. Figure 3-10 shows the two major shipping lanes into Delaware Bay. The axes of these lanes are directed well to the north and south of the Delaware Bay Acid Waste Disposal Site, and neither shipping lane extends offshore as far as the site. The Barnegat Navigational Lane passes to the east of the site. Vessels sailing north or south along the mid-Atlantic coast use either the Barnegat Navigational Lane, or a corresponding southern lane, to either of the access routes into Delaware Bay, not normally entering the waters of the Acid Site. Limited ship traffic crossing the Continental Shelf is likely to enter the site waters.

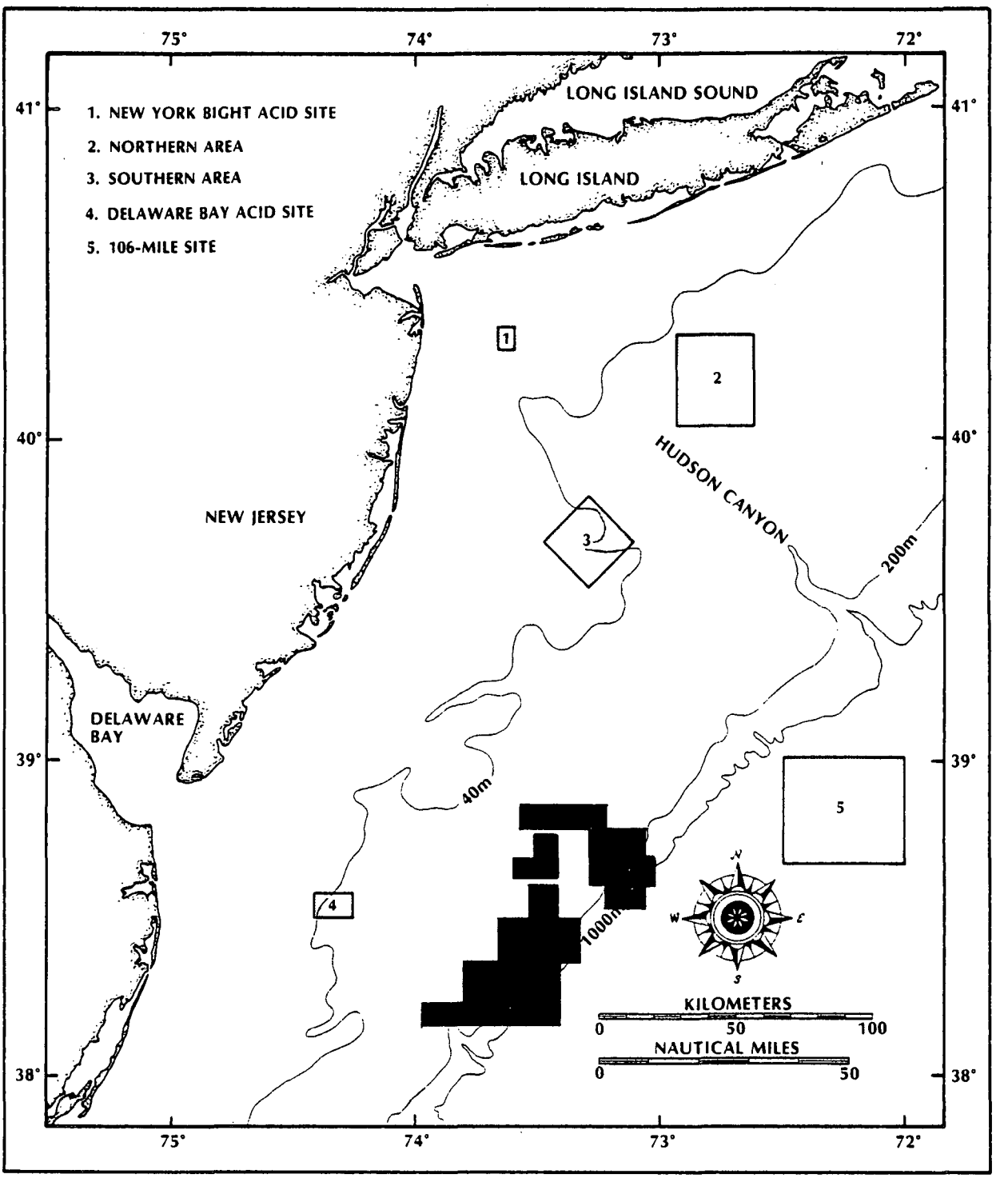


Figure 3-12. Oil and Gas Leases Near Delaware Bay
Source: BLM, 1978.

OCEAN WASTE DISPOSAL

The Philadelphia Sewage Sludge Disposal Site is southeast of the Acid Waste Site and is the only other disposal site in the vicinity. The Sewage Sludge Site received an annual average of 604,000 metric tons of anaerobically digested sewage sludge from 1973 to 1977.

Chapter 4

ENVIRONMENTAL CONSEQUENCES

Use of the 106-Mile Site will have some environmental consequences; however, most of these effects would occur at any ocean location used for disposal of these wastes. The extreme depth of water and low biological productivity of the 106-Mile Site preclude many effects that would be expected at a shallower site. Adverse effects at the site are mitigated by the rapid dilution and dispersion of the wastes. In all, the potential environmental consequences of continuing to use the 106-Mile Site for disposal of wastes are judged less serious than the potential environmental consequences of dumping at the alternative sites.

This chapter describes the scientific and analytic bases for evaluating alternatives discussed in Chapter 2. The discussion includes potential environmental impacts of the various alternative sites considered in Chapter 2, together with any adverse environmental effects which cannot be avoided should the proposed action be implemented. The relationship between short-term uses of the environment and the maintenance and enhancement of long-term productivity and any irreversible or irretrievable commitments of resources which would be involved in the proposal are considered.

The chapter first addresses the effects on public health, specifically by commercial or recreational fisheries and navigational hazards. Next, the environmental consequences of chemical waste disposal at each alternative site are assessed, including effects on the biota and on water and sediment chemistry of the site. Effects of short-dumping in non-designated areas are also addressed.

A large body of data was examined to evaluate the potential effects of chemical waste disposal at these sites. The principal data sources for each area are:

- 106-Mile Site: NOAA surveys, starting in 1974; waste dispersion studies and monitoring of short-term disposal effects sponsored by the permittees; and public hearings concerning relocation of sewage sludge disposal sites and issuing of new permits.

- New York Bight Acid Wastes Site: NOAA-MESA studies beginning in 1973; NMFS/Sandy Hook Laboratory study from 1968 to 1972; site-specific studies sponsored by NL Industries, Inc., beginning in 1948; and routine monitoring surveys sponsored by the permittees.

- Delaware Bay Acid Waste Site: EPA surveys beginning in 1973, and studies sponsored by Du Pont, beginning in 1968.

- Southern Area: NOAA survey in 1975, and public hearings concerning the disposal of sewage sludge in the New York Bight.

- Northern Area: NOAA and Raytheon surveys in 1975, and hearings concerning the disposal of sewage sludge in the New York Bight.

Data from these and other sources were collected and compiled into an extensive data base dedicated to ocean environment data management and evaluation. The following discussion is based on an evaluation of the available data.

EFFECTS ON PUBLIC HEALTH AND SAFETY

The possible direct or indirect link between man and contaminants in the waste is a primary concern in ocean waste disposal. A direct link may affect man's health and safety. An indirect link may cause changes in the ecosystem which, although they do not appear to affect man, could lead to degraded quality of the human environment.

COMMERCIAL AND RECREATIONAL FISH AND SHELLFISH

The most direct link between man and waste contaminants released into the marine environment is through the consumption of contaminated seafood. Shellfishing, for example, is automatically prohibited by the Food and Drug Administration around sewage sludge disposal sites, or in other areas where wastes are dumped which may contain disease-producing (pathogenic) micro-organisms. In this way, the consumption of uncooked shellfish which may be contaminated with pathogens is either eliminated or minimized. Harmful effects caused by eating fish containing high levels of mercury, lead, or persistent organohalogen pesticides have been documented (Subcommittee on the

Toxicology of Metals, 1976). Certain compounds (e.g., oil) have been shown to make the flesh of fish and shellfish not only unhealthy, but unpalatable. Therefore, ocean disposal of wastes containing heavy metals, organohalogens, oil, or pathogens are carefully evaluated with respect to the possible contamination of commercially or recreationally exploitable marine animals.

A foreign longline fishery exists on the Continental Slope, but most U.S. fishing in the mid-Atlantic is restricted to waters over the Continental Shelf. Commercial fishing and sportfishing on the Shelf are wide-ranging and diverse; both finfish and shellfish (molluscs and crustaceans) are taken. The New York Bight is one of the most productive coastal areas in the North Atlantic, and the region may be capable of even greater production when new fisheries develop.

Important spawning grounds and nursery areas exist within the Bight, but critical assessments of the effects of man-induced contamination on fish and shellfish populations are lacking. Many factors complicate the collection and assessment of these data. For example, normal short-term and long-term population cycles are not well understood, catch data are generally inadequate for reliable assessments, and the complete life cycle and distribution of the stock may be unknown. Natural population fluctuations, overfishing, and unusual natural phenomena may have greater influences on the health and extent of the fisheries resource than man-induced contamination. Therefore, assessing the effects of ocean disposal includes uncertainties due to inadequate existing fisheries information.

106-MILE SITE

Waste disposal at this site will not directly endanger human health. The site is not in a commercially or recreationally important fishing or shellfishing area. Infrequent domestic and foreign fishing occur at or near the site; however, the usage is variable and dependent upon occurrence of water masses or eddies that affect fish abundance and distribution. The fish larvae occurring near the site are not well known, but the site is within the range of commercially and recreationally valuable species (Casey and Hoenig, 1977). Disposal activities at the site will have an unknown but probably

localized effect on the larval stages of these species. The NOAA resource assessment surveys do not extend beyond the Shelf; however, the densities of fish eggs and larvae are thought to be low. Bioassays to determine the effects of waste disposal on these species or their prey have not been conducted; however, the results of toxicity tests on EPA-approved organisms suggest that disposal operations will have an insignificant effect on the biota at the site.

A small commercial fishery for the deep sea red crab (Geryon quinquedens) is concentrated in depths of 300 to 500 m, and does not presently exist at the 106-Mile Site or in water depths similar to those at the site (Wigley, personal communication). Greatest densities and biomass of red crabs exist at intermediate depths of 320 to 640 m (Wigley et al., 1975). The extent of recruitment of red crabs used by the commercial industry is dependent on individuals migrating from deeper water. Adequate abundance and size-class data for the red crab are not presently available and additional studies are needed (Wigley, personal communication). The effect of disposal operations on the planktonic larvae of red crabs is unknown but is expected to be localized.

Lobsters (Homarus americanus) are found from the low intertidal to at least 700-m depths, with the potential commercial resource occurring from 90 to 450 m depth (Larsen and Chenoweth, 1976; Gusey, 1976). Lobster fishing does not presently exist at the 106-Mile Site or in water depths similar to those at the site.

As with finfish, the probability of the wastes affecting benthic animals including red crabs or lobsters is extremely low. Therefore, disposal at this site does not directly endanger human health by contaminating edible organisms.

NEW YORK BIGHT ACID WASTES SITE

There is a real, albeit low, potential for endangering public health from additional industrial waste disposal at this site. The site location was chosen 30 years ago because it had no history as a point of concentration for fish or productive fishing (Westman, 1958). Since that time, the site has

apparently become a sportfishing area because the discoloration of the water caused by acid-iron waste disposal either attracts fish or increases catches of available fish, including bluefish, a prized sport fish.

During winter, a commercial whiting fishery exists near the Acid Site and the site continues to be fished by recreational fishermen. There is a potential health problem if additional wastes are released. Increased waste disposal at the site could lead to accumulation of materials in toxic concentrations within the tissues and organs of these fish, and subsequent consumption of contaminated fish could pose a threat to the public health. No health problems associated with sport fish caught at the site have been reported. Although adverse effects have been observed in fish eggs exposed to moderately high concentrations of acid waste (Longwell, 1976), tainting or harmful accumulations of waste components in the flesh of fish taken from the area have not been reported.

Lobsters are the only shellfish which can be exploited near the site. Waste constituents could reach bottom at this shallow site and be incorporated by the animals, but other sources of contamination (e.g., sewage sludge) are probably more significant. The New York Bight Sewage Sludge Site is located only 5 km from the Acid Site.

DELAWARE BAY ACID WASTE SITE

A potential exists for endangering public health from chemical waste disposal at this site. Although the site and vicinity do not support a finfishery, a potentially valuable ocean quahog resource exists to the southwest. As a result of the decline in the surf clam (*Spisula solidissima*) fishery, the National Marine Fisheries Service has encouraged development of a market for the ocean quahog (*Arctica islandica*), another clam which is abundant in the coastal area containing the disposal site (Breidenbach, 1977). In addition, sea scallops (*Placopecten magellanicus*) are harvested. The extent of past fishing from the immediate vicinity of the disposal site is unknown. The FDA has banned shellfishing in the area because of the presence of the sewage sludge disposal site nearby.

Effects due to acid waste disposal are difficult to discern from effects of sludge disposal, but there are relative differences in the chemical composition of these wastes (e.g., higher concentrations of iron and vanadium in the acid waste) that may be useful as environmental tracers. There are several indications that disposal of acid-iron wastes in shallow water may result in some waste constituents reaching the seafloor: (1) reports of acid-iron floc on the bottom at acid waste sites (Folger et al., 1979; Vaccaro et al., 1972), (2) elevated iron concentrations in sediments (Lear et al., 1974; Falk et al., 1974), and (3) elevated concentrations of vanadium in scallops collected near the site (Pesch et al., 1977).

The site has been closed to some shellfishing for several years because of concern for potential bacterial contamination resulting from nearby sewage sludge disposal. Scallops are not included in the ban because the parts consumed (muscle tissue) are not known to concentrate contaminants from sludge disposal. Although there are no established links between elevated vanadium concentrations such as those measured in scallops near the site and threats to public health, renewed industrial waste dumping does not seem prudent in shallow areas such as the Delaware Bay Site (40 m depth) which may be subject to the accumulation of floc or other waste-generated particulates.

SOUTHERN AREA

There is a moderate potential for endangering public health from chemical waste disposal at this site. Surf clams, ocean quahogs, and scallops are abundant in the Southern Area, although most present commercial shellfishing occurs far to the west, near the New Jersey coast. However, declining harvests may cause the Southern Area to be exploited in the future (EPA, 1978). Recreational fishing is unlikely at this site due to its distance from shore and the competition provided by equally attractive sportfishing areas closer to shore. If this area were used as a disposal site for wastes similar to those presently being disposed of at the 106-Mile Site, the potential for an accumulation of waste constituents on the seafloor and in the flesh of shellfish would be greater because of the shallow water depth at this site (40 m).

NORTHERN AREA

It is probable that disposal of aqueous chemical wastes in this area would not directly endanger public health. This site is not in a known area of commercially or recreationally important fishing or shellfishing, although scallops may be present in commercially exploitable numbers. If this resource is developed in the future, disposal operations could result in the accumulation of some waste constituents in the organisms. Water depths at the site are shallow (55 m) and disposal operations would be associated with the same risk of floc accumulation as noted for the Delaware Bay Acid Site and the Southern Area.

NAVIGATIONAL HAZARDS

Navigational hazards may be separated into two components: (1) hazards caused by the movement of transport barges/vessels to and from a site, and (2) hazards caused by barge maneuvering within the site.

If an accident caused chemical wastes to be released, the effects from the dumped waste would probably be equivalent to a short dump. The effects of colliding with another ship would depend upon its cargo, and could be severe if the barge collided with an oil or liquefied natural gas (LNG) tanker. There is a possibility of loss of life in any collision.

The following discussion concentrates on the barging operations from New York Harbor, since most traffic to the 106-Mile Site originates in New York and New Jersey. Du Pont-Edge Moor is the only permittee transporting wastes from other areas. The most serious hazard from any ocean dumping activity would be an accident occurring close to shore where ship traffic is concentrated. The ramifications of a spill from a waste barge or tanker are most serious. This hazard is one that is associated with all ocean dumping, no matter where the disposal site is located, since all trips to an ocean disposal site begin in a coastal port. Accordingly, this section discusses only the relative risks associated with transporting wastes beyond the coastal ports to each of the alternative disposal sites, and the risks associated with on-site disposal operations.

The hazards associated with increased usage of the New York Bight Acid Waste Site are the most severe, due to the heavy shipping traffic associated with New York Harbor. Hazards could increase in the Southern Area as mineral development proceeds in that area. The 106-Mile Site is the preferred choice, because if any accident occurred at the site, wastes would not be released into coastal waters (possibly threatening fishing or other activities), but much farther offshore where shipping activity is limited.

106-MILE SITE

Barges in transit to the 106-Mile Site from New York Harbor use the Ambrose-Hudson Canyon traffic lane for most of the journey. Compared to a coastal site, there may be a slightly greater risk of collision during the round-trip transit to the 106-Mile Site because of the additional distance travelled. If danger to life results from a barging accident, the greater distance offshore would result in longer search and rescue response time than for accidents closer to shore.

Hazards resulting from maneuvers of vessels within the site are negligible. The site is extremely large, and permittees are required to use different quadrants. The frequency of all barging is low, averaging only 2 to 3 times per week. A moderate increase in frequency of dumping at the site would not significantly affect navigational difficulties.

NEW YORK BIGHT ACID WASTES SITE

The New York Bight Acid Wastes Site is situated across one of the outbound traffic lanes from New York Harbor, but the current barging operations within the site are designed to minimize interference with traffic. The permittees using the site barge wastes on an average of once or twice a day. Additional use of the site would increase the possibility of collisions either between barges or the heavy shipping traffic into and from New York Harbor, since the site is rather small. There is a risk that any accidents would be close to New Jersey or Long Island beaches.

DELAWARE BAY ACID WASTE SITE

Use of the Delaware Bay Acid Waste Site would not be expected to pose significant navigational hazards, aside from accidents which might occur during round-trip transit from New York Harbor. Any accidents could release wastes in the coastal waters off New Jersey where fishing and swimming are prevalent.

SOUTHERN AREA

The Southern Area lies outside the traffic lanes for New York Harbor, therefore use of this site would pose few navigational hazards for shipping. However, additional ship traffic resulting from offshore oil and gas development would increase the hazard. The degree and extent of such hazards would depend upon the rate and magnitude of the oil and gas development in the area. Any accidents would probably take place in the heavily fished coastal waters off New Jersey.

NORTHERN AREA

The Northern Area lies outside the traffic lanes for New York Harbor, thus use of this site poses few navigational hazards. Mineral resources are not located in the area, so there is no probability of increased hazards due to future resource development. Any accidents would occur near coastal waters off Long Island.

EFFECTS ON THE ECOSYSTEM

The adverse effects of ocean disposal on the ecosystem can be subtle, and may not exhibit obvious direct effects on the quality of the human environment. These subtle adverse impacts can accumulate over the long term with consequences as serious as any readily observed direct impacts. For example, an organism may accumulate waste constituents in its tissues at concentrations that do not cause its immediate death but, instead, act at the sublethal or chronic level. Such adverse sublethal effects may reduce reproduction, reduce

health of eggs and larvae, slow development of juveniles, or affect other facets of the life cycles of individual organisms and may ultimately result in adverse changes in the entire population of this organism. The population may eventually be eliminated from an area, not because it was immediately killed by a single waste discharge but because of the accumulation of sublethal effects over time. If that population were a major human food source or part of the food chain for an organism which was exploited commercially, man would lose the resource. This scenario is vastly simplified, and is not a projection of current events resulting from industrial waste disposal in the ocean; however, it does illustrate that man, as an integral part of a complex ecosystem, may ultimately feel the results of adverse impacts on other parts of the ecosystem.

The magnitude of the effects of waste disposal on the marine ecosystem depends upon several factors: (1) the type of waste constituents, (2) the concentration of toxic waste materials in the water and sediments, (3) the length of time that high concentrations are maintained in the water or in the sediments, and (4) the length of time that marine organisms are exposed to high concentrations of these materials. Present 106-Mile Site disposal techniques for aqueous chemical wastes maximize the dilution and dispersion of the wastes, thus minimizing the chances for wastes to remain in the water column or to reach the bottom in high concentrations.

Dispersion studies (discussed further in Appendix B) have been conducted on most of the wastes presently dumped at the site. In all cases, high initial dilution occurs as the materials flow from the moving barge and are mixed in the turbulent barge wake. After the period of initial mixing, a plateau concentration is reached which persists for about a day (NOAA, 1978). Little data exist for the dilution after this time period. Laboratory studies of the effects of the wastes on organisms have shown that adverse effects occur only at concentrations several times higher than those which persist for any length of time at the site.

Each of the Du Pont wastes forms a particulate floc when mixed with seawater. These particulates are believed to provide surfaces for adsorption of some trace metals. For example, laboratory studies have shown that the

floc which forms when Grasselli waste is added to seawater contains 20% of the copper, approximately 40% of the cadmium, and most of the lead in the original liquid (Kester et al., 1978). Particulates may be consumed by organisms at the site, thus providing a mechanism for uptake of some metals.

Dispersion studies at the 106-Mile Site have successfully tracked these floc-forming wastes by using acoustic devices to locate the particles. Upon release from the barge, the wastes have been observed to form thin layers along density gradients, such as those associated with thermoclines, rather than mixing uniformly throughout the water column. Industrial waste was observed to disperse above the seasonal thermocline in summer, and to descend only as far as the permanent thermocline in winter. Because thermoclines are characteristic areas of association for plankton and nekton, exposure of these organisms to waste particulates may be increased over exposure in the waters above the thermocline. Specific effects of this exposure on organisms are unknown, but because the wastes are retained in the upper layers at the site, the organisms most likely to be affected by the waste are those in the upper waters.

Bisagni (1976) described the occurrence of Gulf Stream eddies at the 106-Mile Site, which form the bases of the following discussion.

Wastes dumped at the site when a Gulf Stream eddy is present may be entrained by the eddy. However, the infrequent occurrence of eddies at the site (approximately three per year), and their large size, suggest that eddies will not act as significant waste-concentrating mechanisms. Residence times of eddies reported at the site during 1974 and 1975 ranged from 2 to 55 days. The mixing zone represented by an eddy is roughly 60 nmi (110 km) in diameter and 1,000 m deep - a volume of about 1×10^{16} liters for potential dilution, or roughly 1,000 times the mixing volume provided by a quadrant of the site under worst-case conditions.

A hypothetical worst-case situation can be constructed, based on the following factors:

- A stationary eddy 60 nmi in diameter and 1,000 m deep (volume 1×10^{16} liters).

- Normal waste dumping for 55 days (using projected 1979 values from Table B-2 in Appendix B; approximately 1×10^8 liters).

Based on these factors, the ratio of total dilution volume (1×10^{16} liters) to 55-day waste input (1×10^8 liters) is 100,000,000:1, a significant dilution factor.

PLANKTON

The plankton consist of plants (phytoplankton) and animals (zooplankton) which spend all or part of their lives in the water column. Aqueous wastes primarily affect the water column, thus plankton represent the first level of the ecosystem where the effects of waste disposal are likely to be observed. Accordingly, numerous studies on planktonic organisms have been conducted at ocean disposal sites.

106-MILE SITE

Numerous field investigations of plankton at the 106-Mile Site have shown the normal assemblage to be highly variable, primarily due to the presence of several water masses, each with somewhat different species (Austin, 1975; Sherman et al., 1977; Hulburt and Jones, 1977). Because of this high natural variability, long-term changes in plankton species composition, abundance, and distribution, even if caused by waste disposal activities at the site, may never be demonstrated. Future field studies of plankton will concentrate on plankton present in the waste plume to determine the extent of localized effects.

Some field work at the site has concentrated on specific plankton population components rather than considering whole populations or assemblages. Preliminary studies of fish eggs and embryos collected from the site when sewage sludge and acid waste were present showed severe effects on the chromosome and mitotic apparatus of the dividing embryos and malformations in the more developed embryos (Longwell, 1977). The field sampling routine did not, however, result in the collection of samples large enough to permit statistically valid conclusions.

Field and laboratory studies have assessed the effects of waste on the native bacteria populations from the site (Vaccaro and Dennett, 1977). These investigators tested the hypothesis that bacterial species at the site would be more tolerant of environmental changes than those outside the site. Field collections showed no tolerance differences in bacteria taken from inside and outside the disposal site; however, laboratory "exposure of mixed bacterial populations to...Cyanamid waste resulted in...pure cultures showing an increase in waste tolerance." Du Pont-Grasselli and American Cyanamid wastes inhibited assimilation of organic carbon by bacteria. Additional work with Du Pont-Edge Moor and Du Pont-Grasselli waste indicated that "the principal toxic components of Edge Moor waste are trace metals, whereas organic species appear to dominate with regard to Grasselli waste" (Vaccaro and Dennett, 1978). The investigators did not attempt to correlate the laboratory work with actual conditons at the site.

Laboratory studies of the toxicity of 106-Mile Site wastes to plankton have been performed by many investigators (Murphy et al., 1979; Capuzzo and Lancaster, 1978; Lawson in Capuzzo and Lancaster, 1978). Studies have been made on effects of acid-iron wastes which are similar to Edge Moor waste and dumped at the New York Bight Acid Site (Grice et al., 1973; Vaccaro et al., 1972). Additionally, 96-hr bioassays are routinely conducted using EPA-approved species in accordance with the special conditions of each ocean dumping permit. In all, a variety of planktonic species have been tested for effects: Diatoms (e.g., *Skeletonema costatum*, *Thalassiosira pseudonana*, and *Emiliana huxleyi*) and several copepods (e.g., *Acartia clausi*, *Centropages typicus*, *Calanus finmarchicus*, *Pseudocalanus* sp., *Pseudodiaptomus coronatus*, *Temora longicornis*, and *Artemia salina*).

In general, significant mortality occurs only at waste dilutions several times higher than those observed to persist longer than a few minutes at the site. Hulburt and Jones (1977) reported that at least half a dozen cells of several species showed no effects after being kept in barge water for approximately six hours. However, sublethal effects, such as decreased feeding rates, have been observed at lower concentrations (Capuzzo and

Lancaster, 1978), and require further investigation. Low concentrations of Grasselli waste were observed to stimulate growth of diatoms; higher concentrations of the same waste inhibited growth (Murphy et al., 1978).

In tests with clones of oceanic and neritic diatoms, variable sensitivities to Grasselli waste have been observed (Murphy et al., 1979). None of the clones were inhibited at the highest waste concentration which persists for any length of time at the site. Clones of species taken from coastal waters were more tolerant of higher concentrations of the waste than clones of the same species taken from ocean water. Thus, phytoplankton at the 106-Mile Site may be more sensitive to waste inputs than nearshore phytoplankton. Studies on the subject will continue.

Results of routine bioassays of barge samples are discussed in Appendix B. Most of the results show wide ranges of 96-hr LC50 values. The results of these studies demonstrate that little is known about the interaction of plankton and chemical wastes in marine waters. Furthermore, the comparability of controlled laboratory experiments to the conditions existing at the disposal site during waste release is unclear, as are the mitigating effects of the rapid dilution and dispersion of the waste. It is difficult to make unequivocal predictions of long-term consequences of waste discharge on plankton at this site; however, the short-term effects are generally known and limited to the waste plume. Future time series phytoplankton studies may answer some of these questions.

NEW YORK BIGHT ACID WASTES SITE

The effects of past waste disposal on plankton at the New York Bight Acid Wastes Site have been studied extensively. Field studies during waste discharges have shown that NL Industries and Allied Chemical acid-iron wastes do not have a significant adverse effect on zooplankton populations (Wiebe et al., 1973; Redfield and Walford, 1951). Evidence of chromosomal damage in mackerel eggs collected in the site vicinity has been reported (Longwell, 1976), but the cause of the damage could not be definitely linked to the disposal of acid wastes. Interpretations of field results from this site are

difficult; changes in plankton populations resulting from acid waste disposal at the New York Acid Waste Site cannot generally be distinguished from changes caused by pollutants introduced from other sources within the New York Bight.

Laboratory studies show that the acid wastes presently released at this site can cause chronic effects in zooplankton after prolonged exposure to waste concentrations greater than those encountered under field conditions (Grice et al., 1973). Sublethal effects (e.g., failure to reproduce and extended developmental times) have been demonstrated in the laboratory after 21 days of exposure to waste, in concentrations that persist for only minutes after actual discharge of wastes at the site (Vaccaro et al., 1972).

As in the case of the 106-Mile Site, long-term effects on plankton caused by dumping 106-Mile Site wastes at the nearshore site are difficult to predict at this time. Excluding differences in sensitivity between plankton at this nearshore location and plankton in the open ocean, the effects at the two sites would be comparable. However, if the plankton inhabiting waters at the Acid Site were less sensitive to contaminants, the effect of the waste input on indigenous plankton could be less at this site than at the 106-Mile Site. Even so, the number of organisms affected might be less at the 106-Mile Site because of the reduced biomass at the offshore environment in comparison to the nearshore environment.

DELAWARE BAY ACID WASTE SITE

No long-term effects of acid waste disposal on plankton at the Delaware Bay Acid Site have been demonstrated. Elevated concentrations of certain trace metals (nickel, mercury, and manganese) were observed in zooplankton collected in the area (Lear et al., 1974), but the values were extremely variable. As in other alternative sites, future chemical waste disposal at this site should not have any demonstrable long-term effects on plankton species composition, distribution, or abundance. The likelihood and magnitude of effects on other plankton parameters would depend upon the disposal volumes and frequencies.

SOUTHERN AND NORTHERN AREAS

Industrial waste disposal at either the Southern or Northern Areas would not be expected to have significant long-term effects on plankton. These areas are outside the highly stressed New York Bight Apex; therefore, indigenous biota are less likely to be adapted to many man-induced environmental factors. Specific effects would depend upon the nature and volume of the waste and the frequency of disposal. Based on the existing wastes and volumes, any effects would be difficult to demonstrate since plankton populations are so variable.

NEKTON

The nekton include animals (e.g., fish and mammals) capable of swimming and migrating considerable distances.

106-MILE SITE

Continued disposal of chemical wastes at this site should not significantly affect nekton other than causing temporary avoidance of the area. The results of field investigations of effects of dumping on fish populations at the 106-Mile Site have been inconclusive because the field work has been conducted primarily during the infrequent presence of Gulf Stream eddies.

NOAA (1977) reported that total fish catches were comparable inside and outside the disposal site; however, midwater fish were more abundant outside the site boundaries. The lowest catch rate occurred on a night following a dump, but it is not known where the tows were located relative to the waste plume.

Investigations of histopathology in fish collected from the disposal site have been inconclusive (NOAA Pathobiology Division, 1978). Although lesions were observed in some fish, the sample sizes were too small to permit statistically valid conclusions. High cadmium levels were found in the livers of three swordfish from the site area, and high mercury levels were observed in muscle of almost all fish that were analyzed (Greig and Wenzloff, 1977).

However, the elevated concentrations were not attributed to disposal operations at the 106-Mile Site because of the low amounts of these metals added to the area by disposal and the wide-ranging movements of these fish.

The effects of waste disposal on the site micronekton are unknown. Since micronekton constitute a food source for the large predators, it is conceivable that micronekton could uptake contaminants and transfer them through the food web. However, the trophic relationships within many biological systems are not well understood, nor are the rates and mechanisms of uptake and transfer of contaminants. Therefore, no reliable prediction of long-range effects can be made, and future studies should address this subject.

ALTERNATIVE SITES

None of the numerous studies on nekton at the New York Bight Acid Waste Site have detected long-term effects attributable to acid waste disposal. As a result of the many other contaminant inputs to the Bight Apex, in addition to those at the Acid Site, it is unlikely that any deterioration of fish health or populations could ever be demonstrated to be solely due to acid waste disposal. Therefore, the effects of additional chemical waste disposal on fish populations at this site are difficult to predict. However, considering (1) the dilution and dispersion of wastes presently released, (2) the absence of dead fish in the wake of disposal barges, and (3) the ability of fish to move away from temporarily stressed areas, it is unlikely that disposal of other chemical wastes (which comply with the impact criteria) at the New York Bight Acid Waste Site would have any demonstrably adverse effects. This same conclusion also applies to the other alternative sites. The risks associated with the consumption of sportfish taken from the New York Bight Acid Waste Site were previously discussed.

BENTHOS

The benthos consists of animals living on (epifauna) and in (infauna) the sediments. Epifauna at the sites are represented primarily by echinoderms and crustaceans, whereas the infauna primarily include small annelid worms and

molluscs. Benthic organisms can be important indicators of waste-related impacts because they are sedentary, and thus incapable of leaving a stressed environment. Many are commercially valuable (e.g., shellfish), or serve as food sources (e.g., worms) for valuable species.

106-MILE SITE

No effects of chemical waste disposal on the benthos at the 106-Mile Site have been observed. The species composition and diversity at the site are similar to those observed in nearby Continental Slope areas (Pearce et al., 1975; Rowe et al., 1977). Analyses of trace metal contents in benthic invertebrates indicate values within the range of background values (Pearce et al., 1975). The results are expected since the low density liquid waste should not reach bottom in measurable concentrations, because of the tremendous dilution due to the depth and movement of water at the site. Therefore, continued disposal of low-density aqueous wastes should not affect benthic organisms at or near the site.

NEW YORK BIGHT ACID WASTE SITE

The New York Bight benthos exhibits natural temporal and spatial variability which is substantially greater than any changes resulting from the disposal of acid wastes (Pearce et al., 1976a, 1976b). Any effects arising from acid waste disposal are probably overshadowed by effects from the numerous other contaminants introduced to the New York Bight, particularly from the Sewage Sludge and Dredged Material Sites and water flowing into the Bight from New York Harbor. Due to the complex relationship between natural variability and contaminants introduced by other sources, it is extremely difficult to isolate and quantify effects at the site caused solely by the disposal of acid waste. Consequently, it is also difficult to predict the consequences of releasing wastes from the 106-Mile Site at the New York Bight Acid Waste Site. The ecosystem of the Bight Apex is already highly stressed, and disposal of additional materials may increase that stress, perhaps causing significant environmental consequences.

DELAWARE BAY ACID WASTE SITE

Investigations of trace metals in organisms in and around the Delaware Bay Acid Site showed elevated vanadium in the viscera of sea scallops south of the site in the direction of the net current flow (Pesch et al., 1977; Reynolds, 1979). Du Pont-Edge Moor wastes were still being released at the site when these surveys were conducted. Because Edge Moor waste is high in vanadium, and because there are no other known significant anthropogenic sources of vanadium in this area, vanadium is felt to be a tracer of these acid wastes.

SOUTHERN AND NORTHERN AREAS

The benthic organisms at Southern and Northern Areas are similar to those observed at the Delaware Bay Acid Waste Site. Since the sites are similar, especially the shallow water depth, analogous effects are anticipated to occur if industrial waste disposal is initiated there.

WATER AND SEDIMENT QUALITY

The Ocean Dumping Regulations address changes in the quality of water and sediments in a disposal site and in adjacent areas. When these changes can be attributed to materials dumped at a site, EPA must modify site use. This section discusses field studies of water and sediment quality conducted at the 106-Mile Site. Field studies conducted at the New York Bight and Delaware Bay Acid Sites are discussed as they pertain to predicting the effects expected if 106-Mile Site wastes were dumped at the shallow sites rather than the deep oceanic site. Predictions of the environmental consequences of using either the Northern or Southern Areas are based primarily on the studies of the two other shallow sites.

106-MILE SITE

Water and sediments at the 106-Mile Site were sampled as part of NOAA's baseline research program in an effort to define the natural variation of site characteristics over space and time. NOAA has sponsored studies of the behavior of the major wastes being discharged at the site, including dilution

and dispersion of materials, and the effect of dumping on selected water column parameters. Considerable experimentation and refinement of field and laboratory techniques have been required, since normal concentrations of many of the parameters are barely detectable, and little comparable historical work has been done at similar locations so far from shore.

In addition to NOAA's studies, the permittees have contracted with Hydroscience, Inc., to conduct quarterly monitoring surveys. This monitoring program concentrates on the short-term fate of the dumped materials in order to confirm compliance with the Ocean Dumping Regulations with respect to dilution of wastes upon initial mixing.

Emphasis is placed on the NOAA and Hydroscience work at several places within this EIS. Appendix A describes the environmental characteristics of the site and details specific studies of the environmental effects of dumping. Appendix B provides a detailed discussion of the major wastes being discharged at the site, with descriptions of the chemical characteristics and behavior in the water after release. Appendix C describes the monitoring program sponsored by the dumpers.

Trace Metals

Trace metals are the most potentially harmful components of industrial wastes. The wastes dumped at the 106-Mile Site contain metals in concentrations several times higher than background levels in the water at the site. Past work at the site has focused on determining the normal ranges of background concentrations and the effects of waste dumping on these concentrations. Despite conflicting observations of background concentrations of water column trace metals in the early site surveys (Hausknecht, 1977; Brezenski, 1975), refinement of sampling techniques during later surveys yielded background levels within the range of values reported in the literature for similar regions (Hausknecht, 1977; Kester et al., 1978; Hausknecht and Kester, 1976a,b).

Kester et al. (1978) discussed the accuracy and precision of values of metal concentrations analyzed in samples taken at the 106-Mile Site (Table

4-1). Detection limit was defined as twice the variability introduced by the analytical instruments. Reference samples (blanks), which were determined by re-extracting seawater samples, accounted for metals added with analytic reagents and handling procedures. Extraction efficiency was determined using radioactive tracers which were added to a series of seawater samples. Precision was based on analyses of triplicate samples to provide a range of concentrations.

Considerations of accuracy and precision are useful for interpreting variations in metal concentration data, whether by several investigators, or within data generated by an individual investigator. Examination of Table 4-1 shows that the zinc analyses are not as reliable as those of the other metals because of the low extraction efficiency and relatively high variability in blanks and samples. The reagents appear to affect the iron blank, causing it to be high; however, values are reasonably consistent within a data set. In reporting values for iron, lead and zinc, the investigators have not corrected the measured values for the blank values because the sources of the blanks are still under assessment; thus, the reported values for these metals represent the oceanic concentration plus the analytical blank. The cadmium blank has been ignored because it is so low. Copper values have been adjusted for the blank.

TABLE 4-1
CHARACTERISTICS OF THE TOTAL METAL ANALYSES USED IN STUDIES AT THE 106-MILE SITE

Metal	Detection (ng/kg)	Blank (ng/kg)	Efficiency (%)	Precision for a range (ng/kg)
Cadmium	1	1 ± 1	90 ± 1	±2 for 6-20
Copper	5	16 ± 10	99 ± 3	±20 for 100-400
Lead	5	15 ± 19	97 ± 2	±20 for 50-200
Iron	30	230 ± 36	92 ± 1	±60 for 400-1,400
Zinc	8	400 ± 230	48 ± 2	±140 for 500

Source: Kester et al. (1978).

Kester et al. (1978) reported the results of field studies of several waste dumps. A Grasselli waste dump resulted in concentrations of dissolved copper and cadmium, and particulate lead, which were elevated in comparison to values from water outside of the site. However, these elevated values are within the range of natural variability observed for the area. Monitoring of an Edge Moor dump yielded elevated concentrations of iron throughout the 27-hour period studied after the dump. Total and particulate copper, cadmium, and lead concentrations were also altered. Hydroscience (1978 a-h, 1979 a-d) reported no mercury or cadmium values exceeding the limited permissible concentration after initial mixing upon discharge.

Disposal of Du Pont-Edge Moor or Grasselli waste in seawater results in the formation of a precipitate or floc composed primarily of ferric hydroxide or magnesium hydroxide. Kester et al. (1978) concluded that dilution of the floc would occur in the water column above the seasonal or permanent thermocline, thereby restricting the impact, if any, to water column organisms since the material would not settle to the seafloor in measurable quantities. Potential consequences of floc formation are increased adsorption of toxic metals by the waste particles, and increased turbidity in the water column.

Kester et al. (1978) concluded that the Edge Moor and Grasselli flocs provide adsorptive surfaces for some metals which can be toxic if taken up by planktonic filter feeders and transferred through the food chain.

Water column samples analyzed following disposal operations indicated significant increases in total particulate iron, copper, cadmium, and lead, total suspended matter (TSM), and a high correlation of iron with lead, cadmium, copper, and TSM (Kester et al., 1978). However, copper and cadmium are primarily associated with the liquid phase thereby reducing availability for uptake by organisms. Lead is associated with the particulate phase, although it does not appear to be concentrated above the level contributed by the waste. Cadmium persists for a longer period of time in the water column than iron due to the association of cadmium with the soluble phase, whereas particulate iron settles out at a faster rate.

Laboratory analyses of Grasselli waste mixed with seawater indicate that 20% of the copper, 40% $\pm$ 10% of the cadmium and most of the lead (80%) are associated with the floc. Formation of these precipitates may be increased by deposition of calcium carbonate ($CaCO_3$). Near-surface waters are generally supersaturated with $CaCO_3$, which may cause the floc and associated metals to be fairly persistent.

Total iron concentrations in the water column were determined to be a good indication of the persistence of acid waste. Elevated concentrations of particulate iron, copper, cadmium, and lead were measured up to 27 hours after disposal operations were initiated (Kester et al., 1978). Orr (1977a) used acoustic monitoring to determine that the particulate phase (floc) of Grasselli waste persisted for 72 hours at one station. The effect of the floc on marine organisms characteristic of the site has not been investigated thoroughly; however, only low concentrations of contaminants are available for uptake by organisms, and the results of bioassays with selected species suggest that waste disposal operations do not significantly affect biota at the site (Falk and Gibson, 1977; Grice et al., 1973; Wiebe et al., 1973).

Table 4-2 presents an estimate of the potential effects of disposal-related metal input on the total metal concentrations in the water at the 106-Mile Site. This estimate is based on "worst case" conditions of low average flow rate (10 cm/sec) during a period of low mixing with a well-developed seasonal thermocline at 15 m depth. For the five metals examined, the greatest possible percentage increase in concentrations as a result of waste disposal is less than 3.2%. Thus, even in a hypothetical worst-case condition, the total input of metals from waste disposal is within the range of natural variability at the site.

Metal concentrations in sediments of the 106-Mile Site were measured in 1974 by Pearce et al. (1975), and in 1976 by Greig and Wenzloff (1977). The trace metal contents of sediments taken beyond the Continental Shelf appear to be elevated relative to sediments on the Shelf/Slope break, but the elevated metal concentrations are not attributed to present disposal practices at the

106-Mile Site, since they are not unique to the site vicinity. Therefore, there is no evidence that the wastes released at the site have affected the sediments (Pearce et al., 1975).

TABLE 4-2
WORST-CASE CONTRIBUTION OF WASTE METAL INPUT TO THE TOTAL METAL LOADING AT THE 106-MILE SITE

	Cadmium	Copper	Lead	Mercury	Zinc
Background concentration (μg/l)*					
Average	0.37	0.9	2.9	0.72	8.0
Range	0.05-0.60	0.2-1.7	0.8-6.1	0.04-4.0	1.6-21.4
Total Amount (g) in 7.8×10^{12} liters**	2.9×10^{6}	7.0×10^{6}	2.3×10^{7}	5.6×10^{6}	6.2×10^{7}
Estimated 1978 106-Mile Site industrial waste input (g)	1.7×10^{5}	1.9×10^{6}	1.3×10^{7}	11.0×10^{3}	5.3×10^{7}
Estimated input during 14 days† (g)	6.5×10^{3}	7.3×10^{4}	5.0×10^{5}	4.2×10^{2}	2.0×10^{6}
Percent of loading due to dumping during 14 days	0.2	1.0	2.2	0.008	3.2

* From Hausknecht (1977)
** The total volume of one quadrant of the 106-Mile Site to 15 m depth.
† The maximum residence time for a water parcel at the site assuming a flow rate of 10 cm/sec and a distance of 32 nmi in a diagonal across the site.

Continued use of the site for industrial waste disposal will probably produce similar results for measurements of the water and sediments. As NOAA (1977) stated, background values of trace metals at the site are of the order of parts per billion. Sample collection, storage, treatment, and analytical procedures can introduce contamination, which affects the resultant values. Consequently, slightly elevated values due to dumping may be masked by the contamination introduced from sample handling or by the analytical detection limits. Projections of disposal effects on the water column and sediments of any disposal site are based on present technology, with allowances for inherent weaknesses.

Turbidity

Following the disposal of Edge Moor waste, the 1% light level decreased (turbidity increased) from a depth of 45 m (150 ft) to 15 m (50 ft) in the visual center line of the plume (Falk et al., 1974). Turbidity caused by acid-iron floc persisted up to 5 hours in the winter and up to 20 hours in the summer, even though the concentration of iron had decreased significantly. Falk and his co-workers suggest that light penetration may be reduced, even by small amounts of floc, until iron concentrations return to near background levels. The effect of temporary increases in turbidity at the site on marine organisms such as visual predators and phytoplankton is unknown. Decreased growth rates in *Cyprinodon* exposed to chronic levels of Edge Moor waste were presumably related to decreased feeding efficiency caused by decreased visibility (Falk and Phillips, 1977). Earlier observations (reviewed by NL Industries, 1977) that disposal enhanced turbidity serves as a concentrating mechanism for bluefish have not been thoroughly documented by conducting abundance surveys. Some fish may be caught more often when decreased visibility reduces their chance of sensing and avoiding fishing gear.

pH Changes

Short-term changes in pH occur at the site when acid or alkaline wastes are discharged. The most drastic pH changes are confined to the immediate area

around the discharge nozzle. As the waste mixes with seawater, the pH rapidly returns to ambient levels. In tests with Edge Moor wastewater, the pH in waters above the thermocline returned to normal about 3 hours after the dump, while water below the thermocline remained unaffected (Falk and Phillips, 1977). Grasselli wastewater did not cause a measurable change in the pH of water in the barge wake (Falk and Gibson, 1977), nor did American Cyanamid or Merck waste (Hydroscience, 1978 e-h, 1979 c,d).

NEW YORK BIGHT ACID WASTES SITE

Investigations of the effects of waste disposal at the New York Bight Acid Wastes Site have continued for more than 30 years, yet no changes in the water or sediments at the site have been definitely linked to acid waste disposal. The New York Bight Apex is a difficult region in which to assess impacts because of the variety of anthropogenic inputs and the existing high levels of many contaminants.

Most concentrations of water column parameters at the Acid Site are within the range of values found within the Bight Apex. Reduced surface salinity at the site, compared with a control area, has been reported (Vaccaro et al., 1972). Turbidity is greater at the site because of the iron floc which forms when acid-iron waste reacts with seawater (NOAA-MESA, 1975).

Most studies of trace metals (e.g. mercury, copper, lead, cadmium, and zinc) in the Bight have analyzed the levels in the sediments. High sediment metal concentrations in the Bight Apex occur near the Dredged Material and Sewage Sludge Sites (Ali et al., 1975) and values at the Acid Site are much lower compared with these disposal sites. Some workers have reported concentrations of trace metals in Acid Site sediments which were elevated when compared with sediments from supposedly uncontaminated areas (Vaccaro et al., 1972; EG&G, 1978). However, these values have been generally within the range of values from other locations in the Bight.

The effects of moving industrial wastes, which would otherwise be dumped at the 106-Mile Site, to the New York Bight Acid Waste Site are difficult to predict. Some wastes presently released at the 106-Mile Site, if relocated to

the Acid Site, would deliver new contaminants to the Bight. Therefore, no background information exists on which to base an estimate of the effects of dumping these materials. Du Pont-Grasselli used the Acid Site to dump part of its wastes from 1973 to 1975 with no known adverse effects. In addition to new materials, the relocation of 106-Mile Site wastes would introduce greater amounts of materials which presently enter the Bight Apex from other sources. The New York Bight Apex is already a stressed environment, and increasing the waste load could produce additional degradation of the ecosystem.

DELAWARE BAY ACID WASTE SITE

Most values of water chemistry parameters measured at this site during past survey work were comparable to values measured in similar areas within the mid-Atlantic region (Falk et al., 1974). All metals, except iron, have been present at ambient seawater concentrations, with little seasonal or depth variations. When acid-iron waste was released at the site, iron levels were initially very high. In summer, when the seasonal thermocline reduced vertical dispersion of the waste, iron levels remained elevated up to 20 hours after disposal. In winter, with the thermocline absent, values returned to ambient levels within four hours. Large amounts of waste metals are dumped at the nearby sewage sludge site, thus water column effects of industrial waste disposal could be difficult to distinguish from effects of sewage sludge disposal.

Concentrations of several metals have been reported in sediments at the site and its vicinity (Johnson and Lear, 1974; Lear and Pesch, 1975; Lear, 1976; Lear et al., 1977). The range of natural variations in metal concentrations for this area is still undetermined, although high sediment concentrations have been observed at several stations in and near the site (Lear, 1976; Lear et al., 1977). Sea scallops were observed to have elevated concentrations of vanadium (Pesch et al., 1977). Thus, it appears that past acid waste disposal at this site may have affected the sediments and benthos by elevating concentrations of some metals. The ecological effect of accumulating trace metals other than mercury and cadmium is generally unknown.

Relocation of industrial waste dumping from the 106-Mile Site to the presently inactive Delaware Bay Acid Waste Site could cause additional accumulations of metals in the sediments and organisms. In addition, other effects could occur after such a move because some of the 106-Mile Site wastes have never been released into a nearshore marine environment. Thus, shallow water dumping of these wastes is not recommended.

NORTHERN AND SOUTHERN AREAS

The Northern and Southern Areas are in shallow water like the Delaware Bay Acid Waste Site. Therefore, relocation of 106-Mile Site wastes to the Northern or Southern Areas would probably cause effects like those observed at the Delaware Bay Site when industrial waste was dumped there, with potentially serious consequences for nearby shellfisheries.

SHORT DUMPING

The Ocean Dumping Regulations specify that, in emergency situations, the master of a transport vessel may discharge the vessel's waste load in any location and in any manner in order to safeguard life at sea. Emergency situations may result from severe weather conditions typical of the North Atlantic in late fall, winter, and early spring, from vessel breakdowns, equipment failure, or collisions with other vessels or stationary objects.

The potential for illegal short dumping exists, although the USCG ocean disposal surveillance program is designed to discourage such illegal activities through use of shipriders, patrol vessels, aircraft overflights, and vessel log checks. Twelve violations of permit provisions for alleged short dumping, sufficient to cause subsequent actions, were reported by the Coast Guard to EPA Region II between 1973 and 1977 (EPA, 1978). Seven violations were due to disposals outside of an authorized disposal site. Two other violations were referred to EPA Region II (from NASA and the Army Corps of Engineers) for disposal outside authorized sites. Of the nine charges, one was upheld and a civil penalty assessed, two were pending in late 1978, and the charges were withdrawn for six others.

The probability of an emergency situation increases in proportion to the round-trip transit time. (See Table 4-3 for estimated transit times.) Thus, the decision to locate a site far from shore entails an increased risk of emergencies and resultant short dumping. The severity of effects caused by a short dump of toxic waste materials would depend upon the location of the dump, and in particular, the water depth. Industrial wastes are liquid and are rapidly diluted upon discharge, therefore a single pulse of waste input to an area might cause local acute effects, but should not cause any long-term adverse effects. Effects of emergency dumping during inclement weather would be mitigated by the rapid dilution caused by storm activity.

TABLE 4-3
ROUND-TRIP TRANSIT TIMES TO ALTERNATIVE SITES (IN HOURS)*
BASED ON VARIED VESSEL SPEEDS

	New York Harbor		Delaware Bay	
Site	5 kn (9 km/hr)	7 kn (13 km/hr)	5 kn (9 km/hr)	7 kn (13 km/hr)
106-Mile Site	46	32	48	34
NYB Acid Wastes Site	7	3	45	32
Delaware Bay Acid Waste Site	48	36	14	10
Southern Area	22	16	36	26
Northern Area	21	16	51	36

* Does not include time in transit from the loading dock to the Rockaway-Sandy Hook transect (New York Harbor) or from ports in Delaware Bay to the Cape May-Cape Henlopen transect (Mouth of Delaware Bay).

Use of any of the alternative sites introduces the possibility of legal or illegal short dumping. Based upon distance of a site from port, the probability of a short dump is highest for the 106-Mile Site or the Delaware Bay Acid Waste Site and lowest for the New York Bight Acid Wastes Site; intermediate probabilities are associated with the Northern and Southern Areas. Except for the nearshore sites, the effects of a short dump should be temporary, with rapid recovery of the ecosystem. Short dumping at the New

York Bight Acid Wastes Site or the Delaware Bay Acid Waste Site would cause more concern because of the close proximity to shore, and the possibility of waste materials reaching the New Jersey or the Long Island shoreline.

UNAVOIDABLE ADVERSE ENVIRONMENTAL EFFECTS AND MITIGATING MEASURES

Some unavoidable adverse environmental effects would occur upon disposal of aqueous industrial wastes in any oceanic site designated for use. These effects occur immediately upon release of the wastes, and are mitigated by rapid dilution of the wastes after release. Based on field and laboratory observations, the most significant short-term impacts of waste disposal at the 106-Mile Site are:

- Acute mortality in plankton
- Rise in the concentrations of some waste constituents in the upper water column
- Increased turbidity
- Changes in pH
- Possible avoidance of the area by some fish

Other effects have been observed, but their extent and significance are not yet known. These include:

- Possible occurrence of abnormal fish eggs and embryos in the waste plume
- Ingestion of waste particulates by zooplankton
- Inhibition of organic carbon assimilation by bacteria
- Sublethal responses, e.g., reduced feeding rates in copepods
- Stimulation of diatom growth in low waste concentrations and inhibition of growth in elevated concentrations
- Possible transport of waste materials by vertically migrating zooplankton

These effects, and others, will be subjects for future research on effects of waste disposal at the site. It must be noted that most of these effects would be expected to occur at any ocean site where industrial waste is dumped. The only unique factor of a location like the 106-Mile Site is that individual organisms in such a relatively unstressed oceanic area may be more sensitive to wastes than organisms from a stressed coastal area.

Mitigating measures beyond enhanced dilution are not presented here because most of the waste effects which are documented persist only for a short period (e.g., pH changes in the water). Because this site has been in use for many years, EPA has already incorporated mitigating measures into its permit requirements for individual dumpers. As less-understood waste effects become better identified in future research, additional controls will be adopted when appropriate.

RELATIONSHIP BETWEEN USE OF THE SITE AND LONG-TERM PRODUCTIVITY

Continued use of the 106-Mile Site is not expected to have a significant adverse impact on the long-term productivity of the area. The site is outside the range of most commercial and recreational U.S. fishing and significant mineral resource development. To date, no studies have been conducted on the long-term effects of waste disposal on biological productivity of the area. Effects are probably limited to the waste plume, and are mitigated by the rapid dispersion and subsequent dilution of the plume.

IRREVERSIBLE OR IRRETRIEVABLE COMMITMENTS OF RESOURCES

Several resources will be irreversibly or irretrievably committed upon implementation of the proposed action:

- Losses of energy in the form of fuel required to transport barges to and from the site. Transport to distant sites requires more fuel than to nearshore sites.

- Losses of valuable constituents in the waste, (e.g., metals), some of which are available in the U.S. only in short supply. However, present technology is not adequate for metal recovery before dumping.

- Losses of economic resources due to the high costs of ocean disposal at sites far from land. Some ocean disposal costs, however, may be lower than alternative land-based disposal costs, resulting in a net economic gain.

Chapter 5

SEWAGE SLUDGE DISPOSAL AT THE 106-MILE SITE

While it is acknowledged that the only reasonable long-term solution for disposal of harmful sewage sludge is by land-based processes, adverse conditions at the existing New York Bight Sewage Sludge Site (12-Mile Site) could require relocation of the disposal operation to another site. Use of the 106-Mile Site for sewage sludge disposal would be technically feasible, but economically unrealistic for large-scale disposal. However, under suitable conditions, the 106-Mile Site could provide an alternative location for short-term disposal of sewage sludge.

Disposal of sewage sludge, a product of wastewater treatment, is accomplished by two broad classes of methods: (1) ocean disposal by barge or outfall, and (2) land-based treatment and disposal. Barged ocean disposal of sewage sludge in the New York Bight has existed since 1924. It is acknowledged that the only reasonable solution for long-term disposal of environmentally harmful sludge is by land-based processes (addressed in a previous EIS [EPA 1978]). However, there is an immediate need for ocean disposal while land-based alternatives are being developed and field-tested. This need will last at least until December 31, 1981, when ocean disposal of sewage sludge which does not comply with EPA's environmental impact criteria will cease as mandated by law (PL 95-153).

The question of where to dispose of sewage sludge (either on land or in the ocean) from the New York-New Jersey metropolitan area or from Philadelphia, pending implementation of land-based alternatives, has received much attention at scientific meetings, court hearings, Congressional committee meetings, and in the press. One EIS (EPA, 1978) has been prepared on the subject and has resulted in designation (F.R., May 18, 1979) of an area 60 nmi (111 km) from New York Harbor as an alternative sludge disposal site, for use only if environmental conditions at the 12-Mile Site are sufficiently adverse to require relocation of the disposal operation (Figure 5-1). EPA (1978) also addresses the feasibility of using the 106-Mile Site as an alternative sludge disposal site.

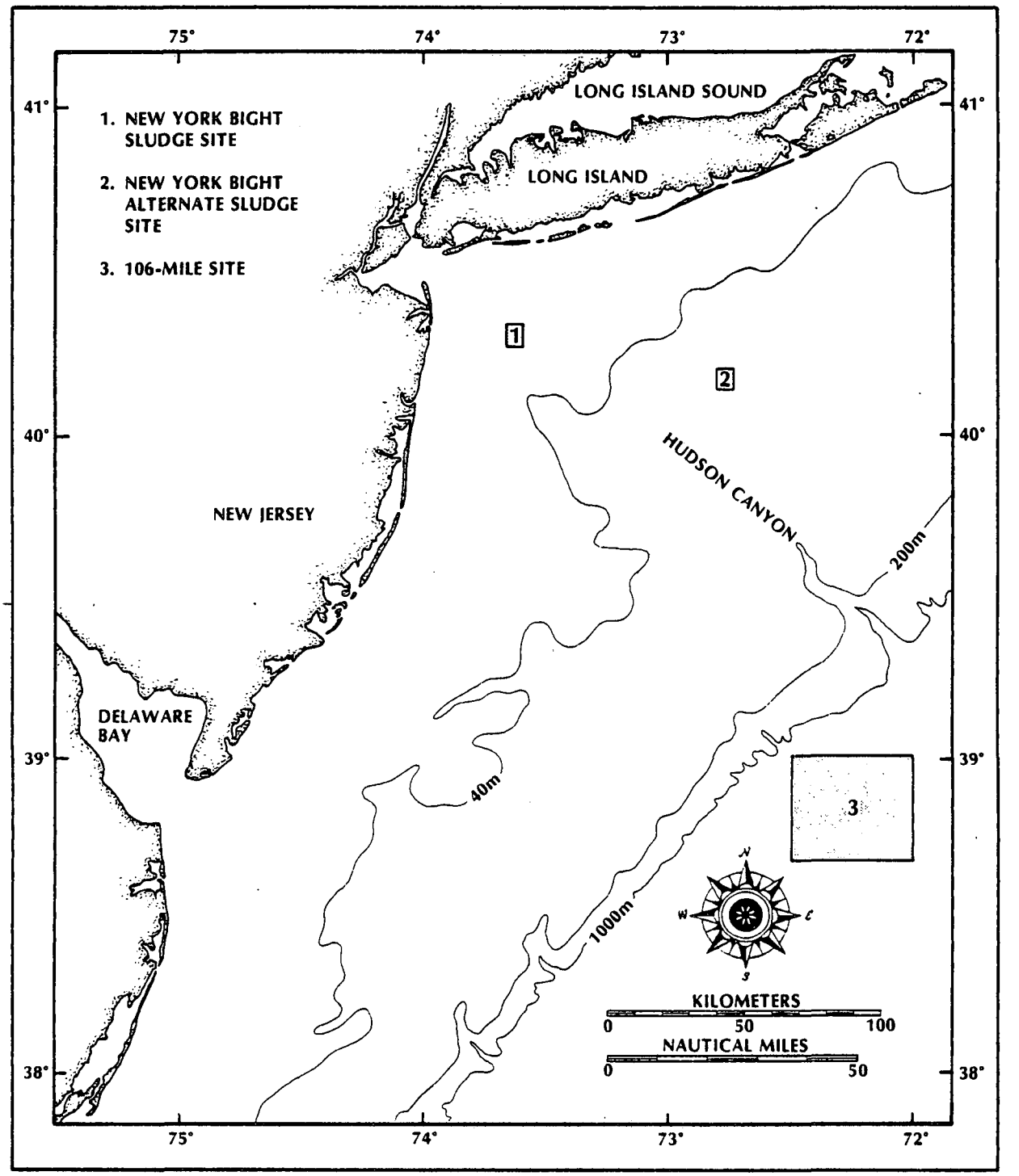


Figure 5-1. Alternative Sewage Sludge Disposal Sites

The 106-Mile Site would be used primarily for disposing of industrial chemical wastes in the foreseeable future, but it is conceivable that severely degraded environmental conditions in the Bight, or threats to public health, could require sewage sludge disposal at an alternative site beyond the Continental Shelf. The 106-Mile Site is the only off-Shelf location in the mid-Atlantic used historically to dispose of sewage sludge, thus it would be a logical choice for an alternate location. Table 5-1 summarizes the history of the proposal to relocate sludge disposal from the New York Bight to the 106-Mile Site.

The 106-Mile Site has been used in the past for limited disposal of the City of Camden sewage sludge, under Interim and Emergency dumping permits. In addition, small amounts of sludge digester cleanout residues from treatment plants in the New York City area have been dumped at the site since 1973. No adverse effects of this sludge disposal have been demonstrated; however, studies of effects of sludge dumping at the 106-Mile Site have been limited.

"Sewage sludge" is a generic term for the dark, humus-like waste material produced by municipal wastewater treatment processes which treat wastes from domestic and industrial sources. It is a mixture of sewage and settled solids removed from raw wastewater during treatment. Sludge dumped at the 12-Mile Site is primarily a combination of digested products of primary and secondary wastewater treatment. The degree of treatment that the material receives determines its ultimate composition. Primary treatment removes 50% to 60% of the suspended solids from raw wastewater. Secondary treatment removes approximately 85% of the suspended solids. Sludges produced by primary or secondary treatment can be subjected to anaerobic digestion to decompose the organic materials.

TABLE 5-1
HISTORY OF THE PROPOSAL TO RELOCATE
SEWAGE SLUDGE DISPOSAL TO THE 106-MILE SITE

February 1976: The draft EIS on the ocean disposal of sewage sludge in the New York Bight was released for public review and comment.

July, August 1976: Long Island beaches bordering the New York Bight were contaminated with sewage-related material and other wastes propelled onshore by unusual summer winds. Waters off the New Jersey coast experienced a massive algal bloom and depletion of oxygen in bottom waters which severely affected benthic marine organisms, especially surf clams. Blame for these events was directed at sewage sludge disposal operations in the New York Bight Apex, although later investigations revealed that sewage sludge was not the cause of the incidents. Nonetheless, consideration of moving sludge disposal operations farther offshore was advanced by adverse public comment directed at the nearshore disposal site.

May, June 1977: EPA Headquarters held a public hearing in Toms River, New Jersey, to consider the possibility of relocating sewage sludge disposal operations from the existing disposal site in the New York Bight Apex and the existing disposal site off the coast of Maryland (the Philadelphia Sewage Sludge Disposal Site) to a site farther offshore, possibly the 106-Mile Site. Many government, public, and academic critics and supporters of the proposition presented arguments, data, and opinions (EPA, 1976).

July 1977: EPA Headquarters awarded a 3-year contract to Interstate Electronics Corporation to perform environmental assessments and prepare EIS's on the designation of ocean disposal sites for different types of wastes. The 106-Mile Site EIS was assigned high priority.

September 1977: The hearing officer for the Toms River public hearing issued his report, recommending that neither the New York area nor the Philadelphia sewage sludge disposal operations be moved from the existing disposal sites. With respect to the 106-Mile Site, the hearing officer stated that "sludge dumping at the 106-Mile Site is not feasible because of the unknown but potentially adverse environmental consequences and the inability to monitor the site effectively." However, the same report recommended that "Preparation of an environmental impact statement on the issue of relocating the sludge...to the 106-Mile Site should begin immediately" (Breidenbach, 1977).

TABLE 5-1. (Continued)

November 1977: Congress amended the MPRSA to require that ocean disposal of harmful sewage sludge be phased out by December 31, 1981 (PL 95-153).

March 1978: EPA Assistant Administrator Jorling issued a decision on the Toms River public hearing, stating that the New York Bight and Philadelphia Sewage Sludge Disposal Sites should continue in use, pending the phase-out of harmful sewage sludge disposal in 1981. The decision directed that an assessment of sewage sludge disposal be included in the EIS on the 106-Mile Site (Jorling, 1978).

September 1978: EPA issued the final draft of the EIS (EPA, 1978) on ocean disposal of sewage sludge in the New York Bight, including an assessment of the feasibility of using the 106-Mile Site. The site was not judged favorable for sludge disposal based on an evaluation of several factors. The major limitations cited in the use of the 106-Mile Site were the unknown environmental effects of disposal and the greater associated costs of using the site as compared to other sites. The EIS recommended the designation of a site farther offshore on the Shelf for use if conditions at the existing site required it. This EIS drew heavily on the material presented at the Toms River public hearing. No new data on sludge disposal effects at the 106-Mile Site were presented.

May 1979: EPA published notice of the final designation of the existing New York Bight Sewage Sludge Disposal Site and the Alternate Sewage Sludge Disposal Site for use if the existing site cannot safely accommodate any more sewage sludge.

June 1979: The draft EIS designating the 106-Mile Site for continued use was issued for public review and comment. The site was judged acceptable for industrial waste disposal and short-term sewage sludge disposal.

August 1979: EPA Headquarters held a public hearing in New Jersey to discuss the proposed designation of the 106-Mile Site and the draft EIS supporting designation. The hearing notice received a limited response.

By 1981, most of the waste treatment plants which serve the New York metropolitan area and currently practice ocean disposal and are expected to provide secondary treatment. New Jersey plants will provide primary treatment. Thus, the character of dumped sewage sludge will gradually change over the next few years as present wastewater treatment plants are upgraded and new facilities are constructed to provide secondary treatment. Table 5-2 compares the physical and chemical characteristics of present New York metropolitan area sewage sludge with the industrial chemical wastes presently dumped at the 106-Mile Site.

AMOUNTS OF SLUDGE DUMPED

From 1960 to 1978, the amount of sewage sludge dumped annually in the New York Bight ranged between 2.5 and 6.4 million metric tons. By 1981, the amount of sludge dumped in the Bight is expected to be about 10 million metric tons, or one and a half times greater than the 1978 amount. Table 5-3 presents the estimated amounts from the individual waste generators expected to dump in the Bight between 1979 and 1981. Projections of the effects of sludge disposal at the 106-Mile Site are based on anticipated 1981 New York-New Jersey sludge volumes.

ENVIRONMENTAL ACEPTABILITY

The City of Camden's relatively brief use of the 106-Mile Site provided little opportunity to study the impacts of sewage sludge disposal. In lieu of adequate experimental data on the site, projections of the effects of potential future sludge disposal must be based on data from studies of other wastes at the site, and on data obtained from studies at other sewage sludge ocean disposal sites.

TABLE 5-2
COMPARISON OF TYPICAL PHYSICAL, CHEMICAL, AND TOXICOLOGICAL CHARACTERISTICS OF SEWAGE SLUDGE AND INDUSTRIAL WASTE DUMPED AT THE 106-MILE SITE

Characteristic	New York City Sludge*	American Cyanamid	Du Pont Edge Moor	Du Pont Grasselli	Merck
Specific gravity	1.009	1.028	1.135 (1.085 - 1.218)	1.109 (1.036 - 1.222)	1.26
pH	ND	2.7 - 8.3	0.1 - 1.0	12.4 - 13.6	5 - 7
Suspended Solids (mg/liter)	25,000	300 (60 - 21,000)	2,000	800 (5 - 15,090)	1,000
Oil and Grease (mg/liter)	4,900	900 (10 - 6,214)	4 (1 - 24)	17 (0.8 - 108)	80
Arsenic (µg/liter)	1,000	600 (20 - 2,600)	ND	ND	200
Cadmium (µg/liter)	2,700	4 (1 - 50)	300 (20 - 900)	200 (3 - 700)	50
Chromium (µg/liter)	59,000	600 (45 - 4,900)	270,000 (52,600 - 900,000)	300 (10 - 3,500)	500
Copper (µg/liter)	82,000	400 (1 - 4,100)	3,000	330 (25 - 1,470)	400
Iron (mg/liter)	ND	ND	33,000 (14,500 - 54,800)	ND	ND
Lead (µg/liter)	66,000	100	41,000 (2,700 - 76,000)	900 (10 - 4,900)	1,500
Mercury (µg/liter)	800	30 (1 - 200)	30 (1 - 200)	7 (1 - 20)	50
Nickel (µg/liter)	17,000	1,000 (145 - 6,400)	29,000 (200 - 65,000)	700 (30 - 2,000)	2,600
Vanadium (µg/liter)	2,000	ND	120,000 (80,000 - 250,000)	ND	1,000
Zinc (µg/liter)	160,000	600 (7 - 5,160)	101,000	500 (30 - 2,700)	400
96-hr LC50: Atlantic silversides (*M. menidia*) (µl/liter)	7,200 - 16,000	0.24 - 2,900	5,000†	560 - 6,950†	650 - 100,000†
96-hr EC50: Diatom (*S. costatum*) (µl/liter)	39 - 1,000	10 - 1,900	712 - 3,450	160 - 8,600	65 - 12,000

* Data from Mueller et al., 1976.
† Aerated
ND = Not determined

TABLE 5-3
ESTIMATED QUANTITIES OF SEWAGE SLUDGE TO BE DUMPED
IN THE NEW YORK BIGHT 1979 TO 1981

Waste Generator	Amount in Thousands of Metric Tons and (Thousands of Tons)					
	1979		1980		1981	
Middletown Sewerage Authority	36	(40)	42	(46)	48	(53)
Passaic Valley Sewerage Commissioners	767	(844)	1,007	(1,108)	1,007	(1,108)
City of Long Beach	9	(10)	9	(10)	9	(10)
Middlesex County Sewerage Authority	767	(844)	915	(1,007)	926	(1,019)
City of New York	4,364	(4,800)	4,634	(5,097)	5,904	(6,494)
Modern Transportation Co.	108	(119)				
Bergen County Utilities Authority	230	(253)	234	(257)	239	(263)
Linden-Roselle & Rahway Valley Sewerage Authorities	252	(277)	261	(287)	270	(297)
Joint Meeting of Essex and Union Counties	334	(367)	334	(367)	334	(367)
Nassau County	418	(460)	435	(479)	453	(498)
Westchester County	533	(586)	683	(751)	703	(773)
City of Glen Cove	13	(14)	13	(14)	13	(14)
General Marine Transport Corp.	11	(12)				
TOTALS	7,842	(8,626)	8,567	(9,423)	9,906	(10,896)

Use of an off-Shelf site for sludge disposal can have several environmental advantages over disposal at a Shelf site:

(1) Except in an area of upwelling, biological productivity is generally much lower in off-Shelf waters than in Shelf waters.

(2) In a site located far from shore, wastes are diluted before they can impact coastal fisheries or shorelines.

(3) Bottom impacts are less likely at a site located in sufficiently deep water because sinking particles undergo rapid horizontal dispersion as they descend slowly, ensuring that very little material sinks directly to the bottom.

(4) Any material that eventually reaches bottom will be so widely dispersed that a substantial build-up of elevated concentrations is highly unlikely.

Several concerns about potential effects of 106-Mile Site sludge disposal were raised at the Toms River Hearing:

- Accumulation of undecayed materials which could ultimately float up to contaminate seas and beaches
- Development of deep-sea anaerobic environments
- Damage to organisms which are adapted to the stable conditions of the deep ocean environment
- Long-range adverse effects on marine biota which remain undetectable until the impact becomes irreversible
- Persistence of pathogens for long periods of time

The above issues and others are addressed in this section. Based upon the present knowledge of the physical characteristics at the 106-Mile Site, and the characteristics of the sludge proposed for disposal at the site, no significant adverse impacts are anticipated.

FATE OF SEWAGE SLUDGE

The fate of dumped sludge in the water column at the site is important in order to understand the potential chemical and biological effects of sludge disposal.

DILUTION AND DISPERSION

The nature of impact from dumped material is determined in large part by the behavior of the waste in the water mass. The material may sink directly to the bottom, as do coarse construction materials and dense dredged materials, or it may remain in the water mass for a long time, dispersing slowly or rapidly throughout all or part of the water column. Shallow water makes the likelihood of bottom contact in a relatively short time more probable. Deep water offers a lower probability of rapid bottom deposition due, in part, to complex changes in the environmental conditions vertically throughout the water column.

The 106-Mile Site is a dynamic region, therefore, its natural complexity limits the predictability of events which may ensue from waste disposal.

Attention must be focused on the interaction of the ocean environment with the dumped sludge. The best evidence of the mechanical settling and dispersion is from direct observation of the sludge after it is released from a barge. Orr (1977b) had the opportunity to track the early stages of a Camden sludge dump at the 106-Mile Site, via acoustic means. From these observations, the points most cogent to the influence of environment on the dumped material are the movement of material to about 60 m depth and the evidence of a strong vertical shear at about 28 m which rapidly spread the upper and lower portions of the dumped material over large horizontal areas. It should be noted that Camden sludge received only primary treatment, thus particles were heavier than those in sludge from secondary treatment. Secondary sludge may disperse differently, but it is probable that the difference will not be significant.

The depth of the seasonal pycnocline in the offshore area ranges between 10 and 60 m, forming a density surface which acts to restrict settling of near neutrally buoyant material such as sludge. The depth and intensity of this pycnocline varies with seasons and storm activity, but is quite pervasive, extending over the several water masses (although perhaps not well developed in Gulf Stream eddies). A permanent pycnocline, between 100 and 150 m (on average), will act as another barrier to settling material. While neither density surface is impenetrable, the retardation of settling will keep the dumped material in the upper surface waters for longer periods of time. The dynamic activity of surface waves, internal waves, shears, and small-scale turbulence enhance this suspended state. Where a variety of water masses interact, fronts and shear lines are commonplace and represent regions of spatially varying speeds and increased turbulence. These conditions increase dispersion of the material in both the vertical and horizontal, thus further reducing the settling rate. This is an anisotropic dispersion (Ichiye, 1965), where horizontal dispersion rates exceed those of the vertical by as much as two orders of magnitude.

With increased residence time in surface waters, the material is subject to transport by near-surface currents which normally move at higher speeds than currents at greater depths. Woods Hole Oceanographic Institution records of currents measured at Site D, about 110 nmi (204 km) east-northeast of the site, represent an approximate description of conditions at the site. Records collected during a 261-day period in the surface waters to depths of 150 m show an average current movement to the west and north of 6 to 11 cm/sec. On a larger scale, this means an average of about 3 to 5 nmi (5 to 10 km) per day of translational movement, with brief periods of faster and slower speeds. Warsh (1975b) suggests that currents follow the bathymetry, and move to the south and west at the 106-Mile Site. In contrast, Bisagni (1976) reported a mean residence time of 22 days for anticyclonic eddies passing through the site.

In oceanic conditions, a typical sludge settling rate was determined by Callaway et al. (1976) who monitored dispersion of sludge dumped in the shoal waters of the New York Bight Apex. Nonflocculated particles, comprising most of the dumped material, had settling velocities of 0.01 to 0.30 cm/sec or less. If the material is dispersed throughout the upper 60 m of the water column, this settling rate provides a mean time to the 60-meter depth of 0.2 hour to 7 days, in which time the material could be transported a maximum of 21 to 35 nmi (40 to 65 km). In that time, this waste fraction is assumed to have reached the density interface at 60 m where it may accumulate for an unknown time. The waste fraction should eventually pass through, settling to the next interface at approximately 100 to 150 m depth. Assuming a linear descent to 100 m depth, the range of time is about 0.33 hour to 12 days. In the longer period, at a mean speed of 3 to 5 nmi (5 to 10 km) per day, the finer fractions could travel a total of 36 to 60 nmi (70 to 110 km) from the site.

Values used here for the purpose of discussion may vary significantly without detracting from the observation that waste material will spend long times in the water column undergoing dispersion, transport, and degradation by chemical and biological processes. Orr (1977b) is presently analyzing data on the horizontal dispersion of the sludge during a 32-hour experiment in which the sludge had, at the end of the experiment, dispersed along several density

interfaces within 45 m of the surface but did not penetrate the 60-meter depth. This experiment adds credibility to the use of a time interval greater than three days for settling to 60 m depth and to a long residency in surface waters.

A worst-case estimate for bottom areas where particles may fall is based upon approximation techniques of Callaway et al. (1976). Assuming a point source dump (with no associated turbulent diffusion as from a discharge in the wake of a moving barge), a 6 cm/sec horizontal current (U), and a particle settling velocity (W_s) of 0.1 cm/sec, the size of the settling area at the 106-Mile Site will be proportional to the depth change of the existing disposal site (depth = H = 22 m) to the 106-Mile Site. Particles will settle over the length $L = UH/W_s$. The 106-Mile Site has an average depth of about 2,000 meters. Solving the equation for L yields 120 km. If a circular settling patch is assumed, the 106-Mile Site yields 45,216 km^2. Assuming an even distribution of solids within the computed area, the accompanying decrease in solids per unit area relative to the New York Bight Sludge Site is of the order of 3,000. Based on current sludge volumes, this results in a bottom accumulation of 0.6 micron - an infinitesimal amount. Therefore, disallowing horizontal and vertical dispersion, density gradients, or degradative processes normal to the 106-Mile Site, and assuming an unrestricted fall of sludge particles from surface to bottom, insignificant amounts of sludge would be deposited on the bottom under the worst conditions.

EFFECTS UPON WATER CHEMISTRY

Sewage sludge produced by secondary treatment contains low concentrations of organic matter. Anaerobic digestion reduces these concentrations even further, but detention time is generally insufficient to remove the slower-degrading constituents: lipids, lignins, celluloses, and industrial wastes (e.g., PCB's, phenols, and pesticides). These materials will most likely not accumulate at the site but will disperse rapidly in the surface waters above the pycnocline where they may be subjected to various degradative processes, including microbial degradation.

Recent in situ studies conducted by Woods Hole Oceanographic Institution (Wirsen and Jannasch, 1976; Jannasch and Wirsen, 1973, 1977), suggest that bacterial activity decreases significantly with lower temperatures and the greater pressures characteristic of the deep-sea environment. Although the depth range of the 106-Mile Site (1,400 to 2,800 m) falls generally within the depth range of the degradation studies (1,800 to 5,300 m) conducted by Jannasch and Wirsen (1973, 1977) and Wirsen and Jannasch (1976), the thermocline/pycnocline barrier at the site is expected to encourage horizontal dispersion of the sludge above 100 to 150 m depth. Actual rates of decomposition at this depth are not known and can, at best, only be extrapolated from some of the above referenced studies.

Chemostat studies, conducted under atmospheric pressure, have demonstrated reduced rates of microbial degradation when substrates are diluted beyond a critical point (Jannasch and Mateles, 1974). Such experimental evidence has been proposed for explaining the ubiquity of certain pollutants in the oceans (Jannasch, 1979). Preliminary studies of organic wastes in the deep sea, however, have implicated a combined role of micro-organisms and higher animals in removing organic wastes (Jannasch, 1979). Metabolic processes in higher animals are instrumental in transforming and degrading some organic pollutants. The combined microbial activity in the intestinal tracts of some higher animals and fish have been implicated in similar transformations (Jannasch, 1979).

Based on the initially low concentrations of slowly degrading organic material associated with the sludge and given the highly dispersive environment at the 106-Mile Site (previously discussed), accumulations of large amounts of undecayed organic matter and the subsequent creation of an anaerobic environment are highly unlikely. Only insignificant amounts of material requiring oxidation will sink to depths of limited dissolved oxygen.

Sludge disposal at the 106-Mile Site will introduce metals, inorganic nutrients, suspended solids, and chlorinated hydrocarbons to the water column. However, since the waste will be introduced into the barge wake, rapid initial dilution will occur. Further dilution and dispersion will occur as the material sinks and the water mass acts upon it.

The following discussion is based in part on the projections made by Raytheon (1976) on the effects of sludge disposal at the Alternate Sewage Sludge Site in the New York Bight. The potential effects on water chemistry at the 106-Mile Site and the Alternate Sludge Site are comparable. Bottom chemistry effects are not discussed since, as indicated earlier, the sludge is not expected to reach the bottom in significant proportions.

Most of the heavy metals introduced by sludge will occur in the particulate fraction. In Table 5-4 the present metal content of sewage sludge has been applied to a worst-case model of nondispersive, nondiluting physical conditions at the site, with sludge dumped in the water column contained within an areal quadrant to a depth of 15 m in a 14-day period. Under such strict conditions, the accumulative concentrations of some metals will be double the low background levels. However, in observed typical conditions, with the pycnocline near 60 m depth and water flushing through the quadrant in 3 days at the rate of 10 cm/sec, the percent metal loading within the quadrant due to sludge dumping is a small fraction of the worst-case value. This suggests that any future sludge disposal at the site should occur under the most dispersive conditions, to avoid elevated concentrations in the water column. Amounts of sludge dumped at a time can be regulated, to permit adequate dilution and dispersion so that concentrations within the site do not remain elevated.

Chlorinated hydrocarbons (e.g., PCB's) and other toxic organic materials in sludge will be introduced to the site in association with particulates in the sludge. However, the concentrations of these materials in the sludge are relatively low and are not expected to increase levels significantly at the site as long as inputs to the sludge are controlled.

Nutrients in the form of inorganic nitrogen (NO_3^-, NO_2^-, and NH_3^+) and inorganic phosphorus (PO_4^-) would be introduced to the site by sludge disposal. Table 5-5 presents an evaluation of worst-case conditions. Only phosphate is added in significant proportions. Most primary production in the ocean is limited by the amount of inorganic nitrogen in the water, and even in the worst case, sludge would introduce insignificant amounts of nitrogen. Dumping sludge at the site would neither significantly increase productivity nor support plankton blooms.

TABLE 5-4
WORST-CASE PROJECTIONS OF METAL LOADING DUE TO SEWAGE SLUDGE DISPOSAL IN A QUADRANT OF THE 106-MILE SITE

Metal Load	Cadmium	Copper	Lead	Mercury	Zinc
Background concentration (μg/liter)* Average	0.37	0.9	2.9	0.72	8.0
Range	0.05 - 0.6	0.2 - 1.7	0.8 - 6.1	0.04 - 4.0	1.6 - 21.4
Total amount (g) in 7.7×10^{12} liters†	2.8×10^{6}	6.9×10^{6}	2.2×10^{7}	5.5×10^{6}	6.2×10^{7}
Estimated metal input (g) in 1981**	3×10^{7}	8.9×10^{8}	6.6×10^{8}	8×10^{6}	1.6×10^{9}
Estimated input in 14 days††	1.1×10^{6}	3.4×10^{7}	2.5×10^{7}	3.1×10^{5}	6.1×10^{7}
Percent of loading due to sludge dumping during 14 days	39	49	113	6	98

* From Hausknecht (1977)
† Volume based on one-fourth of the total area of the site and a minimum seasonal thermocline of 15 m
** Based on sludge metal concentrations from Mueller et al. (1976) and EPA (1978) volume estimates
†† Based on the length of time taken for a water parcel to cross the site at 10 cm/sec.

TABLE 5-5
WORST-CASE PROJECTIONS OF INORGANIC NUTRIENT LOADING DUE TO SEWAGE SLUDGE DISPOSAL, IN A QUADRANT OF THE 106-MILE SITE

	Nitrite and Nitrate	Phosphate
Background concentration* (ug/l)	19.2	114
Total amount in 7.7×10^{12} liters (g)†	1.5×10^{8}	9×10^{8}
Estimated input during 1981 (g)	4.0×10^{7}	4.0×10^{9}
Estimated input in 14 days (g)	1.5×10^{6}	1.5×10^{8}
% total nutrient load due to sludge	1	14

* From Peterson (1975). Concentrations at 15 m depth.

† Volume of a quadrant of the site to 15 m depth.

The heavier particles in the suspended solid fraction are quite inert, mainly silt and sand washed into sewage treatment plants. Such particles can provide sites for biological growth and will sink fairly rapidly. Finer particles, e.g., clays, will remain in the water column for long periods of time and will provide charged sites for bonding with ionic materials (e.g., heavy metals) in solution, and for bacterial growth, which can remove ionic matter from solution.

INTERACTIONS WITH INDUSTRIAL WASTE

Whenever chemically diverse materials are mixed, potential interactions exist. For example, combining sludge with strong acids can cause heavy metals to desorb from sludge particles. Conversely, the particles in sludge can provide nuclei for adsorption of contaminants in chemical wastes.

The potential for interaction of chemical wastes with sludge dumped at the 106-Mile Site is slight. EPA imposes that simultaneous dumps be in separate quadrants of the site, with each quadrant large enough (150 nmi^2) to dilute significantly the material within its boundaries. Sludge and industrial wastes at the site would thus be separated by a sufficient distance to prevent the materials from mixing. Sludge at the 12-Mile Site is presently dumped only 2.7 nmi (5 km) from the New York Bight Acid Site. No interactions between sludge and acid waste have ever been recorded.

EFFECTS UPON ORGANISMS

Many components of sewage sludge can adversely affect organisms. Some of these constituents (e.g., nutrients and heavy metals) are necessary to sustain marine life, but become toxic at the high concentrations found in undiluted sludge. However, rapid dilution and dispersion of the sludge at the site will mitigate all but short-term acute effects on organisms inhabiting the upper water column. Due to the rapid vertical dilution of waste throughout the water column, benthic organisms in the vicinity should not be affected.

Limited biological studies (Longwell, 1977) have been conducted during sludge disposal operations at the 106-Mile Site. Fish eggs were collected inside and outside the sewage sludge plume to study effects upon developing fish embryos. The fish embryos were examined for cell and chromosome damage. Too few fish eggs were collected to permit quantitative comparisons. However, sewage sludge appears to be toxic o fish eggs in the early developmental stages, as indicated by adverse effects on the chromosome and mitotic apparatus of embryos undergoing cell division. No effects of any waste, either industrial or municipal, have been demonstrated on fish populations because of the high natural variability of such populations. Most populations of fish taken commercially in the mid-Atlantic spawn over the Continental Shelf, rather than in off-Shelf water such as the 106-Mile Site. Therefore, although sewage sludge may cause short-term effects on early stages of fish embryos, measurable long-term effects on fish populations are unlikely.

SURVIVAL OF PATHOGENS

Sewage sludge contains many types of pathogenic (disease-causing) organisms, reflecting both the infection and carrier status of a particular population. Sludge pathogens may be classified into four general groups: bacteria, viruses, protozoans, and helminths (Table 5-6).

Of all pathogenic organisms associated with sewage sludge, the greatest public health concern is for viruses, particularly the enteroviruses. This concern is justified by a number of observations:

(1) Most enteric viruses are more resistant to sewage treatment and disinfection processes than enteric bacteria (Akin et al., 1975).

(2) Response to the most common disinfectant (chlorine) varies greatly among the enteroviruses - some types exhibiting much greater resistance than other viral types (Liu et al., 1971).

(3) Enteric viruses, along with enteric bacteria, can become concentrated in shellfish tissues (Mitchell et al., 1966; Liu et al., 1966; Metcalf, 1974).

(4) The lack of adequate viral isolation techniques and low recovery efficiencies of existing methods have produced data with only relative value. Reported densities are most likely underestimates of actual populations in the environment.

Secondary treatment of sewage is highly variable in effectively reducing or inactivating many of these organisms (Akin et al., 1977). Depending on factors such as treatment facility conditions, resistance of organisms, and waste composition and degree of degradation, the microbial content of sewage is reduced anywhere from 25% to 99% (Geldreich, 1978). Sewage treatment processes are generally most effective in providing effluents of acceptable quality. Sludges, on the other hand, are reservoirs for many sewage pathogens.

Most sewage coliforms (50% to 75%) are associated with particulates having sizeable settling velocities (Mitchell and Chamberlin, 1978), resulting in a "die-off" due to sedimentation rather than an actual loss of cell viability. Viruses rarely occur as free individuals and are generally adsorbed to, or embedded in particulate matter. This phenomenon only increases the weight and

bulk of the infectious unit (Akin et al., 1977). Persistent bacterial spores, parasite cysts, and eggs ultimately become sludge constituents because of their relative densities.

TABLE 5-6
IMPORTANT SLUDGE-ASSOCIATED HUMAN PATHOGENS

ORGANISMS	DISEASE
1. ENTERIC BACTERIA	
Salmonellae species	Typhoid Fever Salmonellosis
Shigellae species	Shigellosis
Escherichia coli	Gastroenteritis
2. ENTERIC VIRUSES	
Enteroviruses (67 types)	Gastroenteritis Meningitis Others
Hepatitis A virus	Infectious hepatitis
Adenoviruses (31 types)	Respiratory disease Conjunctivitis Others
Rotavirus	Gastroenteritis
Parvovirus-types	Gastroenteritis
3. PROTOZOANS	
Entamoeba histolytica	Amoebiasis
Giardia lamblia	Giardiasis
Balantidium coli	Balantidiasis
4. HELMINTHS (Worms)	
a. Nematodes (Roundworms)	
Ascaris lumbricoides	Ascariasis
Ancyclostoma duodenale	Ancyclostomiasis
Necator americanus	Necatoriasis
Enterobius vermicularis	Enterobiasis (pinworms)
Strongyloides stercoralis	Strongyloidiasis (threadworms)
Trichuris trichiura	Trichuriasis (whipworms)
b. Cestodes (Tapeworms)	
Taenia saginata	Taeniasis (beef tapeworm)
Taenia solium	Taeniasis (pork tapeworm)
Hymenolepis nana	Taeniasis

Source: Akin et al., 1977.

A number of factors responsible for the decline of sewage pathogens have been identified and studied. Table 5-7 lists the mechanisms most often implicated in "die-off" observations. Although any one of these factors may be effective under particular circumstances or conditions, solar radiation and the adsorption and sedimentation of contaminating micro-organisms with particles in suspension have frequently been suggested as the most effective means of natural pathogen reduction in the ocean (Mitchell and Chamberlin, 1978). Synergistic effects, particularly with physical-chemical parameters, have also been shown to limit the existence of micro-organisms in the marine environment (Brock and Darland, 1970; Cooper and Morita, 1972; Jannasch and Wirsen, 1973).

As part of the monitoring program in the New York Bight, EPA Region II, in response to public concern for sludge disposal and transport of contaminants, initiated a bacteriological monitoring program which included total and fecal coliforms, pathogenic bacteria, and enteric viruses (EPA, 1977a). This twelve-month study emphasized the need to establish standard permissible viral levels for water and shellfish and the necessity for including enteric virus testing in monitoring programs. Results of this investigation showed the presence of human pathogenic viruses (coxsackie, ECHO, poliovirus) and bacterial pathogens (*Salmonella enteritidis*, *Pseudomonas aeruginosa*) in New York Bight waters. The data strongly suggest that the sources of these contaminants are Hudson-Raritan Bay discharges, rather than dumping at the sewage sludge disposal site.

There is little information on the survival of sludge pathogens at the 106-Mile Site. In one study, conducted during a Camden sludge disposal operation, surface and subsurface water samples were collected from a stationary ship and analyzed for total and fecal coliform bacteria (Vaccaro and Dennett, 1977). Within the first hour of sampling inside the waste plume, surface water samples produced positive results for total and fecal coliforms. All of the subsurface samples yielded negative results for both tests.

TABLE 5-7
FACTORS IDENTIFIED AS CONTRIBUTING TO THE "DIE-OFF" OR DECLINE OF SEWAGE PATHOGENS

Cause	Reference
Adsorption and Sedimentation	Orlob, 1956 Rittenberg et al., 1958
Solar Radiation	Gameson and Gould, 1975 Harrison, 1967 Reynolds, 1965
Predation and Bacterial Parasites	Mitchell, 1972 Mitchell et al., 1967
Bacteriophage	Carlucci and Pramer, 1960
Nutrient Deficiencies and Competition	Carlucci and Pramer, 1960 Jannasch, 1967 Jannasch, 1968 Moebus, 1972a Won and Ross, 1973
Toxins and Antibiosis	Aubert et al., 1974 Mitchell, 1971 Moebus, 1972b Sieburth, 1968
Heavy Metal Ion Toxicity	Jones, 1964 Jones, 1967 Jones and Cobet, 1974
Seasonal Temperature Variations	Moebus, 1972a
Physical and Chemical Characteristics	Carlucci and Pramer, 1959 Jannasch and Wirsen, 1973 Jones, 1971 MacLeod, 1968

Accumulation of sludge on the ocean bottom at the 106-Mile Site is highly unlikely (see previous discussion on dilution and dispersion). The depth of the site and the thermocline/pycnocline barriers will restrict the settling of sludge and encourage horizontal dispersion throughout the water column. The chance of contamination of bottom sediments by pathogenic organisms is fairly remote and not a primary issue. Pathogens attached to particulate sludge material suspended in the water column will be vulnerable to predators, toxins, solar radiation, and a number of other factors contributing to

inactivation of disease-causing organisms. The potential for causing disease along coastal waters is seemingly remote; however, the actual survival of sludge-associated human pathogens dumped at an oceanic site so far from shore is still relatively unknown. If the 106-Mile Site is used for future sewage sludge disposal, the monitoring program accompanying the disposal must address these questions.

ENVIRONMENTAL MONITORING

The feasibility of monitoring for impacts of sewage sludge disposal at the 106-Mile Site was addressed at the Toms River Hearing. Opinions expressed at the hearing varied on monitoring feasibility, but all agreed that monitoring the 106-Mile Site, to detect and control short- and long-range impacts of sludge dumping, would be most difficult (some felt it would be impossible). NOAA stated that such a program would be technically possible, but very expensive:

> The techniques required for a monitoring program are available. It is, however, more time-consuming and thus more expensive to monitor a site which is 100 miles from shore and 2,000 meters deep than one which is nearshore and shallow. An effective monitoring program would be built upon our existing knowledge. Initial work directed specifically at sewage sludge would be to define the volume of water through which the sludge settles, the area of the bottom accepting the waste, the rate of water renewal, and rates of deep-sea sludge oxidation. The effects of sludge on deep-sea biota would be addressed through field sampling and by application of specialized techniques for observation at low temperature and high pressure. It is estimated that such a program would require about $2.5 million for each of its first two years and, thereafter, about $1.0 million per annum (Martineau, 1977). [All of the New York Bight monitoring currently costs about $1 million.]

Considering the dispersion data from the site, which indicate that the major potential effects of sludge dumping would occur in the water column above the thermoclines (seasonal or permanent), monitoring could be simpler than originally estimated because extremely deep sampling would be unnecessary. However, the wider dispersion of materials in the upper water column, would necessitate monitoring over a larger area.

SURVEILLANCE

Surveillance of sludge disposal operations at the 106-Mile Site is feasible although it would place an additional burden on the Coast Guard, requiring allocation of additional personnel (Mullen, 1977).

ECONOMICS

EPA (1978) presents a thorough overview of the economic issues imposed by using the 106-Mile Site for sewage sludge disposal. The salient points of that discussion are presented below.

The most severe economic hindrance in transferring all sludge disposal operations from the existing New York Bight Sludge Site to the 106-Mile Site is the size of the existing fleet of sludge dump vessels. The increased costs of using the 106-Mile Site rather than a nearshore site are caused by two factors: (1) transport to the 106-Mile Site takes so much longer that additional vessels are necessary to carry the same amount of material since existing vessels are fully engaged in transit and disposal operations at present sites, and (2) the time required for discharge will increase because the rate will be based on the limiting permissible concentration rather than the present average dumping rate of 5 hours.

Assuming equal discharge rates, the cost of using the 106-Mile Site would be about twice the cost of using the Alternate Sewage Sludge Site, and six to eight times the cost of continuing to use the 12-Mile Site. By 1981, the estimated annual cost to municipal permittees for transporting sludge to the 106-Mile Site is estimated to be within a range of $124 million to $154 million. Many present at the Toms River Hearing felt that such a prohibitive expense to the municipal dumpers would divert funds into ocean disposal which could be used to provide land-based disposal alternatives, thus perpetuating ocean disposal (NOAA, 1977; Forsythe, 1977; Kamlet, 1977).

The projected cost of monitoring sludge disposal is discussed above. A portion of the monitoring cost would be passed on to the permittees, further increasing their economic burden. Similarly, the cost to Federal agencies monitoring the site would be substantial.

Surveillance costs would be high if the 106-Mile Site were used for sludge disposal. The USCG monitors sludge disposal operations at the New York Bight Sludge Site with helicopters and patrol vessels. The 106-Mile Site is beyond the normal range of this equipment, thus shipriders would be required, at an additional expense to the USCG.

LOGISTICS

Use of the 106-Mile Site for sludge disposal would be logistically feasible although initial delays of several months (primarily for obtaining suitable vessels), would probably be necessary before implementation. Increased traffic at the site would present additional navigational hazards; however, dumping in quadrants of the site would tend to mitigate many of the hazards.

The Third Coast Guard District strongly recommended that the total amount of dumping time per day be restricted to the 5-hour rate to avoid vessel congestion at the dumpsite. Because of the increased transit time to the 106-Mile Site over the time to the existing site, the 12 vessels which now comprise the fleet would be inadequate to handle the sludge volumes; therefore, additional vessels would be necessary. These additional vessels would cause further traffic congestion in the 106-Mile Site area, thus posing a greater risk of collision.

SUMMARY

Use of the 106-Mile Site for sewage sludge disposal would be environmentally acceptable under carefully controlled conditions (outlined below), and accompanied by a comprehensive monitoring program. However, substitution of

the 106-Mile Site for existing Shelf sites would impose severe economic burdens, surveillance and monitoring difficulties, and logistics problems. Therefore, the following conclusions are made.

CONCLUSIONS

It is proposed that use of the 106-Mile Site for sewage sludge disposal be decided case-by-case by EPA, on the basis of severity of need. Any permit issued should include provisions for adequate monitoring and surveillance, to prevent significant adverse impacts resulting from disposal. Sludge disposal should be allowed at the site only under the following conditions:

- The 12-Mile Site or any other site cannot safely accommodate more sludge disposal without endangering public health, severely degrading the marine environment, or degrading coastal water quality.
- Independent surveillance by the U.S. Coast Guard or by an unbiased observer (the latter at the permittee's expense) should be conducted.
- Monitoring for short- and long-term impacts should be accomplished by federal agencies and environmental contractors (the latter at the permittee's expense). This monitoring must include studies of the fate of solids and sludge micro-organisms, inside and outside the site, and a comprehensive analysis of environmental effects.
- Vessels should discharge the sludge into the wakes so that maximum turbulent dispersion occurs.
- Vessels discharging sludge should be separated from vessels discharging chemical wastes, so that the two types of wastes do not mix.
- Key constituents of the sludge should be routinely analyzed in barge samples at a frequency to be determined by EPA on a case-by-case basis, but sufficient to evaluate mass loading accurately at the site.
- Routine bioassays should be performed on sludge samples using appropriate sensitive marine organisms.

Chapter 6

LIST OF PREPARERS

Preparation of this EIS was a joint effort employing many members of the Interstate Electronics Corporation scientific and technical staff and EPA Region II. This chapter summarizes the background and qualifications of the primary preparers of the document.

KATHLEEN M. KING

Ms. King is the principal author of the EIS. She is a marine biologist and Manager of the Biological Sciences Branch within the contractor's Oceanic Engineering Division. She holds a B.S. in Biological Sciences from the University of California and an M.A. in Biology (with emphasis on marine biology) from California State University, Long Beach.

Ms. King prepared Chapters 1, 2, 4, and 5 of this EIS. As the Coordinator of the entire document, she directed writing efforts on other sections of the EIS, edited all chapters, and maintained liaison with EPA Headquarters and Region II.

JOHN R. DONAT

Mr. Donat, an Associate Oceanographer at Interstate Electronics, holds a B.S. in Chemical Oceanography from Humboldt State University and is presently continuing study in preparation for an advanced degree in chemical oceanography.

Mr. Donat prepared Appendix B and several sections in Appendix A of the 106-Mile Site EIS.

WILLIAM DUNSTAN

Dr. Dunstan, the Program Manager for the EPA program on Ocean Disposal Site Designation, holds a B.S. in Engineering from Yale University, an M.S. in Marine Biology from Florida State University, and a Ph.D. in Biology from Florida State.

Dr. Dunstan prepared Appendix C and conducted extensive initial editing of the other Chapters and Appendices.

MARSHALL HOLSTROM

Mr. Holstrom is a marine biologist and staff EIS coordinator at Interstate Electronics. He holds a B.A. and M.A. in Biology from Stanford University. He has completed several years of graduate work in Marine Biology at the University of Southern California.

Mr. Holstrom authored sections in Chapters 2 and 4 of the EIS.

RANDY McGLADE

Mr. McGlade, a marine biologist at Interstate Electronics, received his B.S. and M.A. in Marine Biology from California State University, Long Beach.

Mr. McGlade prepared Chapters 3 and 6 of this EIS, and participated in the preparation of Appendix A.

STEPHEN M. SULLIVAN

Mr. Sullivan, a Biological Oceanographer at Interstate Electronics, obtained his B.S. in Oceanography from Humboldt State University in 1977 and has since completed graduate courses at Scripps Institute of Oceanography and California State University, Fullerton.

Mr. Sullivan prepared the biology sections of Appendix A.

Chapter 7

GLOSSARY, UNITS OF MEASURE, AND REFERENCES

GLOSSARY

Abundance	The number of individuals of a species or taxon inhabiting a given area.
Abyssal	Pertaining to the great depths of the ocean beyond the limits of the Continental Slope, generally from 2,000 to 5,000 m depth.
Accuracy	The extent to which the results of a calculation or the readings of an instrument approach the true values of the calculated or measured quantities, and are free from error. When applied to methods of analysis, accuracy is a measure of the error of a method and may be expressed as a comparison of the amount of an element or compound determined or recovered by the test method and the amount actually present.
Acute Effect	The death or incapacitation of an organism caused by a substance within a short time (normally 96 hours).
Adsorb	To adhere in an extremely thin layer of molecules to the surface of solid bodies.
Alkalinity	The sum of anions of weak acids in seawater plus hydroxide ion (OH^-) minus hydrogen ion (H^+) concentrations. Alkalinity can usually be calculated by the empirical equation of alkalinity [milliequivalent/kg = 0.061 x salinity (g/kg)].
Ambient	Pertaining to the normal or unaffected conditions of the surrounding environment.
Amphipods	A large order of predominantly marine crustaceans ranging from free-living planktonic and benthic forms to parasitic groups. Body shape in free-living forms is usually laterally compressed or shrimplike.

Anaerobic digestion	Digestion of organic matter by bacterial action in the absence of oxygen.
Anthropogenic	Relating to the effects or impacts of man on nature.
Antibiosis	Antagonistic association between two organisms whereby one is adversely affected.
Anticyclonic	Clockwise rotation around a high pressure zone (winds) or around a cold core (ocean currents) in the northern hemisphere.
Anticyclonic eddies	Mesoscale (50 to 100 km) features of oceanic circulation in which water flows in a circular (clockwise) pattern around warm core waters.
Apex	See New York Bight Apex.
Appropriate sensitive benthic marine organisms	Species representing a range of bottom-feeding types (filter-feeding, deposit-feeding, burrowing) chosen from a list of the most sensitive species recognized by EPA as being reliable test organisms to determine the anticipated impact on the site.
Appropriate sensitive marine organisms	Species representative of phytoplankton or zooplankton, crustacean or mollusc, and fish chosen from a list of the most sensitive species documented in scientific literature or recognized by EPA as being reliable test organisms to determine the anticipated impact on the site.
Aqueous	Similar to, containing, or dissolved in water.
Assemblage	A recurring group of organisms having a common habitat.
Background level	The naturally occurring level of a measurable parameter within an environment.
Bacteriophage	Virus affecting specific bacteria.
Baseline data	Data collected prior to the initiation of actions which have the potential of altering an existing environment.

Baseline surveys	Surveys conducted to collect information prior to the initiation of actions which have the potential of altering an existing environment.
Benthos	All marine organisms (plant or animal) living on or in the bottom; also, the floor or deepest part of the ocean.
Bight	A slight indentation in the shore line of an open coast or of a bay, usually crescent-shaped.
Bioaccumulate	The uptake and assimilation of materials (e.g., heavy metals) leading to an elevated concentration of the substance within an organism's tissue, blood, or body fluid.
Bioassay	Determination of the toxicity of a substance by its effect on the growth or survival of an organism; usually calculated as LC50 or EC50.
Biochemical Oxygen Demand (BOD)	The amount of oxygen consumed by microbiological organisms while assimilating and oxidizing organic (and some nitrogenous) materials in water or wastewater under specified environmental conditions and time periods.
Biomass	The amount (weight) of living organisms inhabiting a given area or volume.
Biota	Collectively, plants and animals of a region.
Biotic groups	Organisms which are ecologically, structurally, or taxonomically similar.
BLM	Bureau of Land Management.
Bloom	Relatively high concentrations of plankton in an area resulting from their rapid growth and reproduction.
Boreal	Pertaining to the higher northern latitudes, as opposed to tropical.
°C	Degrees Celsius.
C/N	Carbon/Nitrogen Ratio.

Carcinogen	A substance or agent producing cancer.
CE	U.S. Army Corps of Engineers.
Cephalopods	Members of the phylum Mollusca, including squid, octopus, or cuttlefish.
CFR	Code of Federal Regulations.
Chaetognaths	A phylum of small, elongate, transparent, wormlike invertebrates, also known as arrow-worms, which are important carnivores in the zooplankton community.
Chemostat	An apparatus for the continuous culture of bacterial populations in a steady state; rate of growth is governed by the rate at which fresh nutrients flow into the system.
Chlorophyll	A group of green plant pigments which receives and transforms the light energy used in photosynthesis and primary production.
Chlorophyll a	A specific green plant pigment used in photosynthesis and used as an indication of phytoplankton biomass.
Chronic effect	The sublethal effect of a substance on an organism which over a long period of time alters the normal processes and functions of the organism.
cm	Centimeter(s).
cm/sec	Centimeter(s) per second.
Coccolithophorid	Ultra-microscopic planktonic algae, the cells of which are surrounded by an envelope of small calcareous discs.
Coelenterate	A animal phylum which includes hydroids, sea anemones, jellyfish, and corals.
Coliforms	Bacteria residing in the colon of man and animals; indicators of fecal pollution.
Compensation depth	The depth at which photosynthetic oxygen production equals oxygen consumed during respiration in a 24-hour period.

Continental Margin	The zone between the shoreline and the deep ocean floor; generally consists of the Continental Shelf, Continental Slope, and the Continental Rise.
Continental Rise	A transitional zone between the Continental Slope and the ocean floor which is less steeply sloped than the Continental Slope.
Continental Shelf	Part of the Continental Margin extending seaward from the coast to a variable depth, generally 200 m.
Continental Slope	The steeply descending slope lying between the Continental Shelf and the Continental Rise.
Contour line	A chart line connecting points of equal elevation above or below a reference plane, such as sea level.
Copepods	A large group of usually small, planktonic crustaceans that are an important link in the oceanic food chain.
Coriolis effect	An apparent force resulting from the earth's rotation which deflects moving particles in the northern hemisphere to the right, and in the southern hemisphere to the left.
Crustaceans	Invertebrates with jointed appendages and a segmented exoskeleton. The group includes barnacles, crabs, shrimps, lobsters, copepods, and amphipods.
Ctenophores	Predominantly planktonic marine invertebrates, commonly referred to as comb jellies or sea walnuts.
Current meter	Any device for measuring and indicating speed, flow, volume, or direction of flowing water.
Current shear	The measure of the spatial rate of change of current velocity with units of $cm\text{-}sec^{-1}\,m^{-1}$.
Decapods	The largest order of crustaceans in which the animals have five sets of locomotory appendages, each joined to a

	segment of the thorax. Includes crabs, lobsters, and shrimp.
Demersal	Living at or near the sea bottom.
Density	The mass per unit volume of a substance.
Diatoms	Single-celled, primarily planktonic plants with a cell wall made of silica. They are abundant world wide and are important elements in many food chains.
Diffusion	Spontaneous mixing of particles in a liquid under influence of a concentration gradient, with net movement from an area of higher to lower concentration.
Dinoflagellates	Single-celled, planktonic organisms with flagella, which are an important part of marine food chains.
Discharge plume	The region affected by a discharge of waste such that it can be distinguished from the surrounding water.
Dispersion	The movement of discharged material over large areas by the natural processes of mixing.
Dissolved oxygen	The quantity of oxygen dissolved in a unit volume of water; usually expressed in ml/liter.
Dissolved solids	The dissipation of solid matter in solution, such as salt dissolved in water.
Diversity	A measure that usually takes into account the number of species and the number of individuals of each species present in a given area.
Dominant organisms	A species or group of species which strongly affect a community because of their abundance, size, or control of energy flow.
Dry weight	The weight of a sample of organisms after all water has been removed; a measure of biomass.

EC50 (Effective concentration 50)	In bioassay studies, the concentration of a substance which causes a defined effect in 50 percent of the test organisms during a given time (usually 96 hours).
Echinoderms	A phylum of benthic marine invertebrates having rigid calcareous plates and spines or calcareous plates embedded in the skin. This group includes starfish, sea urchins, sea lilies and sea-cucumbers.
Ecosystem	The organisms of a community together with their physical and chemical environment.
Eddy	A water current moving contrary to the direction of the main current, especially in a circular motion.
Effluent	Liquid waste from sewage and industrial processing.
EIS	Environmental impact statement.
Endemic	Restricted or peculiar to a locality or region.
Enteric	Referring to the intestinal tract of man and animals.
EPA	U.S. Environmental Protection Agency.
EPA Headquarters	U.S. Environmental Protection Agency Headquarters, Washington, D.C.
EPA Region II	U.S. Environmental Protection Agency, Region II, New York, N.Y.
Epifauna	Animals which live on the surface of the sea bottom.
Epipelagic	Ocean zone extending from the surface to 200 m in depth.
Estuary	A semienclosed coastal body of water which has a free connection to the sea and within which the sea water is measurably diluted with fresh water.

Euphausiids	Shrimp-like, planktonic crustaceans which are widely distributed in oceanic waters. These organisms, also known as krill, may grow to 8 cm in length and are an important link in the oceanic food chain.
°F	Degrees Fahrenheit.
Fauna	The animal life of a particular location, region, or period.
FDA	Food and Drug Administration.
Flocculate	The process of aggregating a number of small, suspended particles into small masses.
Flora	The plant life of a particular location, region, or period.
FWPCA	Federal Water Pollution Control Act.
g/cm^3	Grams per cubic centimeter.
Gastropods	Molluscs that possess a distinct head (generally with eyes and tentacles) and a broad, flat foot, and which usually have a spiral shell.
Geostrophic current	A current resulting from the balance between gravitational forces and the Coriolis effect.
Gulf Stream	A relatively warm, swift, northward flowing ocean current which flows through the Caribbean, Gulf of Mexico and up the North American east coast.
Heavy metals or elements	Elements which posseses a specific gravity of 5.0 or greater.
Helminths	Parasitic worms.
High-level radioactive waste	The aqueous or solid waste resulting from the reprocessing of irradiated fuel from nuclear power reactors.
Histopathology	The study of tissue changes associated with disease.
Hydrography	The measurement and description of the physical features of bodies of water.

Ichthyoplankton	Planktonic fish eggs and weakly motile fish larvae.
IEC	Interstate Electronics Corporation.
Indigenous	Having originated, or naturally occurring, in a particular region or environment.
Infauna	Animals which live in or burrow beneath the surface of the sea bottom.
In situ	(Latin) = in the original or natural setting.
Insolation	Solar radiation received at the earth's surface.
Invertebrates	Animals without backbones.
ISC	Interstate Sanitation Commission.
Isobath	A line on a marine chart joining points of equal depth below sea level.
kg	Kilogram(s).
kg/day	Kilogram(s) per day.
km	Kilometer(s).
LC50 (Lethal concentration 50)	In bioassays the concentration of a substance which causes 50% mortality in the population of the test organisms during a given time (usually 96 hours).
Limiting permissible concentration (LPC)	A concentration of a waste substance which, after initial mixing, does not exceed marine water quality criteria or cause acute or chronic toxicity.
LORAN-C	Long Range Aid to Navigation.
m	Meter(s).
m^3	Cubic meter(s).
m/sec	Meter(s) per second.
μ	Micron(s); 10^{-6} meter.
μg/kg	Microgram(s) per kilogram, or millionth gram per kilogram.

μg/l	Microgram(s) per liter, or millionth gram per liter.
Macrozooplankton	Planktonic animals with sizes between 200 and 2,000 microns (10^{-6}m), usually composed of copepods, chaetognaths, and larval forms.
Marine	Pertaining to the sea.
MARMAP	Marine Resources Monitoring, Assessment, and Prediction Program.
Mesopelagic	Relating to depths of 200 to 1,000 m below the ocean surface.
mg	Milligram(s), or thousandth gram.
mg/l	Milligram(s) per liter
mi	Mile(s).
Micro-organisms	Microscopic organisms including bacteria, protozoans, and some algae.
Mid-Atlantic Bight	The Continental Shelf extending from Cape Cod, Massachusetts to Cape Hatteras, North Carolina.
Mixed layer	The upper layer of the ocean which is well mixed by wind and wave activity.
ml	Milliliter(s), or thousandth liter.
$ml/m^2/hr$	Milliliter(s) per square meter per hour.
mm	Millimeter(s), or thousandth meter.
Monitoring	As used here, to observe environmental effects of disposal operations through biological, physical and chemical data collection and analysis.
mph	Mile(s) per hour.
MPRSA	Marine Protection, Research, and Sanctuaries Act.
Mutagen	A substance which increases the frequency or extent of mutations.

Myctophids	A group of small mesopelagic fish which possess light-emitting organs and undergo daily large-scale vertical (deep to near-surface) migrations.
Nannoplankton	Minute planktonic plants and animals which are 50 microns or less in size. Individuals of this size will pass through most plankton nets and are therefore usually collected by centrifuging water samples.
NAS	National Academy of Science.
NASA	National Aeronautics and Space Administration.
Nekton	Free-swimming animals which move independently of water currents.
NEPA	National Environmental Policy Act of 1969.
Neritic	Pertaining to the region of shallow water adjoining the seacoast and extending from low-tide mark to 200 m depth.
Neuston	A community of planktonic organisms which are associated with the surface layer of water; mainly composed of certain copepods and the eggs and larvae of fish.
New York Bight	The Continental Shelf which extends from Montauk Point, Long Island to Cape May, New Jersey.
New York Bight Apex	A portion of the New York Bight bounded by 40°10'N latitude and 73°30'W longitude.
NJDEP	New Jersey Department of Environmental Protection.
nmi	Nautical mile(s).
NOAA	National Oceanic and Atmospheric Administration.
NOAA-MESA	National Oceanic and Atmospheric Administration-Marine Ecosystems Analysis.

NOAA-NMFS	National Oceanic and Atmospheric Administration-National Marine Fisheries Service.
NSF	National Science Foundation.
Nuisance species	Organisms without commercial value which out-compete or harm commercially important species.
Nutrient	Any substance which promotes growth or provides energy for biological processes.
OCS	Outer Continental Shelf.
ODSS	Ocean Dumping Surveillance System.
Organophosphate pesticides	A phosphorus-containing organic pesticide, such as parathion or malathion.
Ortho-phosphate	One of the possible salts of orthophosphoric acid; an essential nutrient for marine plant growth.
Oxygen minimum layer	The depth in the water column where the lowest concentration of dissolved oxygen naturally occurs.
Parameters	Values or properties which describe the characteristics or behavior of a set of variables.
Particulates	Fine solid particles individually dispersed in water.
Pathogen	Producing or capable of producing disease.
PCB	Polychlorinated biphenyl.
Pelagic	Pertaining to water of the open ocean or organisms inhabiting this region including plankton, nekton and neuston.
Perturbation	A disturbance of a natural or regular system.
pH	A term used to describe the negative logarithm of the hydrogen ion. Conventionally, pH 7 is considered neutral, less than 7 is acidic,and greater than 7 is alkaline. Range 1 to 14.

Photic Zone	The layer in the ocean from the surface to the depth where light is reduced to 1% of its surface value.
Phytoplankton	Planktonic plants; the base of most oceanic food chains.
Plankton	Usually small passively floating or weakly motile animal or plant life occurring in a body of water.
Polychaetes	The largest class of the phylum Annelida (segmented worms), distinguished by paired, lateral, fleshy appendages provided with bristles (setae) on most segments.
ppb	Parts per billion. A unit of concentration of a mixture indicating the number of parts of a constituent per billion parts of the entire mixture.
ppm	Parts per million. A unit of concentration of a mixture indicating the number of parts of a constituent per million parts of the entire mixture.
ppt (o/oo)	Parts per thousand. A unit of concentration of a mixture indicating the number of parts of a constituent per thousand parts of the entire mixture.
Precipitate	A solid separating from a solution or suspension by chemical or physical change.
Precision	When applied to methods of analysis, precision is a measure of the reproducibility of a method when repeated in a homogeneous sample under controlled conditions, regardless of whether or not the observed values are widely displaced from the true values as a result of a systematic or constant errors present throughout the measurements. Precision can be expressed by the standard deviation.
Predator	An animal which eats other animals.

Primary production	The amount of organic matter photosynthesized by plants from inorganic substances per unit time per unit area or volume.
Protozoa	Microscopic, single-celled organisms which include the most primitive forms of animal life.
Pycnocline	A vertical density gradient in some layer of a body of water, positive with respect to depth and much greater than the gradients above and below it.
Quantitative	Pertaining to the numerical measurement of a parameter.
Recruitment	Addition to a population of organisms by reproduction or immigration of new individuals.
Release zone	An area 100 m on either side of the disposal vessel extending from the point of first waste release to the end of the release.
Runoff	The portion of precipitation on the land that ultimately reaches streams or oceans.
Salinity	The amount of dissolved salts in seawater measured in parts per thousand.
Sea state	The numerical or written description of ocean roughness.
sec	Second(s).
Shelf Water	Water which originates on or can be traced to the Continental Shelf. It has characteristic temperature and salinity values which make it identifiable.
Shellfish	Any aquatic invertebrate having a shell or exoskeleton, esp cially any edible mollusc or crustacean.
Shiprider	An observer aboard ship assigned by the Coast Guard to assure that ocean disposal operations are conducted according to the permit specifications.

Short dumping	The discharge of waste from a vessel prior to reaching a designated disposal site. This may occur legally under emergency conditions, or illegally if done under normal conditions.
Significant wave height	The average height of the one-third highest waves in a given wave group.
Slope Water	Water which originates on or can be traced to the Continental Slope. It has characteristic temperature and salinity values which make it identifiable.
Sludge	A precipitated solid matter produced by sewage and chemical waste treatment processes.
Species	A group of morphologically similar organisms capable of interbreeding and producing viable offspring.
Specific gravity	The ratio of the density of a substance relative to the density of pure water at 4°C.
SPM	Suspended particulate matter.
sq	Square.
SS	Suspended solids.
Standing stock	The biomass or abundance of living material per unit volume or area.
Stress	A effect or series of effects which disrupt the normal ecological functioning of an area.
Surfactants	An agent which lowers surface tension (e.g., soap, bile and certain detergents).
Surveillance	Systematic observation of an area by visual, electronic, photographic, or other means for the purpose of ensuring compliance with applicable laws, regulations, and permits.
Suspended solids	Finely divided particles of a solid temporarily suspended in a liquid (e.g., soil particles in water).

Synergistic	Describing an ecological association in which a process or behavior of an organism is enhanced by the presence of another organism; describing an action where the total effect of two or more active components is greater than the sum of their individual effects.
Taxon (pl. Taxa)	A taxonomic group or entity sufficiently distinct to be distinguished by name and to be ranked in a definite category.
TCH	Total carbohydrate content.
Temporal distribution	The distribution of a parameter over time.
Teratogen	A chemical agent which causes developmental malformations and monstrosities.
Terrigenous sediments	Shallow marine sedimentary deposits composed of eroded terrestrial material.
Thermocline	A sharp temperature gradient which separates a warmer surface water layer from a cooler subsurface layer, and is most pronounced during summer months.
TKN	Total Kjeldahl nitrogen.
TOC	Total organic carbon.
Trace metal or element	An element found in the environment in extremely small quantities.
Trend Assessment Surveys	Non-seasonal surveys conducted over long periods to detect shifts in environmental conditions within a region.
Trophic level	Feeding levels in the food chain of a community which determine the flow of energy and materials from plants to herbivores to carnivores and decomposers.
Turbidity	Cloudy or hazy appearance in seawater caused by a suspension of colloidal liquid droplets, fine solids, or small organisms.

Turnover rate	The time necessary to replace the entire standing stock of a population; generation time.
USCG	U.S. Coast Guard.
Virus	An agent capable of infecting animals, plants and bacteria which is totally dependent on living cells for its reproduction.
Water mass	A body of water usually identified by its temperature, salinity and chemical characteristics and normally consisting of a mixture of water types.
Water type	Water defined by a narrow range of temperature and salinity.
Wet weight	The weight of organisms before drying them to remove the internal water.
yd^3	Cubic yard(s).
Zooplankton	Usually small, passively floating or weakly swimming animals which are important in many marine and freshwater food chains.

UNITS OF MEASURE (ENGLISH EQUIVALENTS OF METRIC UNITS)

Metric	English
centimeter (cm)	0.4 inches (in)
meter (m)	1.1 yards (yds)
kilometer (km)	0.6 statute miles (mi)
	0.54 nautical miles (nmi)
square meter (sq m; m^2)	1.2 square yards (sq yd; yd^3)
square kilometer (sq km; km^2)	0.29 square nautical miles (sq nmi; nmi^2)
gram (g)	0.035 ounces (oz)
kilogram (kg)	2.2 pounds (lb)
metric ton (tonne)	1.1 short tons (2,000 lbs)
liter (l)	0.26 gallons (gal)
cubic meter (cu m; m^3)	1.3 cubic yards (cu yd; yd^3)
centimeters/second (cm/sec)	0.39 inches/second (in/sec)
kilometers/hour (km/hr)	0.54 knots (kn), nautical miles/hour
Celsius (°C)	9/5 °C + 32 Fahrenheit (°F)

REFERENCES

Akin, E.A., W. Jakubowski, J.B. Lucas, and H.R. Pahren, 1977. Health hazards associated with wastewater effluents and sludge: Microbiological considerations. Pages 9-10 in B.P. Sagik and C.A. Sorber, eds. Proceedings of the conference on risk assessment and health effects of land application of municipal wastewater and sludges. Center for Applied Research and Technology. University of Texas at San Antonio. 329 pp.

Akin, E.W., W.F. Hill, Jr. and N.A. Clark. 1975. Mortality of enteric viruses in marine and other waters. Pages 227-236 in A.L.H. Gameson, ed. Discharge of sewage from sea outfalls. Pergamon Press, Oxford England.

Alexander, J.E. and E.C. Alexander. 1977. Chemical properties. MESA New York Bight Atlas Monograph 2. New York Sea Grant Institute. Albany, New York.

Alexander, J.E., R. Hollman, and T. White. 1974. Heavy metal concentrations at the Apex of the New York Bight. Final Report 4-35212. New York Ocean Science Lab. Long Island, New York.

Ali, S.A., M.G. Gross, and J.R.L. Kishpaugh. 1975. Cluster analysis of marine sediments and waste deposits in New York Bight. Environ. Geol. 1:143-148.

Arnold, E.L. and W.F. Royce. 1950. Observations of the effect of acid-iron waste disposal at sea on animal populations. U.S. Dept. of the Interior, Spec. Sci. Rep. - Fisheries No. 11. Washington, D.C. 12 pp.

Aubert, M., D. Pesando, and M.J. Gauthier. 1974. Effects of antibiosis in a marine environment. Pages 191-197 in A.L.H. Gameson, ed. Discharge of sewage from sea outfalls. Pergamon Press, Oxford, England.

Austin, H.M. 1975. An analysis of the plankton from Deepwater Dumpsite 106. Pages 271-357 in NOAA. May 1974 Baseline investigation of Deepwater Dumpsite 106. NOAA Dumpsite Evaluation Report 75-1. Rockville, MD. 388 pp.

Backus, R.H. 1970. The distribution of mesopelagic fishes in the western and tropical North Atlantic Ocean. J. Mar. Res. 28(2):179-201.

Banse, K. 1964. On the vertical distribution of zooplankton in the sea. Pages 55-125 in M. Sears, ed. Progress in oceanography. Vol. 2, Pergammon Press.

Beardsley, R.C., W.C. Boicourt, and D.V. Hansen, eds. 1976. Physical oceanography of the Middle Atlantic Continental Shelf and New York Bight. Special Symp. Vol. 2. Am. Soc. Lim. and Oceanogr.

Beardsley, R.C., and C.N. Flagg. 1976. The water structure, mean currents, and Shelf Water/Slope Water front on the New England Continental Shelf. Pages 209-225 in Mem. Soc. Roy. Sci. Liege 10.

Benninger, L.K., D.M. Lewis, and K.K. Turekian. 1975. The uses of natural Pb-210 as a heavy metal tracer in the river-estuarine system - marine chemistry in the coastal environment. Amer. Chem. Soc. of Special Symposium #18, Washington, D.C.

Bewers, J.M., B. Sundby, and P.A. Yeats. 1975. Trace metals in the waters overlying the Scotian Shelf and Slope. ICES 63rd Statutory Meeting, Montreal, Sept. 1975.

Bigelow, H.B. 1933. Studies of the waters on the Continental Shelf. Cape Cod to Chesapeake Bay, I. The cycle of temperature. Pap. Phys. Oceanogr. Meteorol. 2(4):135.

Bigelow, H.B. and M. Sears. 1939. Studies of the waters of the Continental Shelf, Cape Cod to Chesapeake Bay. III. A volumetric study of the zooplankton. Mem. Mus. Comp. Zool., Harvard. 54(4):183-378.

Bisagni, J.J. 1976. Passage of anticyclonic Gulf Stream eddies through Deepwater Dumpsite 106 during 1974 and 1975. NOAA Dumpsite Evaluation Report 76-1, U.S. Dept of Commerce Publications. 39 pp.

1977a. Deepwater Dumpsite 106 bathymetry and bottom morphology. Pages 1-8 in NOAA. Baseline report of environmental conditions in Deepwater Dumpsite 106. Volume I: Physical characteristics. NOAA Dumpsite Evaluation Report 77-1. Rockville, MD. 218 pp.

1977b. The physical oceanography and experimental studies at Deepwater Dumpsite 106 during June 1976. Atlantic Environmental Group National Marine Fisheries Service, NOAA. 55 pp.

BLM. See Bureau of Land Management.

Boicourt, W.C. 1973. The circulation of water on the Continental Shelf from Chesapeake Bay to Cape Hatteras. Ph.D. Thesis, Johns Hopkins University, Baltimore, Maryland. 183 pp.

Boicourt, W.C. and P.W. Hacker. 1976. Circulation on the Atlantic Continental Shelf of the United States, Cape May to Cape Hatteras. Mem. Soc. R. Sci. Liege Ser 6. 10:187-200.

Bowman, M.J. and P.K. Weyl. 1972. Hydrographic study of the Shelf and Slope Waters of the New York Bight. Technical Report #16. Marine Sciences Research Center, State Univ. of New York. Stony Brook, New York. 46 pp.

Bowman, M.J., and L.D. Wunderlich. 1976. Distribution of hydrographic properties in the New York Bight Apex. Pages 58-68 in M.G. Gross, ed. Middle Atlantic Continental Shelf and New York Bight. Special Symp. Vol. 2. Am. Soc. Lim. and Oceanogr.

1977. Hydrographic Properties. NOAA-MESA New York Bight Atlas Monograph I. New York Sea Grant Institute. Albany, New York.

Bowman, T.E. 1971. The distribution of calanoid copepods of the eastern United States between Cape Hatteras and southern Florida. Smithson. Contrib. Zool. Vol. 96. 58 pp.

Breidenbach, A. 1977. Report of the Hearing Officer. Public hearing on relocating sewage sludge ocean dumping sites, Toms River, New Jersey, May 31-June 1, 1977. U.S. EPA, Office of Water and Hazardous Materials, September 22, 1977.

Brewer, P.G. 1975. Minor elements in sea water. Pages 415-496 in J.P. Riley and Skirrow, eds. Chemical Oceanography. Academic Press, New York, N.Y.

Brezenski, F.T. 1975. Analytical results for water-column samples collected at Deepwater Dumpsite 106. Pages 203-215 in NOAA. May 1974 baseline investigation of Deepwater Dumpsite 106. NOAA Dumpsite Evaluation Report 75-1. Rockville, MD. 388 pp.

Brock, T.D. and G.K. Darland. 1970 Limits of microbial existance: temperature and pH. Science 169:1316-1318.

Brower, W.A., Jr. 1977. Climatic study of New York Bight. Pages 117-218 in NOAA. Baseline report of environmental conditions in Deepwater Dumpsite 106. Volume I: Physical characteristics. NOAA Dumpsite Evaluation Report 77-1. Rockville, MD. 218 pp.

Bryan, G.W. 1971. The effects of heavy metals (other than mercury) on marine and estuarine organisms. Proc. Soc. London B. 177:389.

Bureau of Land Management (BLM), 1978. Draft environmental impact statement - proposed Outer Continental Shelf oil and gas lease sale offshore the Mid-Atlantic States. New York, N.Y.

Buzas, M.A., J.H. Carpenter, B.H. Ketchum, J.L. McHugh, V.J. Norton, P.J. O'Connor, J.L. Simon, and D.K. Young. 1972. Smithsonian Advisory Committee report on studies of the effects of waste disposal in the New York Bight. Submitted to Coastal Eng. Res. Cen., U.S. Army Corps of Engineers. Washington, D.C. 65 pp.

Callaway, R.J., A.M. Teeter, D.W. Browne, and G.R. Ditsworth. 1976. Preliminary analysis of the dispersion of sewage sludge discharged from vessels to New York Bight Waters. Pages 199-211 in M.G. Gross, ed. Middle Atlantic Continental Shelf and the New York Bight. Special Symp. Vol. 2. Am. Soc. Lim. and Oceanogr.

Capuzzo, J.M. 1978. The effects of pollutants on marine zooplankton at Deepwater Dumpsite 106 - preliminary findings. First International Ocean Dumping Symposium, Univ. Rhode Island, October 1978. 14 pp.

Capuzzo, J.M. and B.A. Lancaster. 1978. The effects of pollutants on marine zooplankton at Deepwater Dumpsite 106. Prepared for National Oceanic and Atmospheric Administration. Final Report. 14 pp.

Carlucci, A.F. and D. Pramer. 1959. Factors affecting the survival of bacteria in sea water. Appl. Microbiol. 7:388-392.

1960. An evaluation of factors affecting the survival of Escherichia coli in seawater. II. Salinity, pH, and nutrients. Appl. Microbiol. 8:247.

1960. An evaluation of factors affecting the survival of Escherichia coli in seawater. IV. Bacteriophages. Appl. Microbiol. 8:254.

Carmody, D.J., J.B. Pearce, and W.E. Yasso. 1973. Trace metals in sediments of New York Bight. Mar. Poll. Bull. 4(9):132-135.

Casey, J.G. and J.M. Hoenig. 1977. Apex predators in Deepwater Dumpsite 106. Pages 309-376 in NOAA. Baseline report of environmental conditions in Deepwater Dumpsite 106. Volume 2: Biological characteristics. NOAA Dumpsite Evaluation Report 77-1. Rockville, MD. 485 pp.

Charnell, R.L. and D.V. Hansen. 1974. Summary and analysis of physical oceanographic data collected in the New York Bight Apex during 1969 and 1970. MESA Report 74-3. NOAA-ERL. 44 pp.

Chenoweth, S. 1976a. Commercial and sport fisheries. Pages 10-1 to 10-83 in TRIGOM. Summary of environmental information on the Continental Slope—Canadian/United States Border to Cape Hatteras, N.C. prepared for BLM, New York.

1976b. Phytoplankton. Section 7.1 in TRIGOM. Summary of environmental information on the Continental Slope - Canadian/United States Border to Cape Hatteras, NC. The Research Institute of the Gulf of Maine, Portland. (Also NTIS. PB-284 002).

1976c. Zooplankton. Section 7.2 in TRIGOM. Summary of environmental information on the Continental Slope - Canadian/United States Border to Cape Hatteras, NC. The Research Institute of the Gulf of Maine, Portland. (Also NTIS. PB-284 002).

Chenoweth, S., S.K. Katona, and D.S. Brackett. 1976. Nekton. Section 7.4 in TRIGOM. Summary of environmental information on the Continental Slope—Canadian/United States Border to Cape Hatteras, NC. The Research Institute of the Gulf of Maine, Portland. (Also NTIS. PB-284 002)

Cifelli, R. 1962. Some dynamic aspects of the distribution of planktonic foraminifera in the western North Atlantic. Sears Found. J. Mar. Res. 20(3):201-212.

1965. Planktonic foraminifera from the western North Atlantic. Smithson. Misc. Collect. 148(4):1-36.

Clark, G.L. 1940. Comparative richness of zooplankton in coastal and offshore areas of the Atlantic. Biol. Bull. 78:226-255.

Cohen, D.M. and D.L. Pawson. 1977. Observations from DSRV ALVIN on populations of benthic fishes and selected larger invertebrates in and near DWD-106. Pages 423-450 in NOAA. Baseline Report of environmental conditions in Deepwater Dumpsite 106. Volume II: Biological characteristics. NOAA Dumpsite Evaluation Report 77-1. 485 pp.

Cooper, M.F. and R.Y. Morita. 1972. Interaction of salinity and temperature on net protein synthesis and viability of Vibrio marinus. Limnol. Oceanogr. 17:556.

Drake, C.L., J.I. Ewing and H. Stockard. 1968. The Continental Margin of the eastern United States. Can. Jour. Earth Sci., 5:993-1010.

EG&G. 1975. Summary of oceanographic observations in New Jersey coastal waters near 39°28'N latitude and 74°15'W longitude during the period May 1973 through April 1974. Submitted to Public Service Electric and Gas Co. of New Jersey by EG&G, Environmental Consultants, Waltham, Mass.

1977a. Dispersion in waters of the New York Bight Acid Dumpgrounds of acid-iron wastes discharged from a towed barge. Prepared for NL Industries, Inc., by EG&G, Environmental Consultants. Waltham, Mass.

1977b. Dispersion in waters of the New York Bight Acid Dumpgrounds of by-product hydrochloric acid wastes discharged from a towed barge. Prepared for Allied Chemical Corp., by EG&G, Environmental Consultants. Waltham, Mass.

1977c. Measurements of the dispersion of barged waste near 38°50'N latitude and 72°15'W longitude at the 106 Dumpsite. 261 pp.

1977d. Measurements of the dispersion of barged waste near 38°33'N latitude and 74°20' W longitude. Prepared for E.I. du Pont de Nemours and Co., Edge Moor, Delaware.

1978. Fall 1977 chemical oceanographic monitoring cruise, New York Bight Acid Waste Dumpgrounds, cruise report. Prepared for NL Industries, Inc., and Allied Chemical Corp., by EG&G, Environmental Consultants. Waltham, Mass. 43 pp.

Emery, K.O. and J.S. Schlee. 1963. The Atlantic Continental Shelf and Slope, a program for study. U.S. Geol. Surv., Circular 481. Washington, D.C.

Emery, K.O. and Uchupi, E. 1972. Western North Atlantic Ocean: topography, rocks, structure, water, life, and sediments. Am. Assoc. Petroleum Geol., Memoir 17. 532 pp.

EPA. See U.S. EPA.

Falk, L.L., T.D. Myers, and R.V. Thomann. 1974. Waste dispersion characteristics in an oceanic environment. Submitted to U.S. EPA, Office of Research and Monitoring, Washington, D.C. EPA-600/2-77-112 (NTIS PB 268157) 306 pp.

Falk, L.L. and J.R. Gibson. 1977. The determination of release time for ocean disposed wastewaters. E.I. du Pont de Nemours and Co. Wilmington, Del.

Falk, L.L. and F.X. Phillips. 1977. The determination of release time for ocean disposal of wastewaters from manufacture of titanium dioxide. E.I. du Pont de Nemours and Co. 306 pp.

Federal Register. 1979. Final designation of disposal sites for ocean dumping. Vol. 44(98). May 18, 1979. p. 29052.

Fisher, A., Jr. 1972. Entrainment of Shelf water by the Gulf Stream northeast of Cape Hatteras. J. Geophys. Res. 77(18):3248-3255.

Fleischer, M., et al. 1974. Environmental impact of cadmium: a review by the panel on hazardous trace substances. Environmental Health Perspectives. U.S. Government Printing Office, Washington, D.C. 7:253.

Folger, D.W., H.D. Palmer, and R.A. Slater. 1979. Two waste disposal sites on the Continental Shelf off the Middle Atlantic States: Observations made from submersibles. Pages 163-184 in H.D. Palmer and M.G. Gross, eds. Ocean dumping and marine pollution. Dowden, Hutchinson and Ross, Inc., Stroudsburg, PA.

Forns, J.M. 1973. Zooplankton. Pages 54-64 in H.D. Palmer and D.W. Lear, eds. Environmental survey of an interim ocean dumpsite - Middle Atlantic Bight. EPA Region III 903/9-73-001-A. 134 pp.

Forsythe, E. 1977. Statement of Hon. Edwin Forsythe at Toms River Public Hearing, May 31 - June 1, 1977. Toms River, New Jersey.

Gameson, A.L.H. and D.J. Gould. 1975. Effects of solar radiation on the mortality of some terrestrial bacteria in sea water. Pages 209-219 in A.L.H. Gameson, ed., Discharge of Sewage from Sea Outfalls. Pergamon Press, Oxford England.

Geldreich, E.E. 1978. Bacterial populations and indicator concepts in feces, sewage, stormwater and solid wastes. Pages 51-97 in G. Berg. ed. Indicators of viruses in water and food. Ann Arbor Science Publ. Ann Arbor, Michigan.

Gibson, C. 1973. The effects of waste disposal on the zooplankton of the New York Bight. Ph.D. Dissertation, Lehigh University. Univ. Microfilms Intl. Ann Arbor, Mich. 184 pp.

Ginter, J.J.C. 1978. Foreign fisheries. Pages 80-129 in J.L. McHugh, and J.J.C. Ginter. Fisheries. MESA New York Bight Atlas Monograph 16. New York Sea Grant Institute. Albany, New York. 129 pp.

Goulet, J.R., Jr. and K.A. Hausknecht. 1977. Physical oceanography of Deepwater Dumpsite 106, update: July 1975. Pages 55-86 in NOAA. Baseline report of environmental conditions in Deepwater Dumpsite 106. Volume I: Physical characteristics. NOAA Dumpsite Evaluation Report 77-1. Rockville, MD. 218 pp.

Graikoski, J., R. Greig, D. Wenzloff, B. Nelson, and A. Adams. 1974. Trace metals in marine biota and sediments collected from offshore waters of the New York Bight. NMFS, MACFC, Highlands, N.J. Informal Report, No. 38. 5 pp.

Grant, G.C. 1977. Zooplankton of the water column and neuston. Pages 4-1 to 4-138 in M.P. Lynch and B.L. Laird, eds. Middle Atlantic Outer Continental Shelf environmental studies. Volume II-A: Chemical and biological benchmark studies. Prepared for BLM by Virginia Institute of Marine Science. Gloucester Pt., VA. Contract No. 08550-CT-5-42.

Greig, R., Nelson, B.A., J.T. Graikowski, D.R. Wenzloff and A. Adams. 1974. Distribution of five metals in sediments from the New York Bight. NOAA Milford Lab. Informal Rep 36. Milford, Conn. 33 pp.

Greig, R. and D. Wenzloff. 1977. Final report on heavy metals in small pelagic finfish, euphausiid crustaceans, and apex predators, including sharks, as well as on heavy metals and hydrocarbons (C_{15}+) in sediments collected at stations in and near Deepwater Dumpsite 106. Pages 547-564 in NOAA. Baseline report of environmental conditions in Deepwater Dumpsite 106. Volume III: Contaminant inputs and chemical characteristics. NOAA Dumpsite Evaluation Report 77-1. 798 pp.

Greig, R.A., D. Wenzloff, and C. Shelpuk. 1975. Mercury concentration in fish, North Atlantic offshore water - 1971. Pesticides Monitoring J. 9(1):15-19.

Greig, R.A. and J.B. Pearce. 1975. Further analyses of heavy metals in sediments collected from the Outer New York Bight. NOAA Middle Atlantic Coastal Fisheries Center, Ecosystems Investigations. Report No 63. 20 pp.

Greig, R.A., D.R. Wenzloff, and J.B. Pearce. 1976. Distribution and abundance of heavy metals in finfish, invertebrates, and sediments collected at a deepwater disposal site. Mar. Poll. Bull. 7(10):185-187.

Greig, R.A., A. Adams, and D.R. Wenzloff. 1977. Trace metal content of plankton and zooplankton collected from the New York Bight and Long Island Sound. Bull. Env. Contam. Toxicol. 18:3-8.

Grice, G D. and A.D. Hart. 1962. The abundance, seasonal occurrence and distribution of the epizooplankton between New York and Bermuda. Ecol. Monogr. 32(4):287-309.

Grice, G.D., P.H. Wiebe, and E. Hoagland. 1973. Acid-iron waste as a factor affecting distribution and abundance of zooplankton in the New York Bight. I. Laboratory studies on the effects of acid waste on copepods. Estuar. Coast. Mar. Sci. 1:45-50.

Gross, M.G. 1970. Analysis of dredged wastes, fly ash, and waste chemicals - New York Metropolitan Region, Mar. Sci. Res. Cent., State Univ. New York, Stony Brook, N.Y. Technical Report No 7. 33 pp.

Gusey, W.F. 1976. The fish and wildlife resources of the Middle Atlantic Bight. Shell Oil Company. 582 pp.

Haedrich, R. 1977. Neuston fish at DWD 106. Pages 481-485 in NOAA. Baseline report of environmental conditions in Deepwater Dumpsite 106. Volume II: Biological characteristics. NOAA Dumpsite Evaluation Report 77-1. Rockville, MD. 485 pp.

Haedrich, R.L., G.T. Rowe, and P.T. Polloni. 1975. Zonation and faunal composition of epibenthic populations on the Continental Slope south of New England. J. Mar. Res. 33:191-212.

Harbison, R., L. Madin, and V. McAlister. 1977. Gelatinous zooplankton at Deepwater Dumpsite 106. Pages 305-307 in NOAA. Baseline report of environmental conditions in Deepwater Dumpsite 106. Volume 2: Biological characteristics. NOAA Dumpsite Evaluation Report 77-1. Rockville, MD. 485 pp.

Harris, R., R. Jolly, R. Huggett, and G. Grant. 1977. Trace metals. Pages 8-1 to 8-57 in M.P. Lynch and B.L. Laird, eds. Middle Atlantic Outer Continental Shelf environmental studies. Vol. II-B: Chemical and biological benchmark studies. Prepared for BLM by Virginia Institute of Marine Science. Gloucester Pt., VA. Contract No. 08550-CT-5-42.

Harris, W.H. 1974. Sewage sludge expansion, migration, accumulation, and identification - Nassau County, New York Inner Continental Shelf. Pages 297-330 in U.S. Congress, Senate, Committee on Public Works, Subcommittee on Environmental Pollution; sewage sludge hazard to Long Island beaches: Hearing, 93rd Congress 93-H52.

Harrison, A.P. Jr. 1967. Harmful effects of light, with some comparisons with other adverse physical agents. Ann. Rev. Microbiol. 21:143.

Harvey, G.R., W.G. Steinhauer, and J.M. Teal. 1974. Polychlorobiphenyls in North Atlantic ocean water. Science. 180:643-644.

Hathaway, J.C. 1971. Data file, Continental Margin program, Atlantic Coast of the United States. Vol. 2. Sample collection and analytical data. Woods Hole Oceanographic Institution Tech Rept. 71-15. 496 pp.

Hausknecht, K.A. 1977. Results of studies on the distribution of some transition and heavy metals at Deepwater Dumpsite 106. Pages 499-546 in NOAA. Baseline report of environmental conditions in Deepwater Dumpsite 106. Volume III: Contaminant inputs and chemical characteristics. NOAA Dumpsite Evaluation Report 77-1. Rockville, MD. 798 pp.

Hausknect, K.A. and D.R. Kester. 1976a. Deepwater Dumpsite 106 chemical data report from USCGC DALLAS cruise 21 June-1 July, 1976. University of Rhode Island, Kingston, R.I. 10 pp.

1976b. Deepwater Dumpsite 106 chemical data report from R/V KNORR, August 27-September 7, 1976. University of Rhode Island, Kingston, R.I. 10 pp.

Heezen, B.C. 1975. Photographic reconnaissance of Continental Slope and Upper Continental Rise. Pages 27-32 in NOAA. May 1974 Baseline Investigation of Deepwater Dumpsite 106. NOAA Dumpsite Evaluation Report 75-1. Rockville, MD. 388 pp.

1977. Six dives to the Lower Continental Slope and Upper Continental Rise southwest of Hudson Canyon: geological aspects. Pages 9-27 in NOAA. Baseline report of environmental conditions in Deepwater Dumpsite 106. Volume I: Physical characteristics NOAA Dumpsite Evaluation Report 77-1. Rockville, MD. 218 pp.

Hollman, R. 1971. Nearshore physical oceanography. New York Ocean Science Laboratory Tech. Rpt. No 0008. New York Ocean Science Laboratory, Montauk, New York. 11 pp.

Hopkins, J., R. Freisem, L. Gigliotti, D. Groover, and R. Valigra. 1973. Concentrations of chlorophyll a, b, and c. Pages 106-116 in M.A. Champ, ed. Operation SAMS, A survey of three Atlantic Ocean disposal sites. CERES Publication No. 1. The American University, Washington, D.C. 169 pp.

Horne, R.A. 1969. Marine Chemistry: The structure of water and the chemistry of the hydrosphere. Wiley-Interscience, New York. 568 pp.

Hulburt, E.M. 1963. The diversity of phytoplanktonic populations in oceanic, coastal and estuarine regions. J. Marine Res. 21:81-93.

1964. Succession and diversity in the plankton flora of western North Atlantic. Bull. Mar. Sci. Gulf and Caribbean. 14(1):33-34.

1966. The distribution of phytoplankton and its relationship to hydrography, between southern New England and Venezuela. J. Marine Res. 24:67-81.

1970. Competition for nutrients by marine phytoplankton in oceanic, coastal and estuarine regions. Ecology. 51:475-84.

Hulburt, E.M. and C.M. Jones. 1977. Phytoplankton in the vicinity of Deepwater Dumpsite 106. Pages 219-231 in NOAA. Baseline report of environmental conditions in Deepwater Dumpsite 106. Volume II: Biological characteristics. NOAA Dumpsite Evaluation Report 77-1. Rockville, MD. 485 pp.

Hulburt, E.M. and R.S. MacKenzie. 1971. Distribution of phytoplankton species at the western margin of the North Atlantic Ocean. Bull. Mar. Sci. 21(2):603-612.

Hulburt, E.M. and J. Rodman. 1963. Distribution of phytoplankton species with respect to salinity between the coast of southern New England and Bermuda. Limnol. and Oceanogr. 8:263-69.

Hulburt, E.M., J.A. Ryther, and R.R.L. Guillard. 1960. Phytoplankton of the Sargasso Sea off Bermuda. J. Du Cons. 25(2):115-128.

Hydroscience, 1978a. Ocean monitoring survey at "106" site of Edge Moor barged wastewater, May 22, 1978. Submitted to E.I. du Pont de Nemours and Co., September 14, 1978.

1978b. Ocean monitoring survey at "106" site of Edge Moor barged wastewater, July, 22, 1978. Submitted to E.I. du Pont de Nemours and Co.

1978c. Ocean monitoring survey at "106" site of Grasselli barged wastewater, May 19, 1978. Submitted to E.I. du Pont de Nemours and Co.

1978d. Ocean monitoring survey at "106" site of Grasselli Barged Wastewater, July 24, 1978. Submitted to E.I. du Pont de Nemours and Co.

1978e. Report on ocean monitoring cruise at the 106-Mile Deepwater Dumpsite. Submitted to American Cyanamid Co., August 29, 1978.

1978f. Report on ocean monitoring cruise at the 106-Mile Deepwater Dumpsite. Submitted to American Cyanamid Co., October 24, 1978.

1978g. Report on ocean monitoring cruise at the 106-Mile Deepwater Dumpsite. Submitted to Merck and Co., Inc., Reheis Chemical Co., and Crompton and Knowles, August 23, 1978.

1978h. Report on ocean monitoring cruise at the 106 Mile Deepwater Dumpsite. Submitted to Merck and Co., Inc., Reheis Chemical Co., and Crompton and Knowles, October 23, 1978.

1979a. Ocean monitoring survey at "106" site of Edge Moor Barged Wastewater. Submitted to E.I. du Pont de Nemours and Co.

1979b. Ocean monitoring survey at "106" site of Grasselli barged wastewater, October 25, 1978. Submitted to E.I. du Pont de Nemours and Co.

1979c. Report on ocean monitoring cruise at the 106-Mile Deepwater Dumpsite. Submitted to American Cyanamid Co., February 2, 1979.

1979d. Report on ocean monitoring cruise at the 106-Mile Deepwater Dumpsite. Submitted to Merck and Co., Inc., Reheis Chemical Co., and Crompton and Knowles, February 2, 1979.

Ichiye, T. 1965. Diffusion experiments in coastal water using dye techniques. Pages 54-62 in Symposium on diffusion in oceans and fresh waters. Lamont Geol. Observatory Columbia Univ., Palisades, New York.

Jannasch, H.W. 1967. Growth of marine bacteria at limiting concentrations of organic carbon in seawater. Limnol. Oceanogr. 12:264.

1968. Competitive elimination of Enterobacteriaceae from seawater. Appl. Microbiol. 16:1616.

1979. The ultimate sink. A.W. Bourquin and P.H. Pritchard, eds. Workshop: Microbial degradation of pollutants in marine environments. April 1979.

Jannasch, H.W. and R.L. Mateles. 1974. Experimental bacterial ecology studied in continuous culture. Adv. Microb. Physiol. 11:165-212.

Jannasch, H.W. and C.O. Wirsen. 1973. Deep-sea micro-organisms: In situ response to nutrient enrichment. Science. 180:641-643.

Jannasch, H.W. and C.O. Wirsen. 1977. Microbial life in the deep sea. Sci. Amer. 236:42-52.

Jeffries, H.P. and W.C. Johnson. 1973. Zooplankton. Pages 4-1 to 4-93 in S.B. Saila, ed. Coastal and offshore environmental inventory, Cape Hatteras to Nantucket Shoals. Mar. Publ. Ser. No. 2. Univ. of Rhode Island. 682 pp.

Johnson, P. and D. Lear. 1974. Metals in zooplankton. Pages 24-25 in D.W. Lear, S.K. Smith, and M. O'Malley, eds. Environmental survey to two interim dumpsites - Middle Atlantic Bight. EPA 903/9-74-010A. 141 pp.

Jones, C. and R.H. Haedrich. 1977. Epibenthic invertebrates. Pages 451-458 in NOAA. Baseline report of environmental conditions in Deepwater Dumpsite 106. Volume II: Biological characteristics. NOAA Dumpsite Evaluation Report 77-1. Rockville, MD. 485 pp.

Jones, G.E. 1964. Effect of chelating agents on the growth of Escherichia coli in seawater. J. Bact. 87:483.

1967. Growth of Escherichia coli in heat- and copper-treated synthetic sea water. Limnol. Oceanogr. 12:167.

1971. The fate of freshwater bacteria in the sea. Devs. ind. Microbiol. 12:141-151.

Jones, G.E. and A.B. Cobet. 1974. Heavy metal ions as the principal bactericidal agent in Caribbean sea water. A.L.H. Gameson, ed. Discharge of sewage from sea outfalls. Pergamon Press, Oxford, England.

Jorling, T.C. 1978. Decision on proposals to relocate sewage sludge dumping in the Mid-Atlantic Bight. U.S. EPA, Office of Water and Hazardous Materials. March 1, 1978.

Kamlet, K. 1977. Statement of Kenneth Kamlet for National Wildlife Federation at Toms River Public Hearing, May 31 - June 1, 1977. Toms River, New Jersey.

Kane, J.F. 1977. Statement before the ocean dumping permit hearing at 26 Federal Plaza, New York, New York. October 19, 1977.

Kapp, Raymond. 1974. Testimony on behalf of Dr. Michael Champ of American University and the Marine Science Consortium to the EPA Hearing, Oct. 15, 1974.

Keller, G.H., D. Lambert, G. Rowe, and N. Staresinic. 1973. Bottom currents in the Hudson Canyon. Science. 180:181-183.

Kester, D.R. and R. Courant. 1973. A summary of chemical oceanographic conditions: Cape Hatteras to Nantucket Shoals. Pages 2-1 to 2-36 in S.B. Saila, ed. Coastal and offshore environmental inventory, Cape Hatteras to Nantucket Shoals. Mar. Publ. Series No. 2. Univ. Rhode Island. 682 pp.

Kester, D.R., K.A. Hausknecht, and R.C. Hittinger. 1977. Recent analysis of copper, cadmium, and lead at Deepwater Dumpsite 106. Pages 543-546 in NOAA. Baseline report of environmental conditions in Deepwater Dumpsite 106. Volume III: Contaminant inputs and chemical characteristics. NOAA Dumpsite Evaluation Report 77-1. Rockville, MD. 798 pp.

Kester, D.R., R.C. Hittinger, and R. Mukherji. 1978. Effect of acid-iron waste disposal on transition and heavy metals at Deep Water Dumpsite 106. Presented at International Dumping Symposium, October 9-13, 1978. University of Rhode Island. Unpublished draft. 34 pp.

Ketchum, B.H. and W.L. Ford. 1948. Waste disposal at sea. Preliminary Report on acid-iron waste disposal. Submitted to National Research Council.

1952. Rate of dispersion in the water of a barge at sea. Trans. Amer. Geophys. Union. 33:680-684.

Ketchum, B.H., J.H. Ryther, C.S. Yentsch, and N. Corwin. 1958a. Productivity in relation to nutrients. Rapp. Proc. Verb. Cons. Int. Explor. Mer. 144:132-140.

Ketchum, B.H., C.S. Yentsch, and N. Corwin. 1958b. Some studies of the disposal of iron wastes at sea. Woods Hole Ocean. Inst. Ref. No. 58-57 Woods Hole, MA. Unpublished manuscript submitted to the National Lead Company. 17 pp.

Ketchum, B.H., C.S. Yentsch, N. Corwin, and D.M. Owen. 1958c. Some studies of the disposal of iron wastes at sea: summer, 1958. Woods Hole Ocean. Inst. Ref. No. 58-55. Woods Hole, MA. Unpublished manuscript. 59 pp.

Klein, L.A., M. Lang, N. Nash, and S.L. Dirschner. 1974. Sources of metals in New York City wastewater. Dept. Water Resources, City of New York. New York Water Poll. Control Assn.

Kohn, B. and G.T. Rowe. 1976. Dispersion of two liquid industrial wastes dumped at Deepwater Dumpsite 106, off the coast of New Jersey, U.S.A. Final report, DWD 106 Large-scale dumping study, 1976. Submitted to Ocean Dumping Prgm., NOAA, Rockville MD. 35 pp.

Kopp, J.F. 1969. The occurrence of trace elements in water. Page 59 in D.D. Hemphill, ed. Proceedings of the third annual conference on trace substances in environmental health. University of Missouri, Columbia.

Krueger, W.H., R.H. Gibbs, Jr., R.C. Kleckner, A.A. Keller, and M.J. Keene. 1977. Distribution and abundance of mesopelagic fishes on cruises 2 and 3 at Deepwater Dumpsite 106. Pages 377-422 in NOAA. Baseline report of environmental conditions in Deepwater Dumpsite 106. Volume 2: Biological characteristics. NOAA Dumpsite Evaluation Report 77-1. Rockville, MD. 485 pp.

Krueger, W.H., M.J. Keene, and A.A. Keller. 1975. Systematic analysis of midwater fishes obtained at Deepwater Dumpsite 106. Pages 359-388 in NOAA. May 1974 baseline investigation of Deepwater Dumpsite 106. NOAA Dumpsite Evaluation Report 75-1. Rockville, MD. 388 pp.

Larsen, P.F. and S. Chenoweth. 1976. Benthos. Section 7.3 in BLM. Summary of environmental information on the Continental Slope - Canadian/United States Border to Cape Hatteras, NC. The Research Institute of the Gulf of Maine, Portland, ME. (Also NTIS. PB-284 002).

Lawson, T.J. 1976. Pollution at Deepwater Dumpsite 106. Report on laboratory studies of the effects of Du Pont waste on plankton. Woods Hole Oceanographic Institution. Unpublished manuscript.

Lear, D.W., ed. 1974. Supplemental report. Environmental survey of two interim dumpsites - Middle Atlantic Bight. Operation FETCH Cruise Report, 5-10 November 1973. 105 pp.

1976. Testimony for EPA Region III at Public Hearing, Ocean Dumping Permit, E.I. du Pont de Nemours and Co., Inc. Georgetown, DE. October 13, 1976.

Lear, D.W., S.K. Smith, and M. O'Malley, eds. 1974. Environmental survey of two interim dumpsites - Middle Atlantic Bight. Operation FETCH Cruise Report, 5-10 November 1973. EPA-903/9-74-010a. 141 pp.

Lear, D.W., M.L. O'Malley, and S.K. Smith, eds. 1977. Effects of ocean dumping activity - mid-Atlantic Bight. Interim Report EPA 903/9-77-029 168 pp.

Lear, D.W. and G.G. Pesch, eds. 1975. Effects of ocean disposal activities on mid-Continental Shelf environment off Delaware and Maryland. EPA 903/9-75-015. 203 pp.

Leavitt, B.B. 1935. A quantitative study of the vertical distribution of the larger zooplankton in deep water. Biol. Bull. 68:115-130.

1938. The quantitative vertical distribution of macrozooplankton in the Atlantic Ocean Basin. Biol. Bull. 74:376-394.

Liu, O.C., H.R. Seraichekas, E.W. Akin, D.A. Brashear, E.L. Katz, and W.F. Hill, Jr. 1971. Relative resistance of twenty human enteric viruses to free chlorine in Potomac waters. Proc. 13th Wat. Qual. Conf., University of Illinois, Urbana p. 171.

Liu, O.C., H.R. Seraichekas, and B.L. Murphy. 1966. Fate of poliovirus in northern quahogs. Proc. Soc. Exp. Biol. Med. 121:601-607.

Longwell, A.C. 1976. Chromosome mutagenesis in developing mackerel eggs sampled from the New York Bight. NOAA TM ERL MESA-7. Boulder, Colorado. 61 pp.

Longwell, A.C. 1977. Report on work under contract for July 20-29, 1977 cruise to DWD 106. Milford Lab, Milford, Conn. Unpublished manuscript. 20 pp.

MacDonald, A.G. 1975. Physiological aspects of deep sea biology. Cambridge University Press, London. 450 pp.

MacLeod, R.A. 1968. On the role of inorganic ions in the physiology of marine bacteria. Pages 95-126 in M.R. Droop and E.J.F. Wood, eds. Advances in Microbiology of the Sea. Academic Press, New York.

Malone, T.C. 1977. Plankton systematics and distribution. MESA New York Bight Atlas Monograph 13. New York Sea Grant Institute. Albany, New York. 45 pp.

Marcus, S.J. 1973. Environmental conditions within specified geographical regions offshore east and west coasts of the U.S. and in the Gulf of Mexico. Final report. U.S. Department of Commerce. 735 pp.

Markle, D. and J.A. Musick. 1974. Benthic slope fishes found at 900 m depth along a transect in the western North Atlantic Ocean. Mar. Biol. 26:225-233.

Martineau, D.P. 1977. Letter from D.P. Martineau, Deputy Associate Administrator for Marine Resources, NOAA, to Dr. A.W. Breidenbach, Hearing Officer, Toms River Hearing. Office of Water and Hazardous Materials, U.S. EPA, Washington, D.C.

Mayzaud, P. and J. Martin. 1975. Some aspects of the biochemical and mineral composition of marine plankton. J. Exp. Mar. Biol. Ecol. 17:297-310.

McHugh, J.L. 1978. Historic fish and shellfish landings and trends. Pages 4-79 in J.L. McHugh and J.J.C. Ginter. Fisheries. New York Bight Atlas Monograph 16. New York Sea Grant Institute. Albany, New York. 129 pp.

McIntyre, A.D. 1969. Ecology of marine meiobenthos. Biol. Res. 44:245-290.

McLaughlin, D., J.A. Elder, G.T. Orlob, D.F. Kibler, and D.E. Evenson. 1975. A conceptual representation of the New York Bight ecosystem. NOAA Technical Memorandum ERL MESA-4.

Mero, J.L. 1964. Mineral resources of the sea. American Elsevier Publishing Co., New York.

Metcalf, T.G. 1974. Evaluation of shellfish sanitary quality by indicators of sewage pollution. Pages 75-84 in A.L.H. Gameson, ed. Discharge of sewage from sea outfalls. Pergamon Press., Oxford England.

Milliman, J.D. 1973. Marine geology. In S.B. Saila, ed. Coastal and offshore environmental inventory - Cape Hatteras to Nantucket Shoals. Complement volume. Marine Pub. Ser. No. 3, Univ. Rhode Island, Kingston, R.I. 02881.

Milliman, J.D., O.H. Pilkey, and D.A. Ross. 1972. Sediments of the Continental Margin off the eastern United States. Geol. Soc. of Amer. Bull. 83:1315-1334.

Mitchell, J.R. 1971. Role of predators in the reversal of imbalances in microbial ecosystems. Nature 230:257.

Mitchell, J.R., M.W. Presnell, E.W. Akin, J.M. Cummins, and O.C. Liu. 1966. Accumulation and elimination of poliovirus by the Eastern oyster. Am. J. Epidimiol. 84:40-50.

Mitchell, R. 1972. Ecological control of microbial imbalances. Page 273 in R. Mitchell, ed. Water pollution microbiology. John Wiley, New York.

Mitchell, R., S. Yankofsky, and H.W. Jannasch. 1967. Lysis of Escherichia coli by marine microorganisms. Nature. 215:213.

Mitchell, R. and C. Chamberlin. 1978. Survival of indicator organisms. Pages 51-97 in G. Berg. ed. Indicators of viruses in water and food. Ann Arbor Science Publ. Ann Arbor, Michigan.

Moebus, K. 1972a. Bactericidal properties of natural and synthetic sea water as influenced by addition of low amounts of organic matter. Mar. Biol. 15:81.

1972b. Studies on the influence of plankton on antibacterial act vity of sea water. Helgolaender wiss. Meeresunters. 23:127.

Mueller, J.A., J.S. Jeris, A.R. Anderson, and C.F. Hughes. 1976. Contaminant inputs to the New York Bight. Marine Ecosystems Analysis Program Office NOAA Technical Memo ERL-MESA 6. Boulder, Colorado. 347 pp.

Mullen. 1977. Testimony at Toms River public hearing to investigate the desirability of relocating ocean dumping sites for the disposal of municipal sewage sludge. May 31, 1977, Toms River, Del.

Murphy, L.S., P. Hoar, and R.A. Belastock. 1979. The effect of industrial wastes on marine phytoplankton at Deepwater Dumpsite 106. Prepared for the National Oceanic and Atmospheric Administration. 21 pp.

Musick, J.A., C.A. Wenner, and G.R. Sedberry. 1975. Archibenthic and abyssobenthic fishes of Deepwater Dumpsite 106 and the adjacent area. Pages 229-269 in NOAA. May 1974 baseline investigation of Deepwater Dumpsite 106. NOAA Dumpsite Evaluation Report 75-1. Rockville, MD. 388 pp.

NL Industries, Inc. 1977. Summary of studies made relating to NL ocean disposal site. Prepared in support of Ocean Disposal Permit No. NJ014. Unpublished manuscript.

NOAA. 1975. Baseline investigation of Deepwater Dumpsite 106. NOAA Dumpsite Evaluation Report 75-1. May 1974. 388 pp.

NOAA. 1977. Baseline report of environmental conditions in Deepwater Dumpsite 106. Vol. I. NOAA Dumpsite Evaluation Report 77-1. 218 pp.

NOAA. 1978. Report to the Congress on ocean dumping research. January through December 1977. Washington D.C. 25 pp.

NOAA-MESA. 1975. Annual summary of research results for fiscal year 1974, MESA New York Bight Project. NOAA TM ERL MESA-2. Boulder, Colorado. 193 pp.

NOAA-MESA, 1976. Evaluation of proposed sewage sludge dumpsite areas in the New York Bight: NOAA Technical Memorandum ERL MESA-11, Marine Ecosystem Analysis Program Office. Boulder, Colorado.

NOAA-MESA. 1977. New York Bight Project annual report for fiscal year 1976-1976T. NOAA Tech. Memo ERL MESA-25. Boulder, Colorado. 91 pp.

NOAA-MESA. 1978. MESA New York Bight Project annual report for fiscal year 1977. Boulder, Colorado. 133 pp.

NOAA-NMFS. 1972. The effects of waste disposal in the New York Bight - final report. Volumes 1-9. NOAA/NMFS/MACFC/Sandy Hook Lab. Highlands, NJ.

NOAA-NMFS. 1974. Surf clam survey. Cruise report - NOAA ship Delaware II. 13-28 June 1974 and 5-10 August 1974. Mid-Atlantic Coast. Fish. Cen. Oxford Md.

NOAA-NMFS. 1975. Sea scallop survey. Cruise report - NOAA ship Albatross IV. August 7-16, 1975 and September 27-October 3, 1975: Mid Atlantic Coast. Fish. Cen. Sandy Hook Lab. Highlands N.J.

NOAA-NMFS. 1977a. Fishery statistics of the United States - 1974. Statistical Digest No. 84. Prepared by J.P. Wise, and B.G. Thompson. NOAA - S/T 77-3026. Washington D.C. 424 pp.

NOAA-NMFS. 1977b. New York landings. Annual summary, 1976. Current Fisheries Statistics No. 7212.

NOAA-NMFS. 1977c. New Jersey landings. Annual summary 1976. Current Fisheries Statistics No. 7213.

NOAA-Pathobiology Division. 1978. February 1978 Interim Report - DWD 106 - July 20-29, 1977. Cruise report. Washington D.C. Unpublished manuscript. 8 pp.

National Academy of Science (NAS). 1976. Disposal in the marine environment: An oceanographic assessment. Prepared for the U.S. Environmental Protection Agency. 76 pp.

National Academy of Science, National Academy of Engineering. 1974. Water quality criteria, 1972. U.S. Government Printing Office, Washington, D.C.

New York Ocean Science Laboratory (NYOSL). 1973. The oceanography of the New York Bight - physical, chemical, biological. Technical Report No. 00017.

Oceanographer of the Navy. 1972. Environmental condition report for numbered deep water munitions dump sites. Pages 10-13 in Appendix C. Dept. of the Navy.

Orlob, G.T. 1956. Viability of sewage bacteria in sea water. Sewage Ind. Wastes 28:1147.

Orr, M.H. 1977a. Acoustic detection of the particulate phase of industrial chemical waste released at DWD 106. Prepared for NOAA under Contract 8501-6336-35181.

1977b. Qualitative dispersion characteristics of sewage sludge released at DWD 106 in the presence of a shallow seasonal thermocline. Ocean Engineering Dept., Woods Hole Oceanographic Inst., Woods Hole, Mass. 2 pp. Unpublished.

Pacheco, A.L. 1974. Ichthyoplankton, finfish, and shellfish surveys. Pages 291-296 in BLM. Marine environmental implications of offshore oil and gas development in the Baltimore Canyon region of the mid-Atlantic Coast. Proceedings of Estuarine Research Federation Outer Continental Shelf Conference and Workshop. 504 pp.

Pearce, J., L. Rogers, J. Caracciolo, and M. Halsey. 1977b. Distribution and abundance of benthic organisms in the New York Bight Apex, five seasonal cruises, August 1973 - September 1974. NOAA DR ERL MESA-32. Boulder, Colorado.

Pearce, J.B. 1974. Benthic assemblages in the deeper Continental Shelf waters of the Middle Atlantic Bight. Pages 297-318 in BLM. Marine environmental implications of offshore oil and gas development in the Baltimore Canyon region of the mid-Atlantic coast. Proceedings of Estuarine Research Federation Outer Continental Shelf Conference and Workshop. 504 pp.

Pearce, J.B., J. Thomas, J. Caracciolo, M. Halsey, and L. Rogers. 1976a. Distribution and abundance of benthic organisms in the New York Bight Apex, 26 August-6 September 1973. NOAA DR ERL MESA-9. Boulder, Colorado. 88 pp.

1976b. Distribution and abundance of benthic organisms in the New York Bight Apex, 2-6 August 1973. NOAA DR ERL MESA-8. Boulder, Colorado. 131 pp.

Pearce, J.B., J.V. Caracciolo, and F.W. Steimle, Jr. 1977a. Final report on benthic infauna of Deepwater Dumpsite 106 and adjacent areas. Pages 465-480 in NOAA. Baseline report of environmental conditions in Deepwater Dumpsite 106. Volume II: Biological characteristics. NOAA Dumpsite Evaluation Report 77-1. Rockville, MD. 485 pp.

Pearce, J.B., J. Thomas, and R. Greig. 1975. Preliminary investigation of benthic resources at Deepwater Dumpsite 106. Pages 217-228 in NOAA. May 1974 baseline investigation of Deepwater Dumpsite 106. NOAA Dumpsite Evaluation Report 75-1. 388 pp.

Pequegnat, W.E. and D.D. Smith. 1977. Potential impacts of deep ocean disposal of dredged material. Pages 43-68 in Second International Symposium on Dredging Technology, 2-4 November, 1977, Texas A&M University. BHRA Fluid Engineering, Cranford, Bedford, England.

Pesch, G., B. Reynolds, and P. Rogerson. 1977. Trace metals in scallops from within and around two ocean disposal sites. Mar. Poll. Bull. 8:224-228.

Peschiera, L. and F.H. Freiberr. 1968. Disposal of titanium pigment process wastes. J. Wat. Poll. Cont. Fed. 40:127-131.

Peterson, H. 1975. Micronutrient analysis of seawater samples taken at DWD-106 May 1974. Pages 189-201 in NOAA. May 1974 baseline investigation of Deepwater Dumpsite 106. NOAA Dumpsite Evaluation Report 75-1. 388 pp.

Pratt, S.D. 1973. Benthic fauna. Pages 5-1 to 5-70 in S.B. Saila, ed. Coastal and offshore environmental inventory - Cape Hatteras to Nantucket Shoals. Marine Publication Series No. 2. Occasional Publication No. 5, University of Rhode Island, Providence, RI. 693 pp.

Public Health Service Sanitary Engineering Center (PHSSEC). 1960. Acid waste disposal in the New York Bight: A summary of information on waste disposal in the New York Bight with recommendations of the Technical Advisory Committee. Cincinnati, Ohio. 31 pp.

Raytheon. 1975a. Cruise 1 data report, baseline survey - New York Bight. Volumes 1-5.

1975b. Cruise 2 data report, baseline survey - New York Bight. Volumes 1-6.

1976. Environmental survey of a proposed alternate dumpsite in the Outer New York Bight. Submitted to the U.S. EPA by Raytheon Co.

Redfield, A.C. and L.A. Walford. 1951. A study of the disposal of chemical waste at sea. Report of the Committee for Investigation of Waste Disposal. National Academy of Sciences, National Research Council, Washington, D.C.

Reid, J.B. 1978. Letter to EPA Region II dated May 31, 1978 concerning Ocean Disposal Permit II-NJ-001.

Reynolds, B.H. 1979. Trace metals monitoring at two ocean disposal sites. Environmental Research Laboratory, U.S. Environmental Protection Agency, Narragansett, R.I. EPA-600/3-79-037. 64 pp.

Reynolds, N. 1965. The effect of light on the mortality of E. coli in seawater. Pages 241-249 in Pollutions Marines par les micro-organismes et les Produits Petroliers Symp. de Monaco.

Riley, G.A. 1939. Plankton studies. II. The western North Atlantic, May-June 1939. J. Mar. Res. 2(2):145-162.

Riley, G.A. and S. Gorgy. 1948. Quantitative studies of summer plankton populations of the western North Atlantic. J. Mar. Res. 7(2):100-121.

Riley, G.A., H. Stommel, and D.F. Bumpus. 1949. Quantitative ecology of the plankton of the western North Atlantic. Bull. Bingham Oceanogr. Collect. 12(3):1-169.

Rittenberg S.C., T. Mittwer and D. Ivler. 1958. Coliform bacteria in sediments around three marine sewage outfalls. Limnol. Oceanogr. 3:101.

Robertson, E.E., et al. 1972. Battelle Northwest contribution to the IDOE baseline study. Page 231. 1972. IDOE Workshop.

Rodman, H.G. 1977. Report on estimated costs and other factors involved in barging to Site 106 instead of to 12-Mile Site. NL Industries, Inc. Highlands, N.J. 8 pp. (Includes deleted table containing company proprietary information.)

Rose, C.D., W.G. Williams, T.A. Hollister, and P.R. Parrish. 1977. Method for determining acute toxicity of an acid waste and limiting permissible concentration at boundaries of an oceanic mixing zone. Environ. Sci. Technol. 11:367-371.

Rowe, G.T., R.L. Haedrich, P.T. Polloni, and C.H. Clifford. 1977. Epifaunal megabenthos in DWD 106. Pages 459-464 in NOAA. Baseline report of environmental conditions in Deepwater Dumpsite 106. Volume II: Biological characteristics. NOAA Dumpsite Evaluation Report 77-1. Rockville, MD. 485 pp.

Rowe, G.T. and R.J. Menzies. 1969. Zonation of large benthic invertebrates in the deep sea off the Carolinas. Deep-Sea Res. 16:531-537.

Ryther, J.H. and C.S. Yentsch. 1958. Primary production of Continental Shelf waters off New York. Limnol. Oceanogr. 3:227-235.

St. John, P.A. 1958. A volumetric study of zooplankton distribution in Cape Hatteras area. Limnol. Oceanogr. 3:387-397.

Sanders, H.R. and R.R. Hessler. 1969. Ecology of the deep-sea benthos. Science. 163:1419-1424.

Sanko, P. 1975. Sand mining in New York Harbor. Pages 23-26 in J. Schlee. Sand and gravel. New York Bight Atlas Monograph 21. New York Sea Grant Institute. Albany, New York. 26 pp.

Saunders, P.M. 1971. Anticyclonic eddies formed from shoreward meanders of the Gulf Stream. Deep-Sea Res. 18:1207-1219.

Schlee, J. 1975. Sand and gravel. MESA New York Bight Atlas Monograph 21. New York Sea Grant Institute. Albany, New York.

Schroeder, W.C. 1955. Report on the results of exploratory otter-trawling along the Continental Shelf and Slope between Nova Scotia and Virginia during the summers of 1952 and 1953. Pap. Mar. Biol. Oceanogr., Deep-Sea Res. 3(Suppl. 10):358-372.

Sears, M. and G.L. Clarke. 1940. Annual fluctuations in the abundance of marine zooplankton. Biol. Bull. 79:321-328.

Segar, D.A., G.A. Berberian, and P.G. Hatcher. 1975. Oxygen depletion in the New York Bight Apex, causes and consequences. Page 61 in Abstracts from the Special Symposium on the Middle Atlantic Continental Shelf and New York Bight, November 3-5. Amer. Soc. of Limnology and Oceanography.

Segar, D.A. and A.Y. Cantillo. 1976. Trace metals in the New York Bight. Pages 171-198 in M.G. Gross, ed. Middle Atlantic Continental Shelf and the New York Bight. Amer. Soc. Limnol. Oceanogr. Spec. Symp. Vol. 2. 441 pp.

Shenton, E.H. 1976. Geological Oceanography. Chapters 1-6 in TRIGOM. Summary of environmental information on the Continental Slope - Canadian/United States Border to Cape Hatteras, N.C. The Research Institute of The Gulf of Maine.

Sherman, K., D. Busch, and D. Bearse. 1977. Deepwater Dumpsite 106: zooplankton studies. Pages 233-303 in NOAA. Baseline report of environmental conditions in Deepwater Dumpsite 106. Volume II: Biological characteristics. NOAA Dumpsite Evaluation Report 77-1. Rockville, MD. 485 pp.

Sieburth, J.McN. 1968. The influence of algal antibiosis on the ecology of marine microorganisms. Adv. Microbiol. 1:63.

Smayda, T.J. 1973. A survey of phytoplankton dynamics in the coastal waters from Cape Hatteras to Nantucket. Pages 3-1 to 3-100 in S.B. Saila, ed. Coastal and offshore environmental inventory: Cape Hatteras to Nantucket Shoals. Univ. of R.I., Kingston, RI.

Smith, S.K. 1973. Phytoplankton. Pages 47-54 in Palmer, H.D. and D.W. Lear, eds. Environmental survey of an interim dumpsite - Middle Atlantic Bight. EPA Region III. 903/9-73-001-A. 134 pp.

1974. Phytoplankton. Pages 21-23 in Lear, D., S.K. Smith, and M. O'Malley, eds. Environmental survey of two interim dumpsites - Middle Atlantic Bight. EPA Region III. 903/9-74-010-A. 141 pp.

Smith, C.L., W.G. MacIntyre, and R.H. Bieri. 1977. Hydrocarbons. Pages 9-1 to 9-170 in M.P. Lynch and B.L. Laird, eds. Middle Atlantic Outer Continental Shelf environmental studies. Vol. II-B: Chemical and biological benchmark studies. Virginia Institute of Marine Science. Contract No. 08550-CT-5-42.

Smith, D.D. and R.P. Brown. 1971. Ocean disposal of barge-delivered liquid and solid wastes from U.S. coastal cities. Prepared for the Environmental Protection Agency by the Dillingham Corp., La Jolla, Ca. Contract No. PH86-68-203. 119 pp.

Steele, J.H., and C.S. Yentsch. 1960. The vertical distribution of chlorophyll. J. Marine Biol. Assoc. United Kingdom 39:217-26.

Stoker, H.S. and S.L. Segar. 1976. Environmental chemistry: air and water pollution. Second edition. Scott, Foresman and Company, Glenview, Ill. 232 pp.

Stommel, Henry. 1960. The Gulf Stream, a physical and dynamical description. Univ. of Cal. Press, Berkeley and Los Angeles. 202 pp.

Subcommittee on the Toxicology of Metals. 1976. Lars Friberg, Chairman. Toxicology of Metals. Vol. 1. Report No. EPA-600/1-76/018. 269 pp.

Swanson, R.L. 1977. Status of ocean dumping research in the New York Bight. J. of Waterway, Port, Coastal, and Ocean Division. 12722:9-24.

The Research Institute of the Gulf of Maine (TRIGOM). 1976. Summary of environmental information on the Continental Slope - Canadian/United States border to Cape Hatteras, N.C. Prepared for Bureau of Land Management. (NTIS No. PB 284 001-004).

U.S. Coast Guard. 1976. Commandant instruction 16470.ZB, dated September 29, 1976.

U.S. Environmental Protection Agency March 25, 1975. Memorandum from F.T. Brezenski, Chief, Technical Support Branch, Surveillance and Analysis Division, U.S. EPA Region II, Edison, NJ.

1976. Quality criteria for water. U.S. Government Printing Office, Washington, D.C.

1977a. New York Bight Water Quality, Summer of 1977. U.S. EPA Region II.

1977b. Ocean dumping: Final revision of regulations and criteria. Federal Register, Vol. 42, No. 7. January 11, 1977.

1977c. Public hearing transcript, Ocean County College, Toms River, New Jersey, May 31, 1977.

1978. Final environmental impact statement on the ocean dumping of sewage sludge in the New York Bight. U.S. EPA, Region II, New York, New York. 226 pp. plus 11 appendices.

Vaccaro, R.F. and M.R. Dennett. 1977. The environmental response of marine bacteria to waste disposal activities at Deepwater Dumpsite 106. Prepared for NOAA under Grant Number 04-7-158-44055. 15 pp.

1978. The environmental response of marine bacteria to waste disposal activities at Deepwater Dump Site 106. Woods Hole Oceanog. Inst. Interim Rep. NOAA Grant 04-8-M01-42. Unpublished Manuscript. 25 pp.

Vaccaro, R. F., G.D. Grice, G.T. Rowe, and P.H. Wiebe. 1972. Acid-iron waste disposal and the summer distribution of standing crops in the New York Bight. Water Res. 6:231-256.

Verber, J.L. 1976. Safe shellfish from the sea. Pages 433-441 in M.G. Gross, ed. Middle Atlantic Continental Shelf and the New York Bight. Amer. Soc. Limnol. Oceanog. Spec. Symp. Vol 2. 441 pp.

Voorhis, A.D., D.C. Webb, and R.C. Millard. 1976. Current structure and mixing in the Shelf/Slope Water front south of New England. Jour. Geophys. Res. 81(21):3695-3708.

Wagner, E.O. 1977. Letter addressed to EPA Region II, dated December 1, 1977.

Warsh, C.E. 1975a. Physical Oceanographic Observations at Deepwater Dumpsite 106 - May 1974. Pages 141-187 in NOAA. May 1974 baseline investigation of Deepwater Dumpsite 106. NOAA Dumpsite Evaluation Report 75-1. Rockville, MD. 388 pp.

1975b. Physical oceanography historical data for Deepwater Dumpsite 106. Pages 105-140 in NOAA. May 1974 baseline investigation of Deepwater Dumpsite 106. NOAA Dumpsite Evaluation Report 75-1. Rockville, MD. 388 pp.

Waterman, T.H., R.F. Nunnemacher, F.A. Chace, and G.L. Clarke. 1939. Diurnal vertical migrations of deep water plankton. Biol. Bull. 76(2):256-279.

Webster, F. 1969. Vertical profiles of horizontal ocean currents. Deep-Sea Res. 16:85-98.

Westman, J.R. 1958. A study of the newly created "acid grounds" and certain other fishery areas of the New York Bight. Unpublished manuscript. 50 pp.

1967. Some benthic studies of the acid grounds, July 26, 1967. Unpublished manuscript. 6 pp.

1969. Benthic studies of the acid grounds, October 9 1969. Unpublished manuscript. 8 pp.

Westman, J.R., J.G. Hoff, and R. Gatty. 1961. Fishery conditions in the New York Bight during the summer of 1961. Unpublished manuscript. 10 pp.

Wiebe, P.H., G.D. Grice, and E. Hoagland. 1973. Acid-iron waste as a factor affecting the distribution and abundance of zooplankton in the New York Bight, II. Spatial variations in the field and implications for monitoring studies. Estuar. Coast. Mar. Sci. 1:51-64.

Wigley, R.L. and A.D. McIntyre. 1964. Some quantitative comparisons of offshore meiobenthos and macrobenthos south of Martha's Vineyard. Limnol. Oceanogr. 9:485-93.

Wigley, R.L., R.B. Theroux, and H.E. Murray. 1975. Deep sea red crabs, Geryon quinquedens, survey off Northeastern United States. Mar. Fish. Rev. 37:1-21.

Windom, H., F. Taylor, and R. Stickney. 1973a. Mercury in North Atlantic plankton. J. Cons. Int. Explor. Mer. 35(1):18-21.

Windom, H., R. Stickney, R. Smith, D. White, and F. Taylor. 1973b. Arsenic, cadmium, copper, mercury, and zinc in some species of North Atlantic finfish. J. Fish. Res. Bd. Can. 4(13): 60.

Wirsen, C.O. and H.W. Jannasch. 1976. The decomposition of solid organic materials in the deep sea. Env. Sci. Technol. 10:880-887.

Won, W.A. and H. Ross. 1973. Persistence of virus and bacteria in seawater. J. San Eng. Div. ASCE 99:205.

Wright, W.R. 1976a. Physical oceanography. Chapter 4 in TRIGOM. A summary of environmental information on the Continental Slope - Canadian/U.S. Border to Cape Hatteras, N.C. The Research Institute of The Gulf of Maine.

1976b. The limits of Shelf Water south of Cape Cod, 1941 to 1972. Jour. Mar. Res. 34(1):1-4.

Yentsch, C.S. 1963. Primary production. Oceanogr. Mar. Biol. Ann. Rev. 1:157-175.

1977. Plankton production. MESA New York Bight Atlas Monograph 12. New York Sea Grant Institute. Albany, New York. 25 pp.

APPENDICES

APPENDIX A

ENVIRONMENTAL CHARACTERISTICS OF THE 106-MILE OCEAN WASTE DISPOSAL SITE

CONTENTS

Title	Page
METEOROLOGY	A-1
Air Temperature	A-1
Wind and Storms	A-2
PHYSICAL CHARACTERISTICS	A-4
Water Masses	A-4
Current Regimes	A-11
Waves	A-13
Temperature Structure	A-15
Salinity Structure	A-19
GEOLOGICAL CHARACTERISTICS	A-24
CHEMICAL CHARACTERISTICS	A-26
Water Column Chemistry	A-26
Sediment Chemistry	A-37
Biological Chemistry	A-39
BIOLOGICAL CHARACTERISTICS	A-42
Phytoplankton	A-42
Zooplankton	A-49
Nekton	A-58
Benthos	A-67

CONTENTS (continued)

ILLUSTRATIONS

Title	Page
A-1 Temperature-Salinity Lines of Water Masses and Boundaries between Surface Water Categories in the Area of the 106-Mile Site	A-6
A-2 NOAA National Environmental Satellite Service Observations of Shelf, Slope, and Gulf Stream Waters Surrounding the 106-Mile Site in May 1974	A-9
A-3 Stylized Section from the Continental Shelf through the Dumpsite Eddy, Showing Surface Water Categories and Deeper Water Masses	A-10
A-4 Marsden Square 116, Subsquares 81, 82, and 91, and the 106-Mile Site	A-16
A-5 Average Monthly Sea-Surface Temperatures for Subsquares 81, 82, and 91 in Marsden Square 116	A-17
A-6 Monthly Averages for Temperature versus Depth Marsden Square 116, Subsquare 81	A-18
A-7 Monthly Averages for Temperature versus Depth Marsden Square 116, Subsquare 82	A-18
A-8 Monthly Averages for Temperature versus Depth Marsden Square 116, Subsquare 91	A-19
A-9 Average Monthly Sea-Surface Salinities for Subsquares 81, 82, and 91 in Marsden Square 116	A-20
A-10 Monthly Averages for Salinity versus Depth Marsden Square 116, Subsquare 81	A-21
A-11 Monthly Averages for Salinity versus Depth Marsden Square 116, Subsquare 82	A-22
A-12 Monthly Averages for Salinity versus Depth Marsden Square 116, Subsquare 91	A-23
A-13 Bathymetry in the Vicinity of the 106-Mile Site	A-25
A-14 Monthly Averages of Oxygen Concentration versus Depth at the 106-Mile Site	A-28
A-15 Station Locations of Major Phytoplankton Studies in the Northeastern Atlantic	A-44
A-16 Vertical Distribution of Chlorophyll *a*	A-46
A-17 Summary of the Average Chlorophyll *a* Concentrations at Inshore (less than 50 m) and Offshore (greater than 1,000 m depth) in the Mid-Atlantic Bight	A-46
A-18 Summary of Mean Daily Primary Production per Square Meter of Sea Surface at Inshore (less than 50 m), Intermediate (100 to 200 m), and Offshore (greater than 1,000 m) Sites in the Mid-Atlantic Bight	A-47
A-19 Station Locations of Major Zooplankton Studies in the Northeastern Atlantic	A-53

CONTENTS (continued)

TABLES

Number	Title	Page
A-1	Air Temperature and Wind Data for the 106-Mile Ocean Waste Disposal Site	A-3
A-2	Return Period of Maximum Sustained Winds at the 106-Mile Ocean Waste Site	A-4
A-3	Monthly Wave Height Frequency for the 106-Mile Site	A-14
A-4	Return Periods for High Waves at the 106-Mile Site	A-14
A-5	Average Surface Temperature Ranges and Months of Minimum and Maximum Temperatures for Subsquares 81, 82, and 91 in Marsden Square 116	A-16
A-6	Average Temperature Ranges Between 100 and 500 M for Subsquares 81, 82, and 91 in Marsden Square 116	A-17
A-7	Average Surface Salinity Ranges and Month of Minimum and Maximum Salinity for Subsquares 81, 82, and 91 in Marsden Square 116	A-20
A-8	Average Concentrations of Five Trace Metals in Waters of the Northeast Atlantic Ocean	A-32
A-9	Average Concentrations of Nutrients at Various Depths in the 106-Mile Site	A-35
A-10	Average Concentrations of Six Trace Metals in the Top 4 Centimeters of Sediments	A-38
A-11	Dominant Zooplankton Species in the Vicinity of the 106-Mile Site (Number of Samples in Which the Species Comprised 50% or More of the Individuals of that Group/Number of Stations Sampled)	A-50
A-12	Dominant Neuston Species in the Vicinity of the 106-Mile Site (Number of Samples in Which the Species Comprised 50% or More of the Individuals of that Group/Number of Stations Sampled)	A-52
A-13	Zooplankton Biomass in the Mid-Atlantic	A-57
A-14	Western Atlantic Cetaceans	A-63
A-15	Threatened and Endangered Turtles Found in Mid-Atlantic Slope Waters	A-66
A-16	Average Number and Weight Per Tow of Demersal Fish Taken At Shelf Edge and Slope During Fall and Spring Trawl Surveys, 1969 - 1974	A-68
A-17	Benthic Infauna Collected at or near the 106-Mile Site	A-73

APPENDIX A

ENVIRONMENTAL CHARACTERISTICS OF THE 106-MILE OCEAN WASTE DISPOSAL SITE

METEOROLOGY

The New York Bight receives air from several regions, but air from the tropical Atlantic or Gulf of Mexico predominates during most of the year. The Bight often receives storms which are pushed eastward by the "prevailing westerlies" from midwest areas where polar and tropical air masses meet. However, due to the influence of several physical factors, the Bight possesses a more uniform climate than continental areas in the same latitude.

The seasonal location of the Bermuda High is a primary determinant of general weather conditions in the Bight. When the Bermuda High is centered over the eastern seaboard, as in summer and early autumn, the Bight experiences its longest periods of stable weather conditions. During winter, spring, and late autumn the absence of this high pressure zone allows storms from northeastern and southern regions to move into the Bight, causing extreme weather conditions. However, even in the presence of the Bermuda High, tropical storms and hurricanes move northwards through the Bight during late summer and early autumn.

Warm air from the Gulf Stream region is advected towards coastal regions throughout the year. In the Bight, the air is quickly cooled by Shelf Water, which causes humid summer conditions and persistent fog during warm and cold months.

AIR TEMPERATURE

Marine surface air temperatures in the area of the Bight are buffered throughout the year by the influence of the underlying Atlantic waters. Summer temperatures are lower and winter temperatures are higher in the Bight than on adjacent coastal land masses.

At the 106-Mile Site, air temperature data from 1949 to 1973 (Brower, 1977) show that the mean maximum temperature ranged between 16.2°C in February to 29.9°C in July (Table A-1). The annual mean maximum temperature was 22.6°C. The mean minimum temperatures for the same period ranged between -4.0°C in February to 18.6°C in August. The annual mean minimum temperature was 5.7°C.

WINDS AND STORMS

Northwesterly winds prevail over the 106-Mile Site from October to March, with average speeds approaching 19 kn. From April to September the prevailing winds are southwesterly and reach an average speed of 11 kn. The percentage of winds greater than 33 kn increases seaward throughout the year. At the dumpsite, there is a maximum frequency greater than 5% from November through April, with a peak of 8.5% in February; it is less than 1% from May through August, with a minimum of 0.2% in June. These infrequent summer winds are due to disturbances by tropical cyclones and severe thunderstorms. Return values of maximum sustained winds are presented in Table A-2.

The storms sweeping over the New York Bight and the 106-Mile Site are of two general classifications: extratropical cyclones, which form outside the tropic regions in marine or continental areas, and tropical cyclones, which form in tropical waters, such as the Gulf of Mexico and the Caribbean Sea. Prevailing winds and weather in the area of the New York Bight are quickly altered by invading extratropical cyclones. Strong winds accompanying storms often bring heavy rain or snow (Brower, 1977). Exceptionally cold northwesterly winds are also characteristic of these storms. Nearly 600 such storms were observed within the Bight region from May 1965 to April 1974.

Although tropical cyclones are infrequent in comparison with extratropical cyclones, they are more destructive than any other type of storm (Brower, 1977). Wind speeds of tropical cyclones range from less than 34 kn to greater than 63 kn. From 1871 to 1976, 114 tropical cyclones entered the New York Bight, although the force of several of these storms had been reduced to the level of an extratropical storm by the time they reached the Bight. The

TABLE A-1
AIR TEMPERATURE AND WIND DATA FOR THE 106-MILE OCEAN WASTE DISPOSAL SITE

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Air Temperature												
No. of observations	436	308	403	516	426	520	410	421	526	427	529	438
Maximum Temp (°C)	17.3	16.2	16.6	20.1	21.9	26.8	29.9	29.4	27.9	25.8	21.6	18.2
Minimum Temp (°C)	-3.5	-4.0	-1.6	3.3	7.2	12.2	18.2	18.6	14.7	10.1	3.7	-0.3
Mean Temp (°C)	7.0	6.4	7.5	10.5	14.1	19.6	23.5	24.0	21.6	18.3	13.5	9.2
Surface Winds												
No. of observations	440	309	409	514	427	521	410	423	528	430	529	444
Percent Frequency ≤ 10 Knots	23.5	22.3	25.7	34.3	50.6	54.9	54.1	51.3	46.4	39.4	28.8	26.1
Percent Frequency ≥ 34 Knots	7.9	8.5	5.0	4.3	0.9	0.2	0.5	1.2	2.0	2.9	5.9	6.5
Mean Wind Speed From All Directions (knots)	18.3	18.9	18.0	14.6	12.0	11.2	10.9	11.2	12.4	14.7	16.9	17.8
Prevailing Direction	NW	NW	NW	SW	SW	SW	SW	SW	NE	NW	NW	NW
Mean Wind Speed From Prevailing Direction (knots)	20.9	21.7	19.2	13.0	12.5	12.2	12.6	12.4	15.7	17.1	19.5	20.1

Source: Adapted from Brower, 1977.

TABLE A-2
RETURN PERIOD OF MAXIMUM SUSTAINED WINDS
AT THE 106-MILE OCEAN WASTE DISPOSAL SITE

Return Period (Years)	Maximum Sustained Winds (Knots)
5	72
10	79
25	90
50	99
100	111

*Period of Record: 1949-1973
Source: Brower, 1977.

greatest frequency of tropical cyclones in the New York Bight occurs during late summer and early autumn. On the average, one tropical cyclone per year has occurred in the Bight area over the past 106 years (Brower, 1977).

PHYSICAL CHARACTERISTICS

WATER MASSES

A water mass may be defined as a seawater parcel having unique properties (temperature, salinity, oxygen content) or a unique relationship between these properties. Each water mass thus defined is given a name which qualitatively describes its location or place of origin. Water masses are produced in their source areas by either or both of two methods: (1) alteration of temperature and/or salinity through air-sea interchange, and (2) mixing of two or more water types. After formation, the water masses spread at a depth determined by their density relative to the vertical density gradient of the surrounding water.

A water mass possesses unique properties, therefore physical oceanographers have found it possible to represent any water mass by plotting data consisting of two of three parameters (temperature, salinity, oxygen content) as coordinates. In most cases, a temperature-salinity (T-S) diagram is sufficient for the identification of a water mass. To construct such a

diagram, water samples are generally taken from several depths at an oceanographic station, and the temperature and salinity values for each sample are determined. The values are plotted and a smooth curve is drawn through each point, in order of depth. The water mass may appear as the entire curve or as an area of the T-S diagram (Figure A-1). In cases of exceptionally homogeneous water, a single point on the plot identifies the parcel, which is then termed a "water type".

NOAA has characterized the physical oceanographic environment at the 106-Mile Site as extremely complex and variable in all but near-bottom water (NOAA, 1977). Normally, the surface layer of the site is Slope Water, which lies between fresher Shelf Water to the west and more saline Gulf Stream Water to the east. However, conditions often change, periodically allowing Shelf Water to enter the site from the west, or permitting Gulf Stream Water, in the form of southward moving Gulf Stream eddies, to be present about 20% of the time.

SHELF WATERS

The waters lying over the mid-Atlantic Continental Shelf are of three general types: Hudson River Plume Water, surface Shelf Water, and bottom Shelf Water (Hollman, 1971; Bowman and Wunderlich, 1977). Hudson River Plume Water results from the combined discharge of the Hudson, Raritan, and various other rivers into the northwest corner of the Bight Apex. This low-density water floats over the Shelf waters as it moves into the Bight. During episodes of high runoff, the plume may spread over large areas of the Bight and produce large vertical and horizontal gradients of salinity. This water type persists throughout the year, but its extent and depth are highly dependent on flow rates of the Hudson and Raritan Rivers (McLaughlin et al., 1975). Generally, the plume flows southward between the New Jersey coastline and the axis of the Hudson Shelf Valley. Bowman and Wunderlich (1976) have found that the plume direction is sensitive to wind stress and reversals in the residual flow. Consequently, the plume may flow eastward between the New Jersey coastline and the axis of the Hudson Shelf Valley, or may occasionally split and flow eastward and southward.

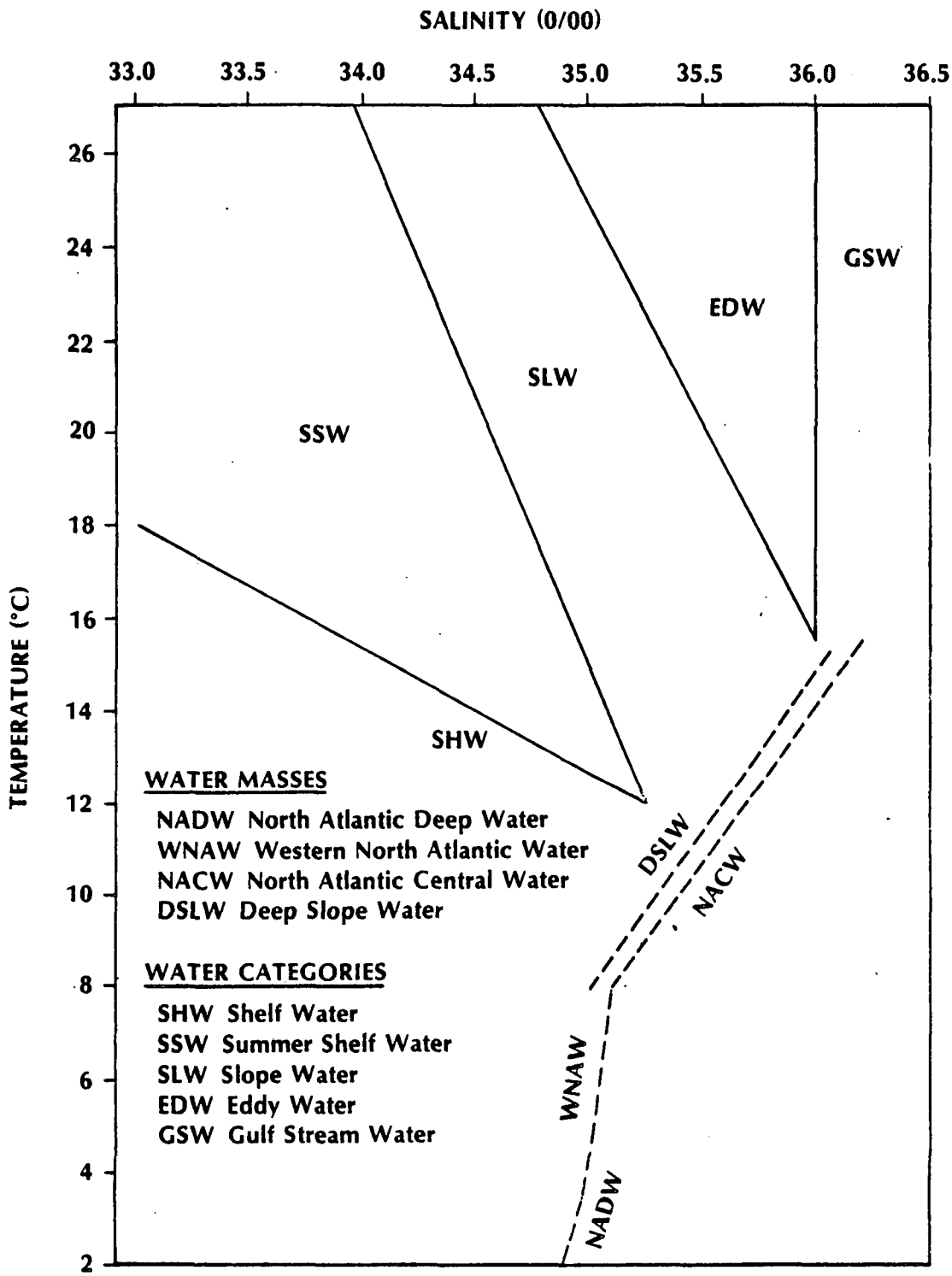


Figure A-1. Temperature-Salinity Lines of Water Masses (dashed lines) and Boundaries (solid lines) between Surface Water Categories in the Area of the 106-Mile Site
Source: Goulet and Hausknecht, 1977.

With the onset of heavy river discharges in the spring, surface salinities in the Bight decrease, and, initially, a moderate, haline-maintained (i.e., maintained by salinity differences) stratification occurs, separating the coastal waters into upper and lower layers - surface Shelf Water and bottom Shelf Water. Decreasing winds and increasing insolation increase the strength of the stratification and cause it to undergo a rapid transition (usually within a month) from a haline-maintained to a thermal-maintained (i.e., maintained by temperature differences) condition (Charnell and Hansen, 1974). This two-layer system becomes fully developed and reaches maximum strength by August.

Surface Shelf Water is characterized by moderate salinity and high temperatures in summer and low temperatures in winter. During the winter the water column is vertically homogeneous over most of the Bight Shelf. With the rapid formation of the surface Shelf Water layer during the spring, the bottom waters become isolated until sufficient mixing takes place the next winter. Bigelow (1933) found that the "cool cell" (having temperature typically less than 10°C) of the bottom Shelf Water layer extended from south of Long Island to the opening of Chesapeake Bay and seaward, nearly to the Shelf edge. This cold water persists even after the surface layers have reached the summer temperature maximum. Bigelow (1933) observed that this "cool cell" was surrounded on all sides by warmer water.

The upper layer of the bottom Shelf Water is usually found between 30 and 100 m depth during the summer (Bowman and Wunderlich, 1977). Seaward, near the Shelf edge, strong temperature, salinity, and density gradients occur which limit large-scale mixing between the Shelf Waters and the waters found over the Continental Slope. The mechanism by which bottom Shelf Water is replenished is currently under study.

SLOPE WATERS

The Slope Water mass is a highly complex, dynamic body of water which represents an area of mixing between Shelf Waters, which bound it on the north

and west, and the Gulf Stream, which forms its southern boundary (Figure A-2). These boundaries (frontal zones) are not stationary, but migrate seaward and landward.

The Gulf Stream frequently migrates in such a way that anticyclonic (clockwise) current loops are formed. Occasionally, these loops detach and form separate entities known as eddies. The eddies are rings of Gulf Stream Water surrounding a core of warm Sargasso Sea Water which originates to the east of the Gulf Stream. Great amounts of this water may be advected to depths as great as 800 to 1,000 m (NOAA, 1977). After detachment, the eddies may migrate into the Slope Water region, usually in a southwesterly direction. The eddies may interact with Shelf Water, causing considerable disturbance in the water column within the 106-Mile Site (Figure A-2). While there appears to be no seasonal pattern in the occurrence of the eddies, Bisagni (1976) found that, based upon the trajectories of 13 eddies between 1975 and 1976, the 106-Mile Site was wholly or partially occupied 20% of the time by eddies. The eddies either dissipate or are reabsorbed by the Gulf Stream, usually in the region of Cape Hatteras.

Periodically, a seaward migration of the Shelf/Slope Water boundary brings highly variable Shelf Water into the upper waters of the disposal site, thereby producing a complex vertical structure consisting of thin layers of cool, low-salinity Shelf Water interspersed with warm, high-salinity Slope Water.

Marcus (1973) found the Shelf/Slope front to be over the 200-m isobath during summer, and north and west of this isobath during fall. Warsh (1975b) reported winter and spring positions of this front ranging from the Shelf break to 70 nmi (130 km) south and east of the Shelf break. The surface waters of the Shelf are cooler than those of the Slope except during the summer months, when the well-defined thermal front disappears. Fisher (1972) has observed Shelf Water overlying Slope Water as far as 54 nmi (100 km) seaward of the 200-m isobath. It was suggested that wind-driven advection may be responsible for these migrations (Boicourt, 1973; Boicourt and Hacker, 1976). The onshore movement at lower depths of more saline Slope Water is frequently associated with the offshore movement of low-salinity Shelf Water.

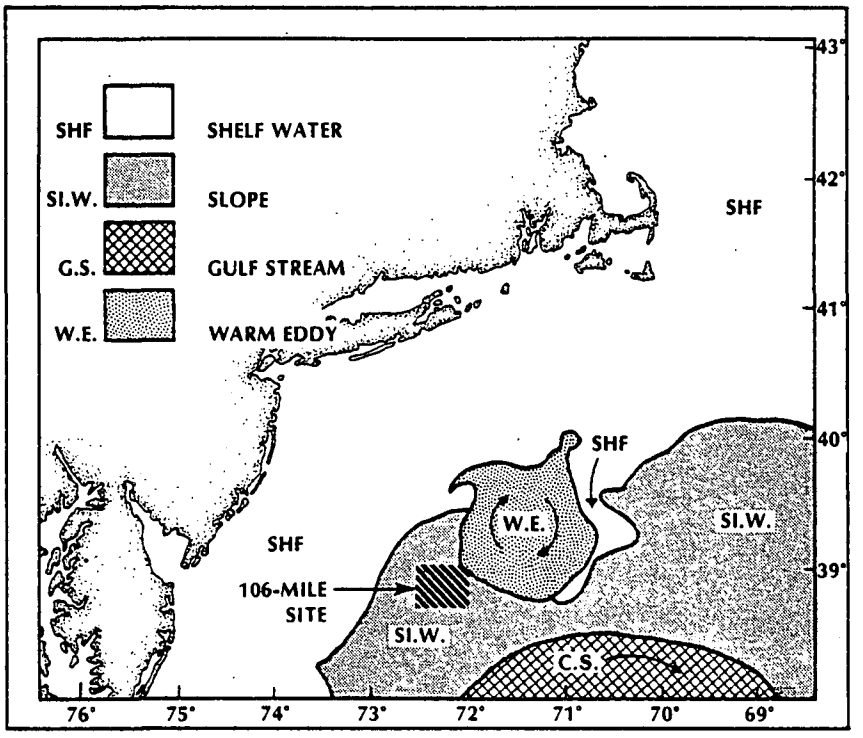


Figure A-2. NOAA National Environmental Satellite Service Observations of Shelf, Slope, and Gulf Stream Waters Surrounding the 106-Mile Site in May 1974
Source: Warsh, 1975a.

The combined effects of mixing, boundary migration, and the usual seasonal distribution of river runoff and rain produce a multitude of different water types which cause a confused, interlayered water column. Figure A-3 displays a stylized representation of this complex arrangement.

As in many other deep-water sites, the water column of the Slope Water mass can be divided into three general layers: the upper or surface layer where variability is great, the thermocline region where temperature changes rapidly with depth, and the deep water where seasonal variability is small.

In Slope Water, generally, stratification forms in the upper water column early in May and persists until mid or late fall when cooling and storm activity destroy the strata. The permanent thermocline is at a depth of 100 to 200 m. During the period when the surface layers are stratified, a seasonal thermocline forms which reduces the mixed layer to surface waters

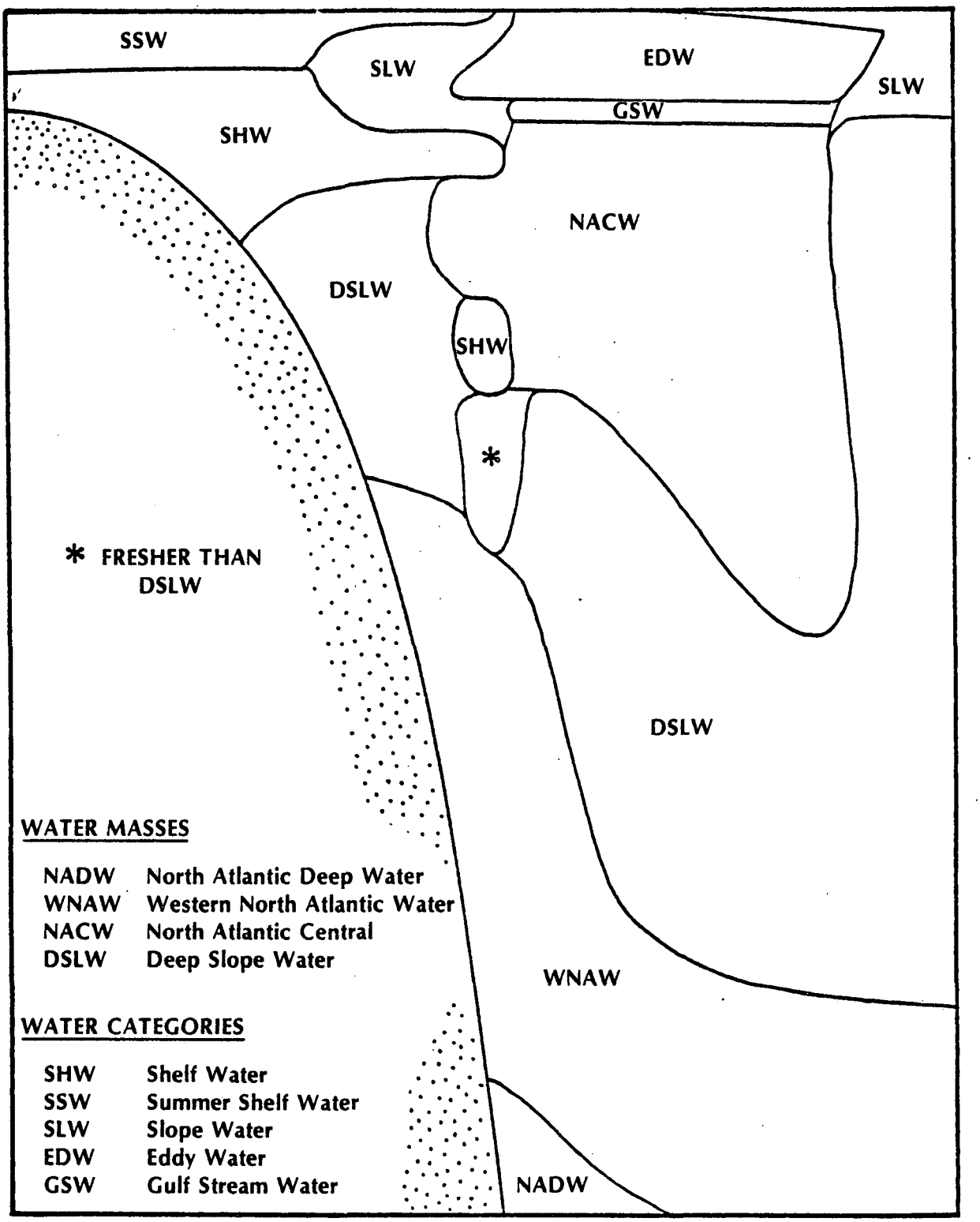


Figure A-3. Stylized Section from the Continental Shelf through the Dumpsite Eddy, Showing Surface Water Categories and Deeper Water Masses
Source: Goulet and Hausknecht, 1977.

above 30 to 40 m depth. From fall through early spring, the water column is isothermal from the surface to depths between 100 and 200 m. At that point, inversions are observed where low-salinity, cool Shelf Water flows under warmer, high-salinity Slope Water.

The upper layer of the Slope Water mass is termed surface Slope Water. It extends from the sea surface to a depth of about 200 m. The Shelf Water extends seaward to the 200-m isobath, thus the vertical extent at the Shelf/Slope interface is the same as that of the surface Slope Water mass. Consequently, the seaward boundary of the Shelf Water mass borders only the surface Slope Water mass; direct mixing between Shelf Water and the waters of the permanent thermocline, below the surface Slope Water mass, does not usually occur. However, mixing of waters across the Shelf Water/Slope Water front may be caused by the strong circulation of eddies or meanders from the Gulf Stream (NOAA, 1977).

The spillage of cooler Shelf Water into the relatively warm surface Slope Water has been documented by numerous researchers (Bowman and Weyl, 1972; Wright, 1976b; Bigelow, 1933). Wright (1976a) suggests that significant interchange of Shelf and Slope Waters may occur by this method. Beardsley et al. (1976) report that this process of cool water spillage, or "calving," may be related to the occurrence of anticyclonic Gulf Stream eddies and subsequent migration of eddies along the Shelf edge. Based upon an aerial survey of the formation and subsequent behavior of an anticyclonic eddy, Saunders (1971) found that bottom Shelf Water may have been pulled off the Shelf and displaced at least 81 nmi (150 km) southward to the eastern edge of the eddy. The amount of Shelf/Slope Water mixing promoted by this process and the frequency of occurrence of this type of induced mixing is unknown (Beardsley et al., 1976). However, estimates range from 300 km^3/year to 8,000 km^3/year (Stommel, 1960; Fisher, 1972; Beardsley et al., 1975).

CURRENT REGIMES

There are no major, well-defined circulation patterns in the surface layers of the Slope Water region (Wright, 1976a). Large natural variability and lack of many long-term current records limit the usefulness of any estimates of the

mean current for this region. The westward-flowing Labrador Current loses its distinctiveness somewhere west of the Grand Banks. Current measurements have been made by several researchers using neutrally buoyant floats, parachute drogues, and moored current meters in the region of the Shelf break and Slope south of New England (Webster, 1969; Voorhis et al., 1976; Beardsley and Flagg, 1976). The mean currents in this area flow westerly, generally of the order of 0.2 to 0.4 kn (10 to 20 cm/sec), following the bottom contours. This direction is similar to the direction taken by currents over the Continental Shelf.

Wright (1976a) indicates that along the northern boundary, Slope Waters flow slowly to the southwest, following the bathymetry to Cape Hatteras, where they turn and flow seaward into the Gulf Stream. Evidence of a slow northeastward flow along the Gulf Stream, in the southern part of the Slope Water region, was also found. Wright (1976a) suggests that the Gulf Stream and the Shelf Water form a cul-de-sac near Cape Hatteras, and, while some interchange of water occurs across these boundaries, most of the water entering the Slope Water region from the east probably exists along the same path.

Beardsley et al. (1976) have studied the kinetic energy spectrum from several sites over the Continental Shelf and Continental Slope. They found that the considerable variance of kinetic energy in the Slope Water currents was due to inertial periods of motion. This fraction of the variance in the kinetic energy increased significantly towards the Shelf. From the long-term records obtained at a site 204 km northeast (39°20'N, 70°W) of the dumpsite, Beardsley et al. (1976) found that at 100 m depth much of the observed variance in kinetic energy is due to motions recurring at 30-day intervals.

Anticyclonic or warm water eddies form north of the Gulf Stream, and entrain Sargasso Sea water during formation. Movement of the eddies is generally to the west or southwest, but may be interrupted for extended periods, during which the eddies appear to remain stationary (Bisagni, 1976). The mean speed calculated for five eddies was 3.8 nmi/day, and a mean residence time of 22 days was found. A mean eddy radius of 30 nmi has been estimated.

The Oceanographer of the Navy (1972) reported a mean surface current speed of about 25 cm/sec for a region near the 106-Mile Site. The direction of the flow was either east-northeast or south-southwest. No other current estimates for the 106-Mile Site have been reported in the literature.

WAVES

Brower (1977) has compiled wave data for the New York Bight coastal region, the disposal site, and adjacent waters. The data are taken from the MESA New York Bight Atlas Monograph 7, Marine Climatology (December 1976) and from published and unpublished data for the New York and mid-Atlantic Bights. Observations for the period from 1949 to 1974 are discussed below.

Wave heights increase with distance from shore throughout the year. Differences in height are smaller during summer. The average frequency of observations reporting hazardous waves (wave heights greater than or equal to 3.5 m) is 5% to 6% from December through March. The frequency of hazardous waves at two stations near the New Jersey coast varies from less than 0.5% in summer, to approximately 1% to 2% in winter, and the frequency seaward at the dumpsite area varies from about 1% in summer to more than 10% from November until March, with a peak of 13% in January and February (Table A-3). The frequency tends to increase northwest to southeast across the Bight throughout the year.

The frequency of waves less than 1.5 m in height follows the same pattern. Near shore, the frequency ranges from 70% in winter to 90% in summer. Offshore, at the dumpsite, the frequency of occurrence ranges from 35% to 40% in winter, to nearly 80% in early summer.

Table A-4 lists the mean return periods (recurrence intervals) for maximum significant wave height and the extreme wave height in the dumpsite. The maximum significant wave height is the average height of the highest one-third of the waves in a given wave group. Thus, Table A-4 shows that, for example, there will be a maximum significant wave height of 21 m (69 ft) within the site area at least once in every 100 years. Similarly, an extreme wave height of 38 m (124 ft) will occur at the site at least once every 100 years.

TABLE A-3

MONTHLY WAVE HEIGHT FREQUENCY FOR THE 106-MILE SITE

Wave Height	Number of Observations/Month											
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
	355	243	329	392	314	382	274	290	401	337	409	377
WH < 1.5 m	33.5	36.2	38.8	48.7	68.2	75.9	78.6	66.3	60.0	50.2	39.8	38.5
WH < 2.5 m	70.7	68.1	75.3	82.7	90.1	95.3	95.0	97.6	89.5	80.2	79.2	78.5
WH ≥ 3.5 m	12.7	13.1	11.0	6.6	1.9	1.0	0.9	0.7	3.5	5.3	10.1	10.3

WH < 1.5 M Percent frequency of wave height < 1.5 m
WH < 2.5 M Percent frequency of wave height < 2.5 m
WH ≥ 3.5 M Percent frequency of wave height ≥ 3.5 m

Mean return periods (recurrence intervals) for maximum significant and extreme waves; i.e., the wave value is that height which will be equalled or exceeded, on the average at least once during the period.

Source: Brower, 1977.

TABLE A-4
RETURN PERIODS FOR HIGH WAVES AT THE 106-MILE SITE

Return Period (Years)	Maximum Significant Wave in Meters (Feet)	Extreme Wave in Meters (Feet)
5	12.4 (41)	22.4 (74)
10	14.2 (47)	25.5 (84)
25	16.7 (55)	29.7 (98)
50	18.8 (62)	33.6 (111)
100	21.0 (69)	37.6 (124)

Source: Brower, 1977.

TEMPERATURE STRUCTURE

The waters in and around the 106-Mile Site are subject to the sudden changes in temperature that may occur between Shelf and Slope Waters. Shelf Water is always much colder than Slope Water during the winter months; however, during the warmer months of the year, peak surface temperatures of Shelf Water exceed those of Slope Water. The horizontal temperature gradient between the two water masses becomes less marked only during periods of warming and cooling. The water masses are then best distinguished by salinity differences (Warsh, 1975b).

Warsh (1975b) summarized hydrographic data collected by the USCG and the NOAA Marine Resources Monitoring, Assessment, and Prediction (MARMAP) program. These data were taken during all seasons over an area encompassing the mid-Atlantic Shelf and the Slope, including the disposal site region. Monthly summaries from Marsden Square 116, subsquares 81, 82, and 91 (Figure A-4) are discussed below. Table A-5 gives the ranges of temperatures for each subsquare. These areas, while differing in the month of minimum temperature, had the same month of maximum temperature. Surface temperatures ranged between 5.1°C (February, subsquare 82) and 25.0°C (August, subsquare 82). Figure A-5 illustrates the average monthly sea surface temperatures for each subsquare.

In the upper 50 m of the water column, a seasonal thermocline develops in late spring (May) and is usually present through mid-autumn (October). However, remnants of the thermocline may be present as late as November. By December, the water is generally isothermal to a depth of 100 m, but temperature inversions have been observed near 30 m. These inversions may persist through April or May. The permanent thermocline is usually found between 100 and 500 m. The temperature ranges between 100 and 500 m for each subsquare are listed in Table A-6.

From 500 to 1,000 m, temperature decreases to a range of 4°C to 6°C. At depths below 1,000 m, the temperature ranges from 2°C to 4°C. Figures A-6, A-7 and A-8 display the monthly temperature profiles for each subsquare.

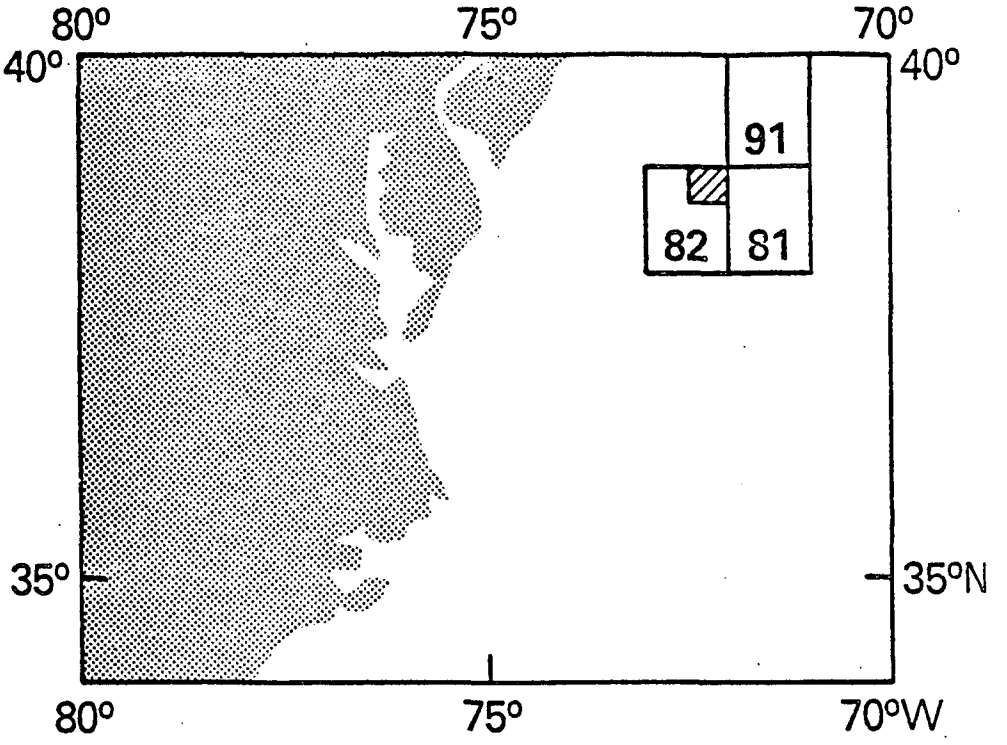


Figure A-4. Marsden Square 116, Subsquares 81, 82, and 91, and the 106-Mile Site (Diagonal Lines in Subsquare 82)
Source: Warsh, 1975b.

TABLE A-5
AVERAGE SURFACE TEMPERATURE RANGES AND MONTHS OF MINIMUM AND MAXIMUM TEMPERATURES FOR SUBSQUARES 81, 82, AND 91 IN MARSDEN SQUARE 116

Subsquare	Month of Minimum Temperature	Average Surface Temperature Range (°C)	Month of Maximum Temperature
81	January	7.8 - 24.9	August
82	February	5.2 - 25.0	August
91	March	5.4 - 24.5	August

Source: Warsh, 1975b

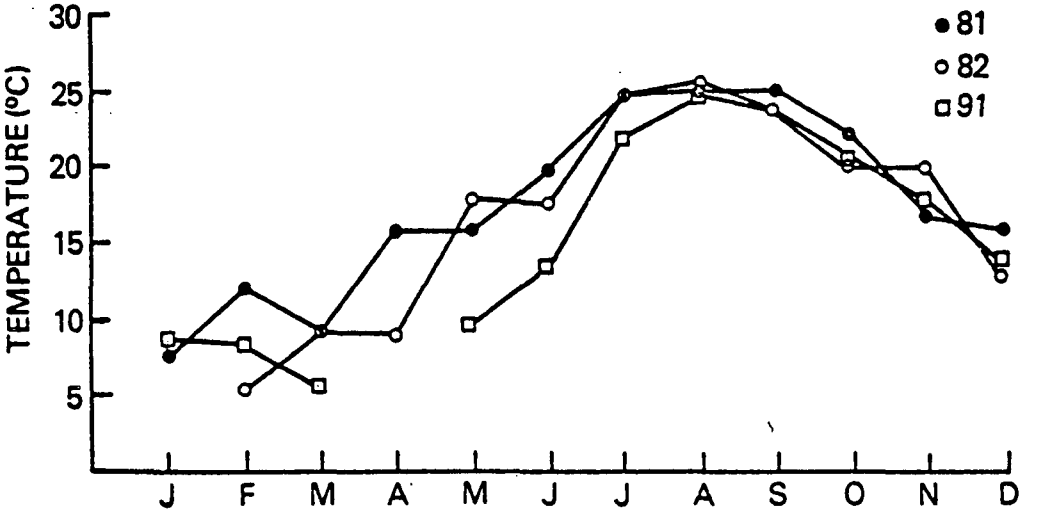


Figure A-5. Average Monthly Sea-Surface Temperatures for Subsquares 81, 82, and 91 in Marsden Square 116
Source: Warsh, 1975b.

TABLE A-6
AVERAGE TEMPERATURE RANGES BETWEEN 100 AND 500 M FOR SUBSQUARES 81, 82, AND 91 IN MARSDEN SQUARE 116

Subsquare	Average Temperature Ranges (°C) From 100 to 500 m
81	5.0 - 14.4
82	4.8 - 15.8
91	5.0 - 14.6

Source: Warsh, 1975b.

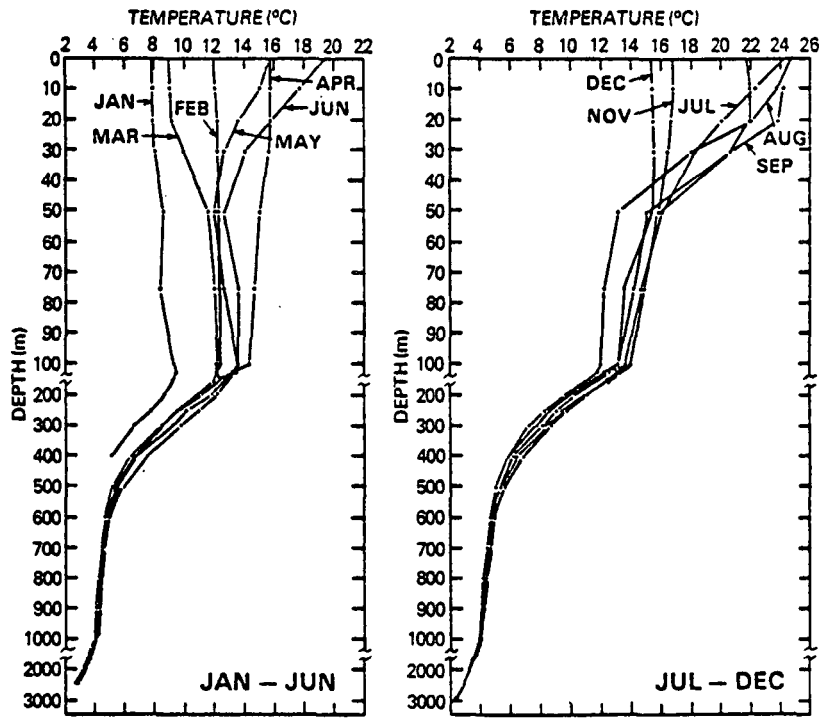


Figure A-6. Monthly Averages for Temperature versus Depth in Marsden Square 116, Subsquare 81
Source: Warsh, 1975b.

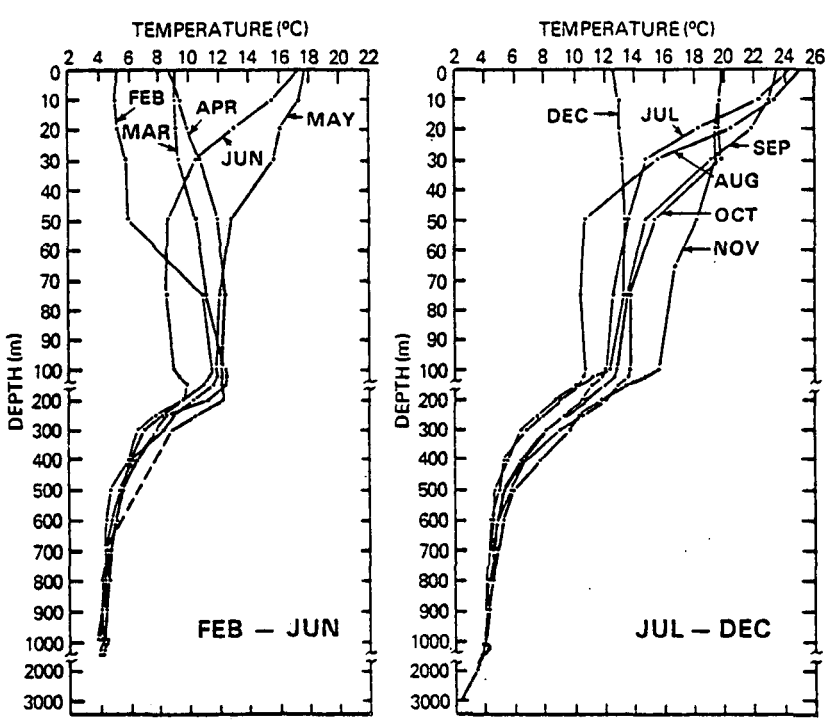


Figure A-7. Monthly Averages for Temperature versus Depth Marsden Square 116, Subsquare 82
Source: Warsh, 1975b.

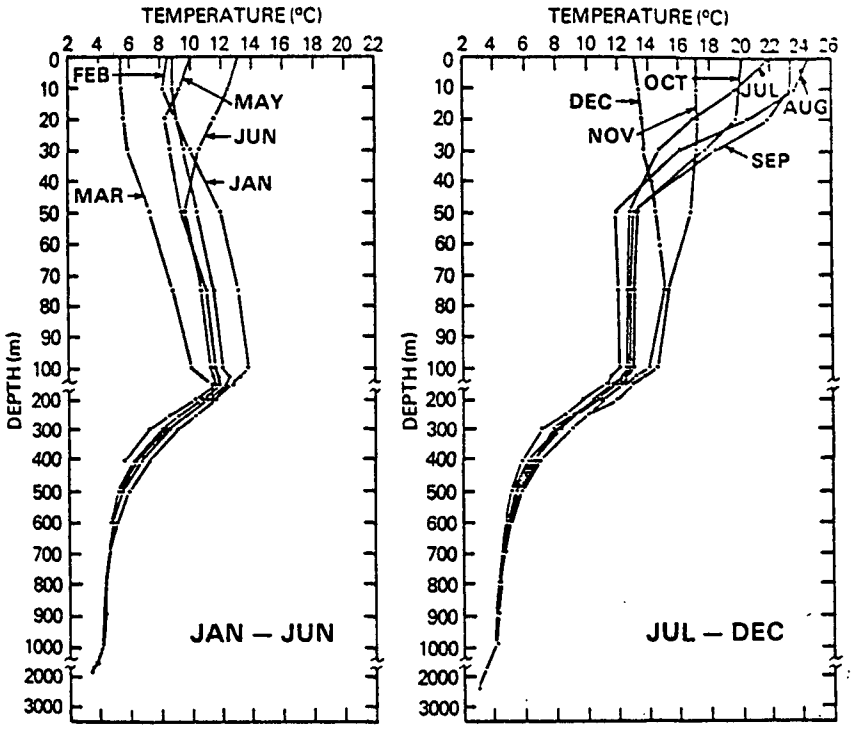


Figure A-8. Monthly Averages for Temperature versus Depth
Marsden Square 116, Subsquare 91
Source: Warsh, 1975b.

SALINITY STRUCTURE

The waters in and surrounding the 106-Mile Site are subject to the sudden changes in salinity which may occur between Shelf and Slope Waters. Shelf Water is always fresher than Slope Water during the winter months. During the warmer months of the year, the two water masses are best distinguished by temperature differences. During periods of warming and cooling, the water masses are best distinguished by salinity differences (Warsh, 1975b).

Table A-7 provides ranges of salinity for each subsquare. The ranges of surface salinity are quite variable, and are dependent upon the water mass present (Shelf, Slope, or Gulf Stream) within each square. The values range from 32.70 ppt in June (subsquare 82) to 35.75 ppt in April (subsquare 81). Figure A-9 illustrates the average monthly sea-surface salinities for each area.

Salinity generally increases to depths of 100 to 150 m, where the maximum salinities are encountered. Values at these depths average approximately 35.75 ppt. Salinity then decreases with depth to about 400 m where the minimum average salinity of 34.95 ppt exists. Below 400 m depth , the water column is nearly isohaline, and salinity values may range between 34.90 ppt and 35.05 ppt. Figures A-10, A-11, and A-12 display the monthly salinity profiles for each subsquare.

TABLE A-7
AVERAGE SURFACE SALINITY RANGES AND MONTH OF MINIMUM AND MAXIMUM SALINITY FOR SUBSQUARES 81, 82, AND 91 IN MARSDEN SQUARE 116

Subsquare	Month of Minimum Salinity	Average Surface Salinity Range (ppt)	Month of Maximum Salinity
81	January	33.05 - 35.75	April
82	June	32.70 - 35.45	November
91	May	32.85 - 34.90	November

Source: Warsh, 1975b

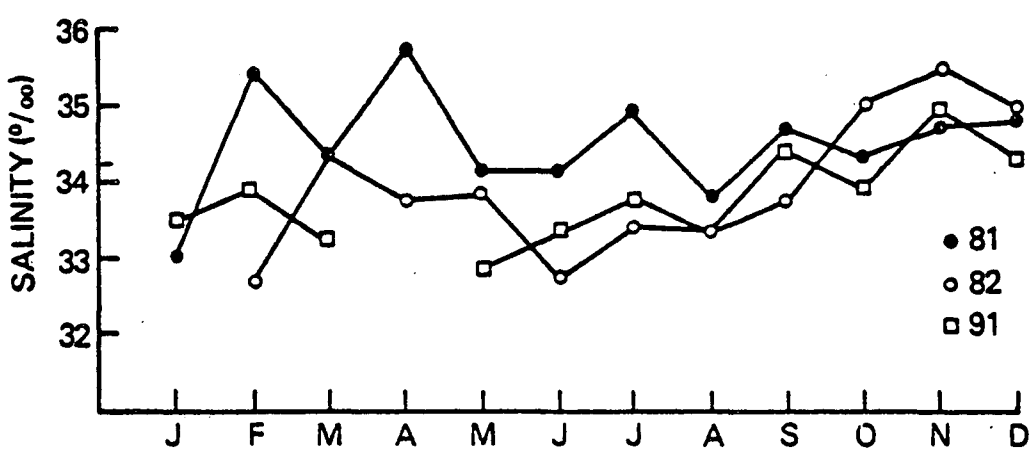


Figure A-9. Average Monthly Sea-Surface Salinities for Subsquares 81, 82, and 91 in Marsden Square 116
Source: Warsh, 1975b.

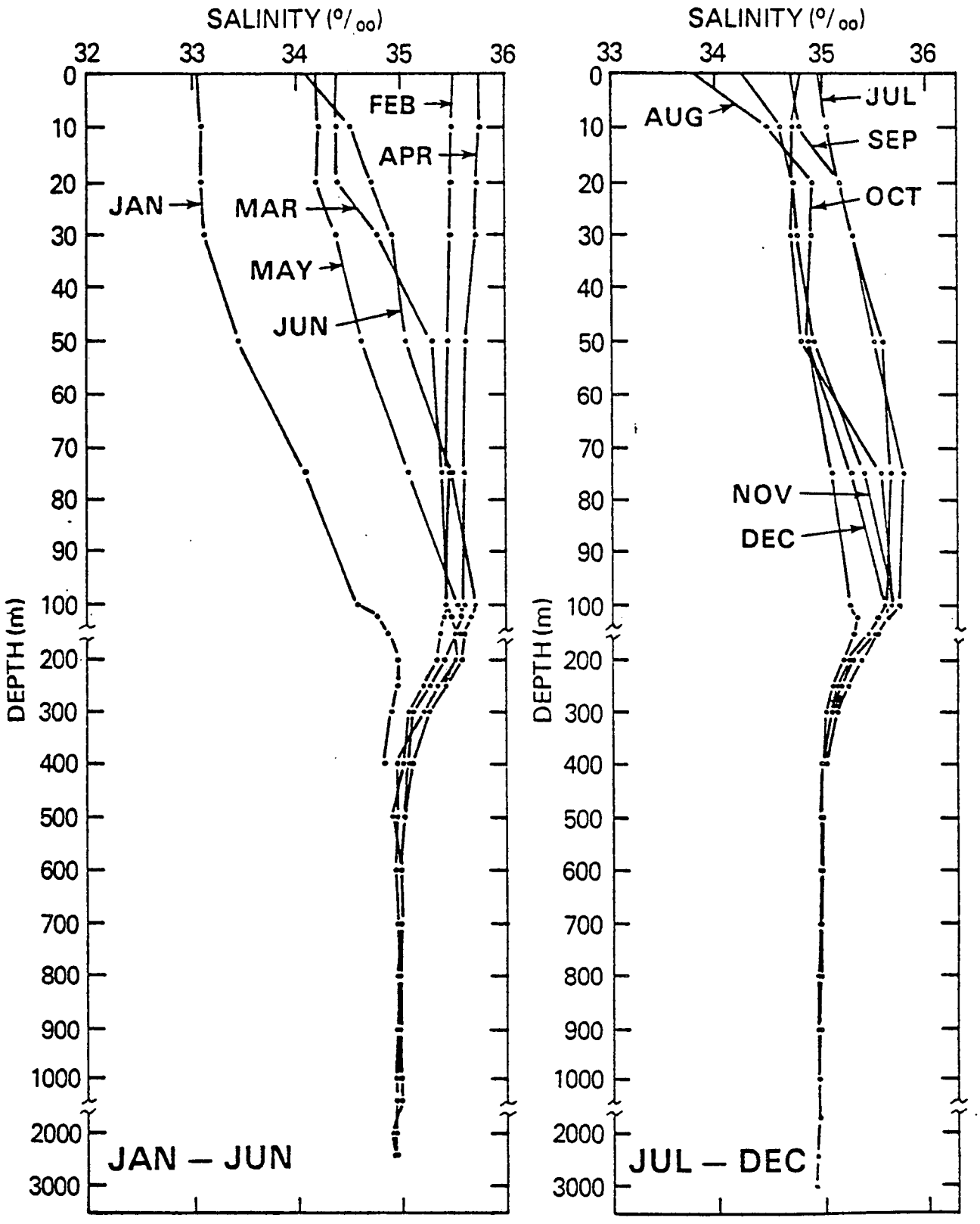


Figure A-10. Monthly Averages for Salinity versus Depth in Marsden Square 116, Subsquare 81
Source: Warsh, 1975b.

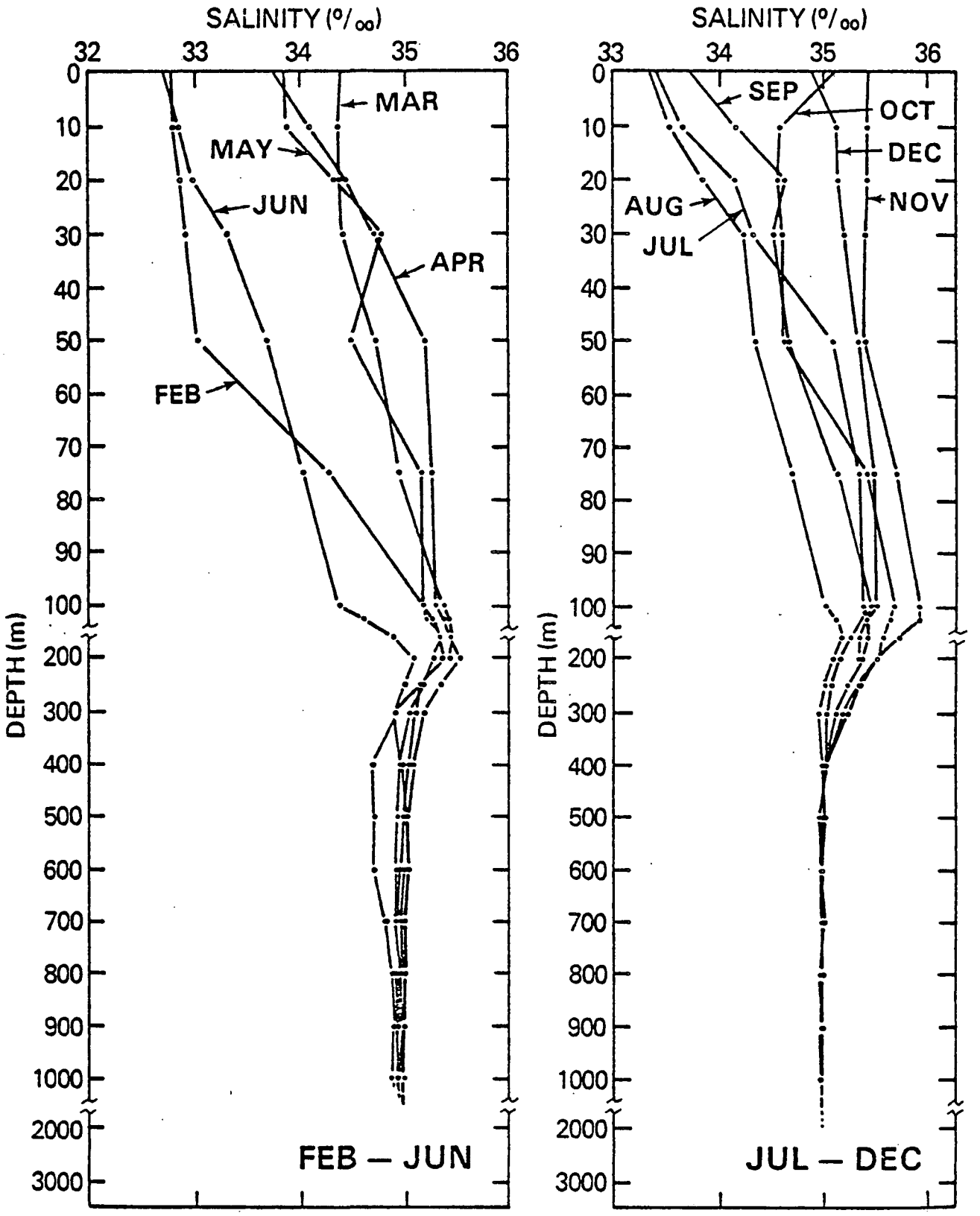


Figure A-11. Monthly Averages for Salinity versus Depth
Marsden Square 116, Subsquare 82
Source: Warsh, 1975b.

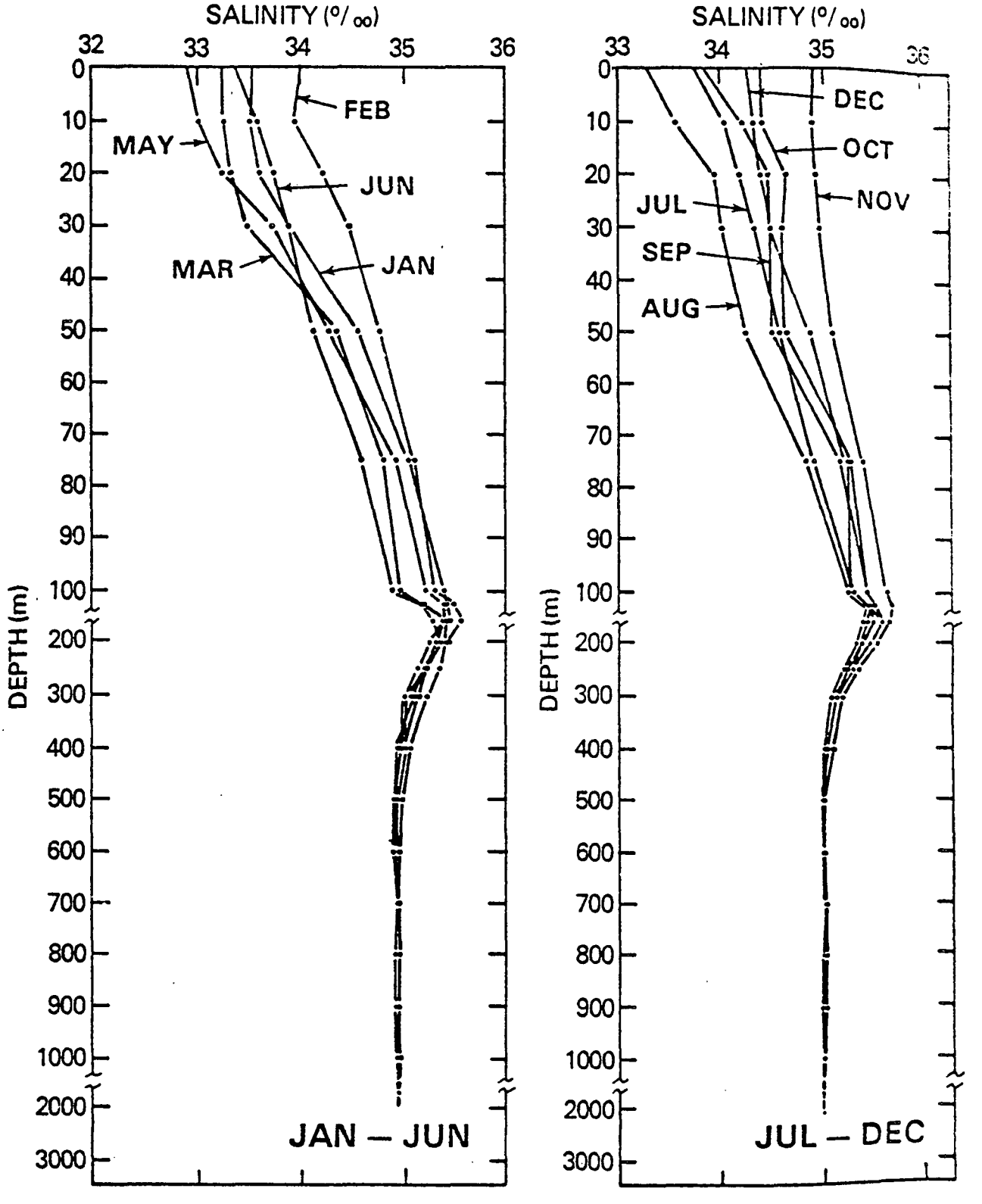


Figure A-12. Monthly Averages for Salinity versus Depth in Marsden Square 116, Subsquare 91
Source: Warsh, 1975b.

GEOLOGICAL CHARACTERISTICS

The 106-Mile Site covers portions of the Continental Slope and Continental Rise (Figure A-13). Water depths within the site range from 1,440 m in the northwest corner to approximately 2,750 m in the southeast corner. The Continental Slope portion of the site experiences a 4% grade, whereas the grade of the Continental Rise portion is 1% (Bisagni, 1977a).

Four submarine canyons incise the Continental Slope within the site: Mey, Hendrickson, Toms, and Toms Middle Canyon. Numerous smaller canyons exist in the Slope region west of the site. The massive Hudson Canyon is 32 nmi (60 km) north of the site, and extends from the New York Bight Apex to the edge of the Continental Slope.

The mid-Atlantic Continental Shelf is one of the best studied continental margins in the world, yet few studies have concentrated on the Continental Slope. Emery and Uchupi (1972) suggest that marine geologists may have found the numerous submarine canyons which incise the Slope to be geologically more interesting than the more featureless region of the Slope.

Based upon interpretation of bottom photographs, seismic reflection profiling, and data from the Deep Sea Drilling Project, Heezen (1975) concluded that the upper Continental Rise is a tranquil area of nearly uniform sedimentation that has existed for at least 1,000 years. The sediments are characterized as a wedge of Mesozoic and Cenozoic sediment, which is up to 13 km thick near the Baltimore Canyon (Shenton, 1976).

A narrow transition zone of recent high erosion separates the upper Continental Rise from the lower Slope area. Sediment cores and seismic reflection profiling in this area of the Continental Slope have shown that recent sediments along with Pliocene or Holocene deposits were totally absent in the area, apparently removed by current action since 1975 (Bisagni, 1977a). Before that time, photographs showed that the bottom was covered by a soft sediment of hemipelagic ooze and that significant currents were absent (Heezen, 1975).

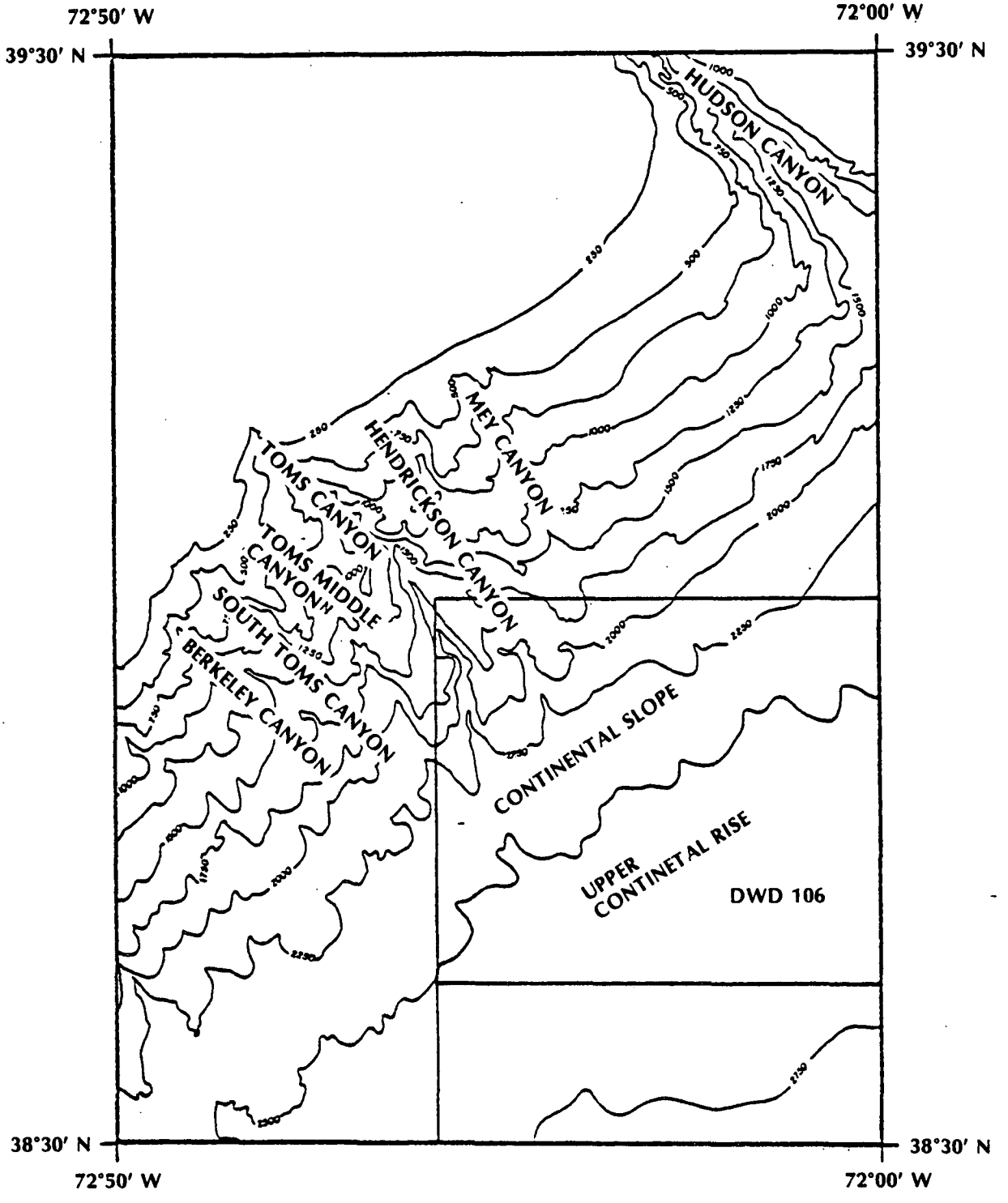


Figure A-13. Bathymetry in the Vicinity of the 106-Mile Site
Source: Bisagni, 1977a.

The lower Slope and Rise, which lies below 3,500 m depth, exhibits numerous current-induced bedforms, formed by the southwestward-flowing Western Atlantic Undercurrent (Heezen, 1975). The lower Slope and Rise may be thick prisms of deep sea turbidites, clays, and slump deposits (Drake et al., 1968).

The recent sediments deposited on the Continental Slope and Rise are primarily silt and clay (Milliman, 1973). Most of the sand in this region is biogenic in origin, although patches of terrigenous sand occur in the axes of some canyons (Hathaway, 1971; Keller et al., 1973). Sediments on the Slope tend to be olive or brown in color (Milliman, 1973), which may be a function of the high oxygen content of the Slope water and iron staining. Calcium carbonate is a major component of Slope sediments, contributing as much as 75% of the sediments in some areas. The carbonate grains are chiefly the tests of planktonic foraminifera, benthonic foraminifera, and echinoid plates. Coccoliths are often common components, but are seldom abundant (Milliman, 1973).

Heavy minerals in the sand-sized fraction average less than 2% in Slope sediments. Amphiboles represent 31% to 45% of the heavy mineral fraction; epidote represents less than 10% (Milliman, 1973). The light minerals are mostly quartz, feldspar and glauconite. The clay minerals, which are more prevalent on the Slope than across the Shelf, are chiefly illite and montmorillonite (Emery and Uchupi, 1972). Milliman (1973) reports illite fractions which range from 30 to 40%, chlorite fractions of 10% to 20% and kaolinite fractions ranging from 20% to 30%.

CHEMICAL CHARACTERISTICS

WATER COLUMN CHEMISTRY

DISSOLVED OXYGEN

Oxygen is a fundamental requirement for aerobic marine life. It is produced by photosynthesis in the photic (i.e., sunlit) zone, usually less than 100 m in depth, and is used by animals in respiration and in the decomposition of organic matter.

The contrasting processes of photosynthesis and respiration are the main causes of in situ changes in the concentrations of dissolved oxygen. In the photic zone, photosynthesis by phytoplankton may predominate and lead to the liberation of oxygen. Under optimal conditions, development of an "oxygen maximum layer" in the surface waters will occur. Below this layer, respiration and decomposition predominate and oxygen values diminish steadily with depth. Another layer, where dissolved oxygen concentrations are at a minimum, will form at depths varying between 150 and 1,000 m.

The ability of a water parcel to maintain certain minimal concentrations of oxygen determines the survival of life in that parcel. The saturation level of dissolved oxygen with respect to the atmospheric oxygen level in seawater is dependent on the temperature, salinity, and barometric pressure of the wet atmosphere at sea surface. The oxygen level at great ocean depths, where no atmospheric phase exists, is determined by the temperature, salinity, and barometric pressure before that water left the sea surface. Subsequent mixing among different water masses and types, and in situ biochemical alteration from phytosynthesis and respiration, modify the oxygen content of the water under study.

At all depths, seawater is saturated with atmospheric gases with the exception of those, such as oxygen, which are involved in life processes. Oxygen concentrations below the saturation level suggest that biochemical oxidation, including respiration and bacterial activity, is removing oxygen faster than it is being replenished by mixing or other processes.

Dissolved oxygen concentrations are generally higher during the winter months because of increased mixing in the water column. Increased plankton populations during the spring result in a high fallout of dead organisms; consequently, a higher oxygen demand exists in deeper water, due to microbial decomposition of organic matter. As a result, bottom waters tend to have lower dissolved oxygen levels at this time of year.

Warsh (1975b) summarized historical data for the water column within and adjacent to the 106-Mile Site. Within the site, monthly average oxygen values

at the surface range from 4.9 ml/liter in August to 7.5 ml/liter in April (Figure A-14). The oxygen minimum zone is between 200 and 300 m depth where the oxygen values range between 3.0 ml/liter in February and 3.5 ml/liter in September. The historical data for the site show the development of a subsurface oxygen maximum zone during several months. Values varied from approximately 7.0 ml/liter at 30 m depth during August to 8.2 ml/liter at 10 m depth during February.

Monthly average oxygen values for surface waters adjacent to the 106-Mile Site range from 4.6 ml/liter in October to 7.5 ml/liter in March. The oxygen minimum zone in waters adjacent to the site occurs between 200 and 300 m depth. Oxygen values in this zone show approximately the same range as the waters within the 106-Mile Site.

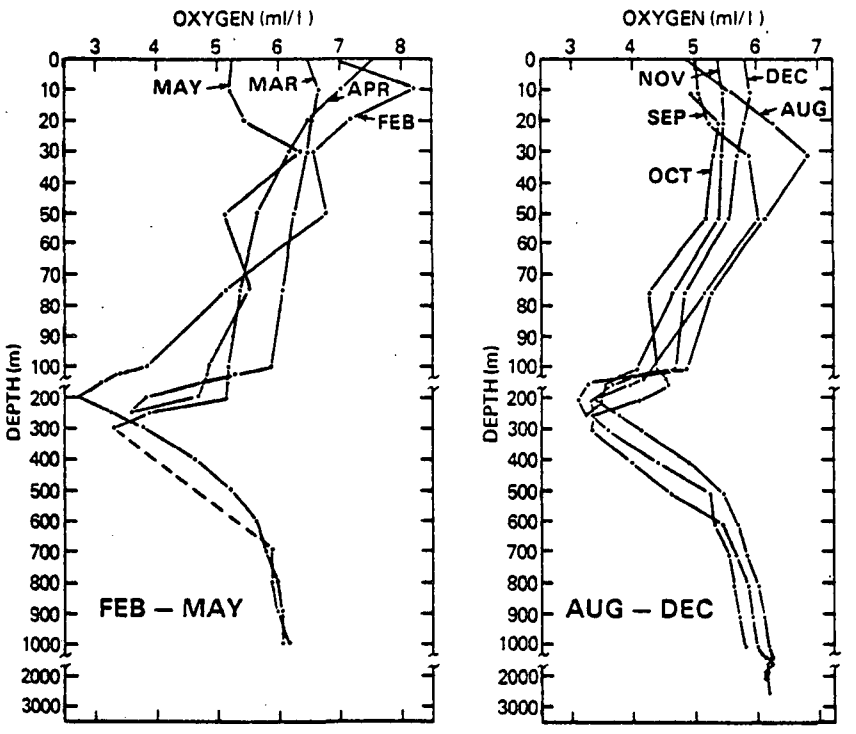


Figure A-14. Monthly Averages of Oxygen Concentration versus Depth at the 106-Mile Site
Source: Warsh, 1975b.

Baseline investigation of the 106-Mile Site during May 1974 (NOAA, 1975) found concentrations of dissolved oxygen at the surface ranging from 4.4 ml/liter to 6.9 ml/liter. The highest values occurred in areas over the Continental Shelf and generally decreased seaward. An oxygen minimum layer occurred between 200 and 400 m depth. Most of the values recorded for this layer were about 3.2 ml/liter. The lowest value recorded for the minimum layer was 3.1 ml/liter at approximately 300 m depth. At depths below the oxygen minimum layer, values increased to slightly above 6 ml/liter. From 1,200 m depth to the bottom, the amount of dissolved oxygen fluctuated between 6.2 and 5.3 ml/liter. Hausknecht and Kester (1976a) reported oxygen values at the 106-Mile Site taken during July 1976. Surface values averaged 5.3 ml/liter whereas concentrations at the oxygen minimum layer (300 m depth) averaged approximately 3.5 ml/liter.

pH AND ALKALINITY

The expression pH is used conventionally to measure the acidity or alkalinity of an aqueous solution. The scientific definition is $-\log A^{H+}$, the negative logarithm of hydrogen ion activity. A neutral solution normally has a pH value of 7 at 25°C, while acidic solutions are lower than 7, and alkaline solutions are higher than 7. The advantage of the pH scale is that its range is only from 0 to 14, from 1-molar HCl to 1-molar NaOH, where hydrogen activity varies from 1 to 10^{-14}. The pH scale can be smaller than 0 and greater than 14 when HCl concentration exceeds 1 mole (Du Pont-Edge Moor wastes contain 2- to 4-molar HCl), and NaOH exceeds a 1-mole concentration, respectively.

Surface seawater pH is generally 8.2 $\pm$ 0.4, thus slightly alkaline. This narrow range is maintained by the global and geochemical silicate and carbonate mineral equilibria. At sea surface, the air-sea exchange of carbon dioxide tends to restore any perturbation of pH value back to approximately 8.2.

Hausknecht and Kester (1976a, 1976b) reported pH values for samples taken during the summer at the 106-Mile Site. At the surface, the average pH was 7.9, while below 300 m depth, the pH decreased to an average of 7.6.

The alkalinity of seawater is defined as the sum of anions of weak acids present in seawater plus hydroxide ion (OH^-) minus hydrogen ion (H^+) concentrations. Alkalinity is important for fish and other aquatic life because it buffers pH changes which occur in nature, induced by photosynthesis and respiration, or by ocean dumping of acid and alkaline solutions. Carbonic and boric acids are two major weak acids in seawater near the sea surface. Alkalinity is increased by the dissolution of carbonate minerals, such as limestones, and decreased by the precipitation of carbonate minerals, such as oolite deposition over the Bahama Bank. Most of the time, alkalinity of seawater can be calculated by the empirical equation of alkalinity (milliequivalent/kg = 0.061 x salinity (g/kg).

TRACE METALS

Trace metals are present in seawater in minute quantities. The significance of a trace metal introduced by ocean disposal depends upon its relationship to the biota; i.e., the concentration of the metal, the form in which it exists, and how these two factors affect an organism. It is common practice to use the term "heavy metal" and "light metal" in discussions of trace metals. The terms originated from systems used to subclassify the known metals. Heavy metals have densities greater than 5 g/cm^3, i.e., 5 times the density of water at 4°C. Metals with densities less than 5 are properly classified light metals.

The heavy metals (e.g., vanadium, chromium, manganese, iron, and copper) are usually incorporated into proteins, some of which serve as enzymes, or biological catalysts. The light metals (e.g., sodium, maganesium, potassium, and calcium) readily form ions in solution, and, in this form, help to maintain the electrical neutrality of body fluids and cells and the proper liquid volume of the blood and other fluid systems (Stoker and Segar, 1976).

Environmental persistence of some metals is a serious problem. As elements, metals cannot be biologically or chemically degraded in nature, unlike organic compounds. The toxicity of metal-containing compounds can be altered by chemical reaction and/or complex formation with other compounds,

but the undesirable metals are still present. In some cases, such reactions produce more toxic forms of the metal. The stability of metals permits transportation for considerable distances in the ocean.

One of the most serious results of metal persistence is the potential for biomagnification of metal concentrations in food webs. Biomagnification of metals occurs as small organisms containing metals in tissues are eaten by larger organisms which in turn are eaten by still larger animals. As a result of this process, the metals in the higher levels of the food web can reach concentrations many tim s higher than those found in air or water. Thus, biomagnification can cause some fish and shellfish to become health hazards when used as food for human beings.

Metal pollution is complicated by the fact that some toxic metals are needed in trace amounts by all plants and animals, thus a balance must be reached between too little and too much of essential metals. However, in seawater, insufficient amounts of these micronutrients are not normal problems. Certain trace metals (e.g., arsenic, beryllium, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, selenium, silver, vanadium, and zinc) are important because of their potential toxicity and/or carcinogenic properties. The chemical behavior and the toxicity of a metal in the aquatic environment depends upon the form (complex, absorbed, or ionized) in which it exists, and whether the metal is present in solution or in colloidal or particulate phases. For example, the toxicity of copper to some marine organisms is controlled by the formation of copper-organic complexes. Mercury, which is toxic in sufficient amounts of any of its forms (except the metallic), is especially toxic when methylated by organisms.

Hausknecht (1977) reported metal concentrations from studies conducted at the 106-Mile Site during May 1974 and February and August 1976. The average metal concentrations for all samples taken during these cruises are presented in Table A-8. For comparison, average metal concentrations for the New York Bight Apex and Northwest Atlantic Ocean are included in the table.

TABLE A-8
AVERAGE CONCENTRATIONS OF FIVE TRACE METALS IN WATERS
OF THE NORTHEAST ATLANTIC OCEAN

AREA	CADMIUM (μg/l)	COPPER (μg/l)	LEAD (μg/l)	MERCURY (μg/l)	ZINC (μg/l)
106-Mile Site:					
May 1974*	0.30	0.70	3.10	0.63	6.8
February 1976*	0.46	0.40	0.70	0.17	6.9
August 1976*	0.035	0.23	0.07	-	-
New York Bight Apex:					
Summer†	3.1	80.0	140.0	-	11.0
Fall**	0.1	5.6	3.0	0.008	19.0
Open Ocean††	0.044	0.39	-	0.008	1.07
Continental Slope††	0.034	0.24	-	0.041	0.72
Continental Shelf††	0.036	0.56	-	0.122	1.11

Sources: * Hausknecht (1977)
† Klein et al. (1974)
** Alexander et al. (1974)
†† Bewers et al. (1975)

The cadmium concentrations in samples taken during May 1974 and February, 1976 cruises were comparable; however, these cadmium values were an order of magnitude greater than those found during the August 1976 cruise and the cadmium values listed for the Shelf, Slope, and open waters of the Northwest Atlantic. In comparison to the New York Bight Apex values for summer, the 106-Mile Site values for cadmium were as much as two orders of magnitude lower.

The copper values for the three studies at the disposal site varied little, and all fell within the same order of magnitude. These values were comparable to the values found by Bewers et al. (1975) for the Northwest Atlantic. The 106-Mile Site copper concentrations are one or two orders of magnitude less than those given for the New York Bight Apex.

Lead concentrations at the site showed a range of as much as two orders of magnitude for the 1974 and 1976 values. As with cadmium and copper, lead values at the site were much lower than the concentrations found in the New York Bight Apex.

Mercury concentrations at the site varied slightly between 1974 and 1976 and were significantly higher than mercury values listed for the Slope and open waters of the Northwest Atlantic. Concentrations of the metal were, however, comparable to those reported for the Continental Shelf.

Zinc concentrations for the 106-Mile Site showed remarkable consistency between 1974 and 1976. The values were higher than the Northwest Atlantic values but an order of magnitude less than zinc concentrations in the New York Bight Apex.

After undertaking an analytical program to produce highly reliable metal analyses of seawater samples collected from the site, Kester et al. (1978) concluded that the natural levels of cadmium, copper, and lead at the site are comparable to other oceanic regions. Earlier samples were believed to be contaminated and thus yielded high concentrations of these metals.

NUTRIENTS

In addition to the conservative elements (not involved in biological processes; e.g., sodium, chlorine, bromine, strontium, and fluorine) and the trace metals, nutrients in seawater are important for the growth of marine phytoplankton. The major nutrients are inorganic phosphate, nitrate, nitrite, ammonium, and hydrated silicate. Nutrients are consumed by phytoplankton only in the upper layers of the ocean where light conditions permit photosynthesis and growth. Inorganic phosphorus and nitrogen are generated primarily by bacterial decomposition of organic debris and soluble organics. Silicate is generated by the dissolution of the siliceous shells of diatoms, radiolaria, and silicoflagellates.

Nitrogen exists in the sea in combination with other elements: in ammonia (NH_3), as urea [$(NH_2)_2CO$], and as oxides of nitrogen in the nitrite ion (NO_2^-) and nitrate ion (NO_3^-). Nitrogen enters into the composition of all living things and is one of the nutrients used by plants to form the complex protein

molecules from which animals derive nitrogen. The complex nitrogenous compounds found in plants and animals are decomposed by bacteria into chemically simpler compounds after the organism dies.

Phosphorus has a biologically activated cycle involving alternation of organic and inorganic phases. This cycle is similar to that of nitrogen, except that only one inorganic form, phosphate, is known to occur. Phosphorus can be found in organisms, particulate and dissolved organic compounds, and as phosphate. Phosphate is probably the only form used by plants.

The nitrogen-phosphorus ratio near the sea surface varies greatly. Nitrogen and phosphorus are extracted from seawater by phytoplankton, but phosphorus is regenerated more rapidly than nitrogen, thus causing nitrogen to be the nutrient which limits phytoplankton growth. A phytoplankton population will cease to grow when nitrogen is depleted. However, in coastal waters, land run-off and sewage effluents may provide excess nitrogen to the system. When this situation occurs, phosphate becomes the growth-limiting factor.

The phosphate and nitrate contents of mid-Atlantic Continental Shelf and Slope waters vary seasonally. Shelf and Slope waters are vertically mixed during the winter. Consequently, phosphate and nitrate concentrations are fairly uniform from the surface to the bottom. In spring, mixing is reduced and the water column stratifies. Phosphate and nitrate concentrations decrease in the surface layers due to increased biological activity and lack of replenishment by mixing with nutrient-rich deeper layers. By the end of summer, nitrate in the upper waters is depleted and phosphate is present in low concentrations. Vertical mixing of the water column begins in the fall and nutrients are transferred from subsurface to the surface layer (Kester and Courant, 1973).

Peterson (1975) reported vertical profiles for phosphate, nitrate, silicate, and ammonia, compiled for samples taken during May 1974 at the 106-Mile Site (Table A-9). Average concentrations of phosphate generally increased with depth ranging from 0.1 mg/liter in the upper 15 m to 0.2 mg/liter at 500 m depth. Average nitrate concentrations increased with

depth, ranging from 0.01 mg/liter in the upper 15 m to 1.22 mg/liter at 500 m depth. Silicate was observed to follow the same profile as phosphate and nitrate. Concentrations ranged from 0.09 mg/liter at the surface to 1.28 mg/liter at 500 m depth. Ammonia concentrations were quite uniform throughout the water column, ranging only from 0.0071 mg/liter at the surface to 0.0068 mg/liter at 500 m depth.

TABLE A-9
AVERAGE CONCENTRATIONS OF NUTRIENTS AT VARIOUS DEPTHS IN THE 106-MILE SITE

Depth (meters)	(mg/liter)			
	Phosphate	Nitrate	Silicate	Ammonia
Upper 15	0.10	0.01	0.09	0.0071
100	0.13	0.60	0.39	0.0066
500	0.20	1.22	1.28	0.0063
Below 1,000	0.19	1.09	1.28	0.0070

Source: Adapted from Peterson, 1975.

ORGANIC COMPOUNDS

Organic compounds are numerous and diverse, with varying physical, chemical, and toxological properties. Organics occur naturally in the marine environment, resulting either from chemical/biological processes or oil seeps. However, anthropogenic sources (e.g., oil spills, urban run-off, or disposal operations) provide the major oceanic inputs. Field work and laboratory experiments have demonstrated acutely lethal and chronic (sublethal) effects of organics on marine organisms.

One of the largest groups of organic compounds is the hydrocarbons, which contain only the elements hydrogen and carbon. Tens of thousands of such compounds are known to exist. They are found in all 3 physical states (gas, liquid, solid) at room temperatures. The physical state characteristic of each is related to the molecular structure, and particularly to the number of carbon atoms making up the molecule. Generally, within this group, the tendency to exist as a solid increases with increasing number of carbon atoms. Hydrocarbons may be classified as "aliphatic" or "aromatic" on the bases of

their molecular structures. An aromatic hydrocarbon contains, as a structural unit, one or more 6-membered carbon rings. Aliphatic hydrocarbons lack this characteristic ring structure.

Smith et al. (1977) reported levels of dissolved and particulate aliphatic hydrocarbons in the waters of the outer mid-Atlantic Bight just northwest of the 106-Mile Site. The mean concentration was highest during winter with a value of 7.6 μg/l, whereas in summer, the mean hydrocarbon concentration was at a low of 0.22 μg/l. The mean concentration reported for spring was 0.53 μg/l.

Chlorinated hydrocarbons are basically composed of carbon-hydrogen skeletons to which chlorine atoms are attached. The polychlorinated biphenyls (PCB's) are one type of chlorinated hydrocarbon compounds and have properties similar to chlorinated hydrocarbon pesticides. Theoretically, 210 different PCB compounds can be formed by varying the number and position of the chlorine constituents. Some of the compounds are more common than others. Commercial mixtures, which generally contain many types of PCB's are usually in the form of liquids or resins.

The PCB's are stable at high temperatures (up to 800°C), resistant to acids, bases, and oxidation, and are only slightly soluble in water. These properties make them quite adaptable to various uses, e.g., (1) heat transfer fluids in industrial heat exchangers, (2) insulators in large capacitors and transformers required by electrical power companies, (3) hydraulic fluids, and (4) plasticizers in polymer films. PCB's have also been used as a constituent of brake linings, paints, gasket sealers, adhesives, carbonless carbon paper, and fluorescent lamp ballasts.

PCB's were first identified in 1881, and have been widely used since the 1930's. The first environmental contamination was found in 1966, when PCB residues were identified in fish. It is now apparent that PCB's are distributed throughout the environment.

Most PCB's are introduced into the environment accidentally. Available evidence indicates that the physiological effects of the PCB's are similar to

those of DDT. As with DDT, long-term chronic effects appear to create more of a problem than acute toxicity. The PCB's appear to be more effective enzyme inhibitors than DDT. It is now believed that some eggshell thinning previously blamed upon DDT may be caused by PCB's or synergistic PCB-DDT combinations.

Harvey et al. (1974) measured PCB's in North Atlantic waters over the Continental Shelf and Slope off the northeastern United States. The data show widespread distribution in the North Atlantic, with an average PCB concentrations of 35 parts per trillion in the surface waters and 10 parts per trillion at 200 m depth. A wide range of concentrations (1 to 150 parts per trillion) was found, with extreme concentrations occurring only several kilometers apart. No apparent relationship between PCB concentrations and the proximity to land was observed, and it was suggested that the high variation may be due to localized slicks, rainfall, or ship discharge.

SEDIMENT CHEMISTRY

Most of the sediment data collected at the site are derived from photographs and a few grab samples (Pearce et al., 1975). Sediments within the disposal site are mainly sand and silt, with silt predominating. Heezen (1977) reported that the Continental Slope around the 106-Mile Site may have a transitory blanket of hemipelagic ooze which, dependent upon the strength of the bottom current, is either deposited or swept away.

TRACE METALS

Trace metals are conservative elements in sediments. Distribution and accumulation of metals over background levels in sediments may delineate the benthic area affected by disposal of waste. Recommendations have been made to use either the individual metal concentration, or the metal-to-metal concentration ratios, to trace a particular type of waste and separate it from other wastes disposed nearby. These techniques have been applied to nearshore disposal sites.

Pearce et al. (1975) noted that the heavy metal content of sediment samples taken in the vicinity of the 106-Mile Site appeared to be elevated relative to uncontaminated Shelf sediments. The stations at which these elevated levels occurred are located near the Hudson Canyon, therefore the investigators suggested that materials which had an elevated heavy metal content, and which originated inshore, were tranported seaward via the Shelf valley and Canyon.

Greig and Wenzloff (1977) reported that heavy metal values, in deepwater sediments collected in 1976 in and near the 106-Mile Site, were generally similar (Table A-10) to those reported for collections made in 1974 (Pearce et al., 1975). Greig and Pearce (1975) reported concentrations for cadmium, chromium, copper, nickel, lead, and zinc in waters of the outer Continental Shelf. Cadmium, chromium, and copper were rarely detectable in sediments; nickel and zinc were usually measurable, but were present in very small amounts relative to their abundance in Bight Apex sediments. Lead varied somewhat, but was often undetectable. The values obtained were generally less than those previously reported for sediments collected from the New York Bight Apex (Carmody et al., 1973; Greig et al., 1974). The concentrations found by Greig and Pearce were also somewhat less than those reported for stations near the 106-Mile Site.

TABLE A-10
AVERAGE CONCENTRATIONS OF SIX TRACE METALS IN THE TOP 4 CENTIMETERS OF SEDIMENTS

Date	Metal (mg/kg dry weight)					
	Cadmium	Chromium	Copper	Nickel	Lead	Zinc
May 1974 Pearce et al. (1975)	-	25.9	27.6	25.2	28.7	60.2
February 1976 Greig & Wenzloff (1977)	1.4	25.8	27.0	31.5	13.2	50.5

Harris et al. (1977) analyzed sediment samples from the mid-Atlantic Continental Shelf for barium, cadmium, chromium, copper, iron, nickel, lead, vanadium, and zinc. It was found that concentrations of iron, zinc, nickel, lead, total organic carbon, and the percent silt-clay generally increased seaward across the Shelf. These increases correlated with a decrease in the average particle size of sediment grains across the Shelf. Metal concentrations, percent silt-clay, and total organic carbon showed a general consistency from season to season.

ORGANICS

Hydrocarbon (C_{15}+) concentrations, in and near the 106-Mile Site, were found to be similar to those of Continental Shelf sediments from the Northern and Southern Areas, which are assumed to be uncontaminated (Greig and Wenzloff, 1977). The amounts (approximately 20 mg/kg) of C_{15}+ hydrocarbons in sediments from the area near the 106-Mile Site were much less than those found in sediments at other disposal sites in relatively shallow coastal water, viz., 6,530 mg/kg at the Dredged Material Site and 1,568 to 3,588 mg/kg at the 12-Mile Sewage Sludge Disposal Site in the New York Bight Apex.

Smith et al. (1977) reported levels of total aliphatic and aromatic hydrocarbons in sediments of the mid-Atlantic Continental Shelf to be generally less than 1 μg/g (1 ppm). The concentrations strongly correlated with the amount of silt-clay in sediments, suggesting that, whether inputs are general or localized, hydrocarbons accumulate primarily in locations where fine-grained sediments are deposited.

BIOLOGICAL CHEMISTRY

General observations on trace metal concentrations in phytoplankton can be made despite the lack of specific data. The uptake of contaminants and associated incorporation into the phytoplankton may have no apparent effect upon the organisms or primary production; however, as the phytoplankton are consumed, the contaminants can be transferred to and concentrated in consumers at the next higher trophic level (biomagnification). The end result of this accumulation through the food web is that higher trophic levels (and

eventually man) may exhibit concentrations of contaminants far in excess of ambient levels in the environment. This is considered to be a far less important problem in the deep ocean than in nearshore waters since the dispersed distribution and wide-ranging horizontal migrations of the epipelagic nekton tend to retard the accumulation of contaminants in oceanic nekton populations (Pequegnat and Smith, 1977). Other existing evidence suggests that, aside from mercury and cadmium, few, if any, of the trace metals are irreversibly accumulated by nektonic species.

Windom et al. (1973a), reporting on zooplankton samples collected between Cape Cod and Cape Hatteras, found nearshore samples to be higher in mercury than offshore samples. Species composition of the samples varied considerably, although a general copepod dominance was maintained. However, the high mercury concentrations measured did not seem as strongly correlated with species composition as with sampling distance off shore.

Windom et al. (1973b) provide information on the cadmium, copper, and zinc content (expressed as ppm dry weight) of various organs in 35 species of fish obtained from waters of the North Atlantic. Cadmium concentrations in liver tissue were generally less than 1.7 ppm, although one sample contained 5 ppm cadmium. Cadmium levels in other organs and whole fish were usually less than 1 ppm; however, some species had values as high as 2.6 ppm. Copper levels in the fish tissues sampled were, in most cases, less than 10 ppm. Zinc levels were reported to be in the range of 10 to 80 ppm; however, a zinc level of 397 ppm was obtained for the bay anchovy (Anchoa mitchilli).

Pearce et al. (1975) reported that the levels of silver, cadmium, and chromium did not vary greatly in most of the finfish and invertebrates collected within and adjacent to the 106-Mile Site. The results did show, however, that copper, zinc, and lead varied significantly, with lead showing the greatest variation of all metals. Liver tissues from the deep-sea slickhead (Alepocephalus agassizi) had the highest levels of silver, cadmium, copper, and zinc. The values for these metals were several orders of magnitude greater than the metal concentrations found in windowpane flounder (Scopthalmus aquosus) taken from the sewage sludge and dredged material disposal sites in the New York Bight Apex. The levels of the metals (as wet

weight) in liver tissues from the slickhead were: cadmium 13.9 ppm, copper 28.6 pm, silver 1.2 ppm, and zinc 271.0 ppm. The copper concentrations in other species of fish obtained were similar to the copper levels in fish examined by Windom et al. (1973b).

Greig and Wenzloff (1977) found uniform metal concentrations in three species of mid-water fish (Gonostoma elongatum, Hygophum hygomi, and Monaconthus [=Stephanolepis] hispidus) during spring 1974, 1975, and 1976 studies near the 106-Mile Site; however, copper concentrations were highest in fish taken in 1976. In Apex predators, such as sharks, cadmium concentrations were generally less than 0.12 ppm in muscle tissue, but levels in the liver were consistently higher, ranging from 0.28 to 7.2 ppm. Lancetfish, oilfish, and dusky shark had similar cadmium concentrations.

Copper and manganese concentrations were low in the muscle of the sharks and other fishes examined; levels were mostly below 1.5 ppm for copper and below 0.5 ppm for manganese. With the exception of lancetfish, almost all samples of fish muscle examined had concentrations of mercury which exceeded the 0.5 ppm action level set by the Food and Drug Administration. Mercury levels in lancetfish were most often below 9.23 ppm. Lead concentrations were below the detection limit (about 0.6 to 0.8 ppm) of the method employed for both muscles and livers of the fishes examined. Zinc concentrations in the muscles of fishes examined were several orders of magnitude greater than the cadmium, copper, manganese, and lead levels. Zinc levels ranged from 1.0 to 6.9 ppm and were about the same magnitude as those found in the muscle of several finfish obtained from the New York Bight.

In another study, Greig et al. (1976) determined the concentration of nine metals in four demersal fish species and three epipelagic fish species from the outer Bight in water depths of 1,550 to 2,750 m. It was found that mercury concentrations in deepwater fish muscle averaged three times higher than muscle concentrations reported by Greig et al. (1975) from offshore Continental Shelf finfish.

BIOLOGICAL CHARACTERISTICS

The biota at the 106-Mile Site exhibit complex diurnal, seasonal, and longer term cycles of species composition and abundance. Several factors contribute to these cycles: the influence of various water masses, each with its characteristic biota, the location of the site relative to the boreal fauna found to the north and the temperate to subtropical fauna found to the south, and the effects of unusual or non-periodic physical conditions.

The mid-Atlantic is biologically heterogeneous; this section, however, discusses only the environmental aspects of the region which are directly relevant to the specific conditions at the 106-Mile Site. The water column is described first, then the benthic biota are characterized. For the benthos, the discussion is confined to organisms characteristic of fine silt and clay bottoms at abyssal depths. A discussion of the biota typical of other sediment types and other depths in the mid-Atlantic is not pertinent to this EIS.

PHYTOPLANKTON

Phytoplankton are free-floating algae which produce the organic matter upon which the rest of the marine food chain is built. Phytoplankton consist of autotrophic algae which are represented by six taxonomic groups: Bacillariophyta, Pyrrophyta, Cyanophyta, Coccolithophorida, Chlorophyta, and Euglenophyta. The algal cells are commonly found in combinations of single, filamentous, or colonial units of varying size in the euphotic zone (upper 100 m) and require sunlight, nutrients, and certain conditions of temperature and salinity in order to synthesize organic matter. The various combinations of these factors in the euphotic zone dictate the floral characteristics of the waters at any particular time or place.

Few phytoplankton investigations have been performed at the 106-Mile Site, and the available data indicate summer as the only season in which sampling was performed. Hulburt and Jones (1977) found the phytoplankton abundance at the 106-Mile Site to vary with depth from 100 to 100,000 cells/liter, with the phytoplankton much more abundant in the upper 20 m than at 25 to 50 m depth.

Abundance was greatly reduced at greater depths. The dominant species of phytoplankton was a group of unidentifiable naked cells. Phytoplankton populations at the 106-Mile Site were found to be composed of a mixture of coastal and oceanic species, due to the location in a transitional area between coastal and oceanic waters and in the path of meandering Gulf Stream eddies.

Data from Hopkins et al. (1973) indicate the summer chlorophyll values at the 106-Mile Site are highest at or near the surface, decrease to very low levels at 100 m depth, and then slowly rise to a second maximum (much smaller than the first) at depths greater than 1,000 m. Steele and Yentsch (1960) observed these chlorophyll concentrations at great depths and attributed these higher concentrations to the sinking of phytoplankton until their density equals that of the surrounding water. The subsurface accumulation of chlorophyll occurs at depths where water density, inversely related to temperature, is increasing most rapidly. This phenomenon becomes more apparent as the summer progresses and is most distinct in Slope waters. This midwater accumulation of chlorophyll disappears with the destruction of stratification of the water column in fall.

More data exist on phytoplankton in mid-Atlantic Continental Shelf and Slope waters than exist for the 106-Mile Site. The locations of the stations from which phytoplankton samples have been taken are shown in Figure A-15. The available information indicates that the phytoplankton population in the mid-Atlantic is comprised mainly of diatoms during most of the year. Hulburt (1963, 1966, 1970) described 33 abundant phytoplankton species, of which 27 were diatoms, 4 were dinoflagellates, and 2 were nannoflagellates. Hulburt (1963, 1966, 1970) and Hulburt and Rodman (1963) found that *Rhizosolena alata* dominates during summer, and *Thalassionema nitzschioides*, *Skeletonema costatum*, *Asterionella japonica*, and *Chaetoceros socialis* dominate during winter. Spring dominants include *Chaetoceros* spp. and *Nitzschia seriata*. *Thalassionema nitzschioides* dominates in fall.

In several studies, phytoplankton densities ranged between 10^3 and 10^6 cells/liter, generally decreasing with distance from land (Hulburt, 1963, 1966, 1970). Major pulses in phytoplankton abundance were due to four neritic

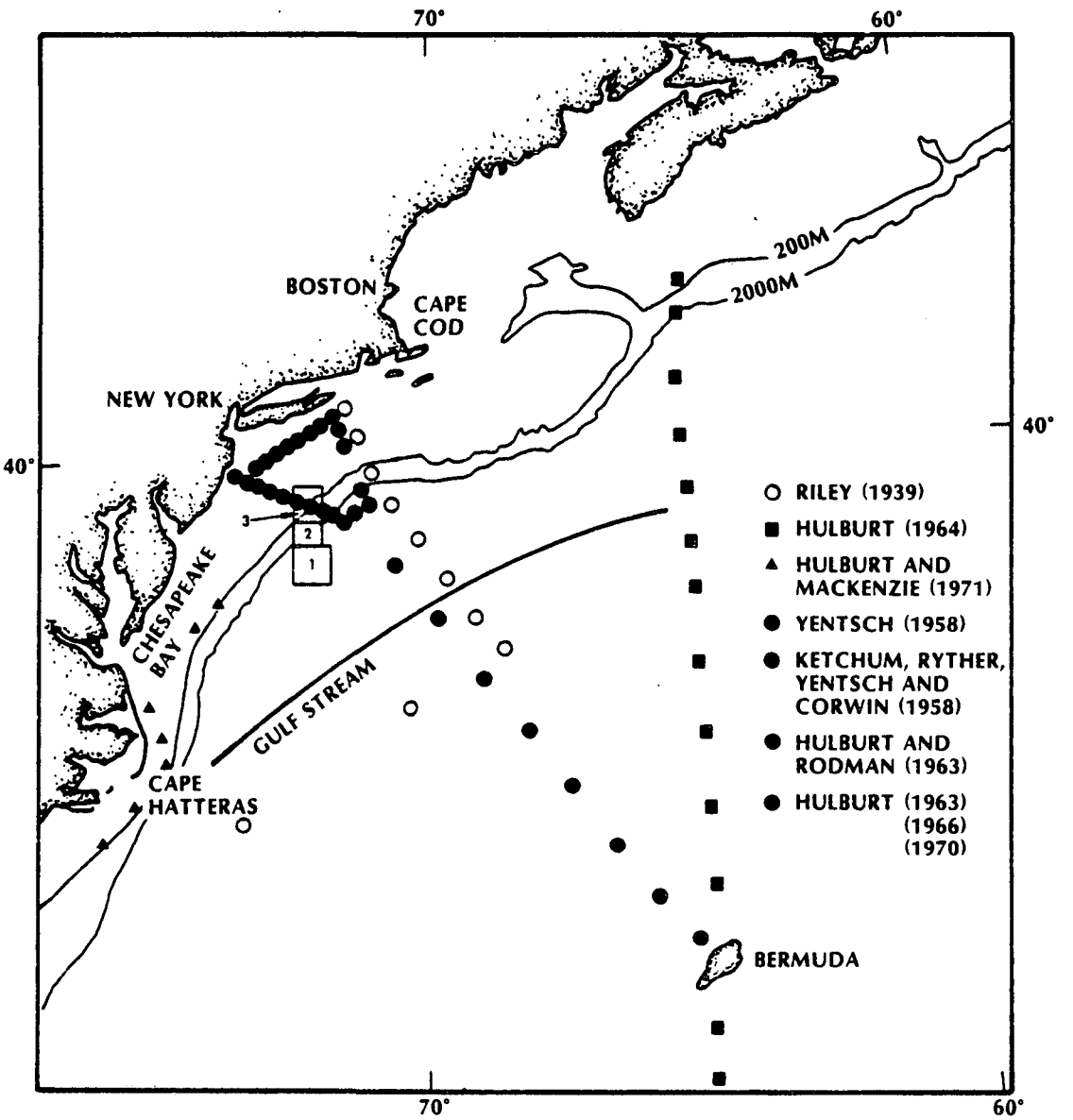


Figure A-15. Station Locations of Major Phytoplankton Studies in the Northeastern Atlantic
Source: Chenoweth, 1976b

diatom species: Skeletonema costatum, Asterionella japonica, Chaetoceros socialis, and Leptocylindrus danicus (Hulburt, 1963, 1966, 1970; Malone, 1977). Uniform distributions were exhibited by Rhizosolena alata in summer, and Thalassionema nitzschioides in winter. The flagellates Chilomonas marina, C. gracilis, Ceratium lineatum, Katodinium rotundatum, Oxytoxum variabile, and

Abundance was greatly reduced at greater depths. The dominant species of phytoplankton was a group of unidentifiable naked cells. Phytoplankton populations at the 106-Mile Site were found to be composed of a mixture of coastal and oceanic species, due to the location in a transitional area between coastal and oceanic waters and in the path of meandering Gulf Stream eddies.

Data from Hopkins et al. (1973) indicate the summer chlorophyll values at the 106-Mile Site are highest at or near the surface, decrease to very low levels at 100 m depth, and then slowly rise to a second maximum (much smaller than the first) at depths greater than 1,000 m. Steele and Yentsch (1960) observed these chlorophyll concentrations at great depths and attributed these higher concentrations to the sinking of phytoplankton until their density equals that of the surrounding water. The subsurface accumulation of chlorophyll occurs at depths where water density, inversely related to temperature, is increasing most rapidly. This phenomenon becomes more apparent as the summer progresses and is most distinct in Slope waters. This midwater accumulation of chlorophyll disappears with the destruction of stratification of the water column in fall.

More data exist on phytoplankton in mid-Atlantic Continental Shelf and Slope waters than exist for the 106-Mile Site. The locations of the stations from which phytoplankton samples have been taken are shown in Figure A-15. The available information indicates that the phytoplankton population in the mid-Atlantic is comprised mainly of diatoms during most of the year. Hulburt (1963, 1966, 1970) described 33 abundant phytoplankton species, of which 27 were diatoms, 4 were dinoflagellates, and 2 were nannoflagellates. Hulburt (1963, 1966, 1970) and Hulburt and Rodman (1963) found that Rhizosolena alata dominates during summer, and Thalassionema nitzschioides, Skeletonema costatum, Asterionella japonica, and Chaetoceros socialis dominate during winter. Spring dominants include Chaetoceros spp. and Nitzschia seriata. Thalassionema nitzschioides dominates in fall.

In several studies, phytoplankton densities ranged between 10^3 and 10^6 cells/liter, generally decreasing with distance from land (Hulburt, 1963, 1966, 1970). Major pulses in phytoplankton abundance were due to four neritic

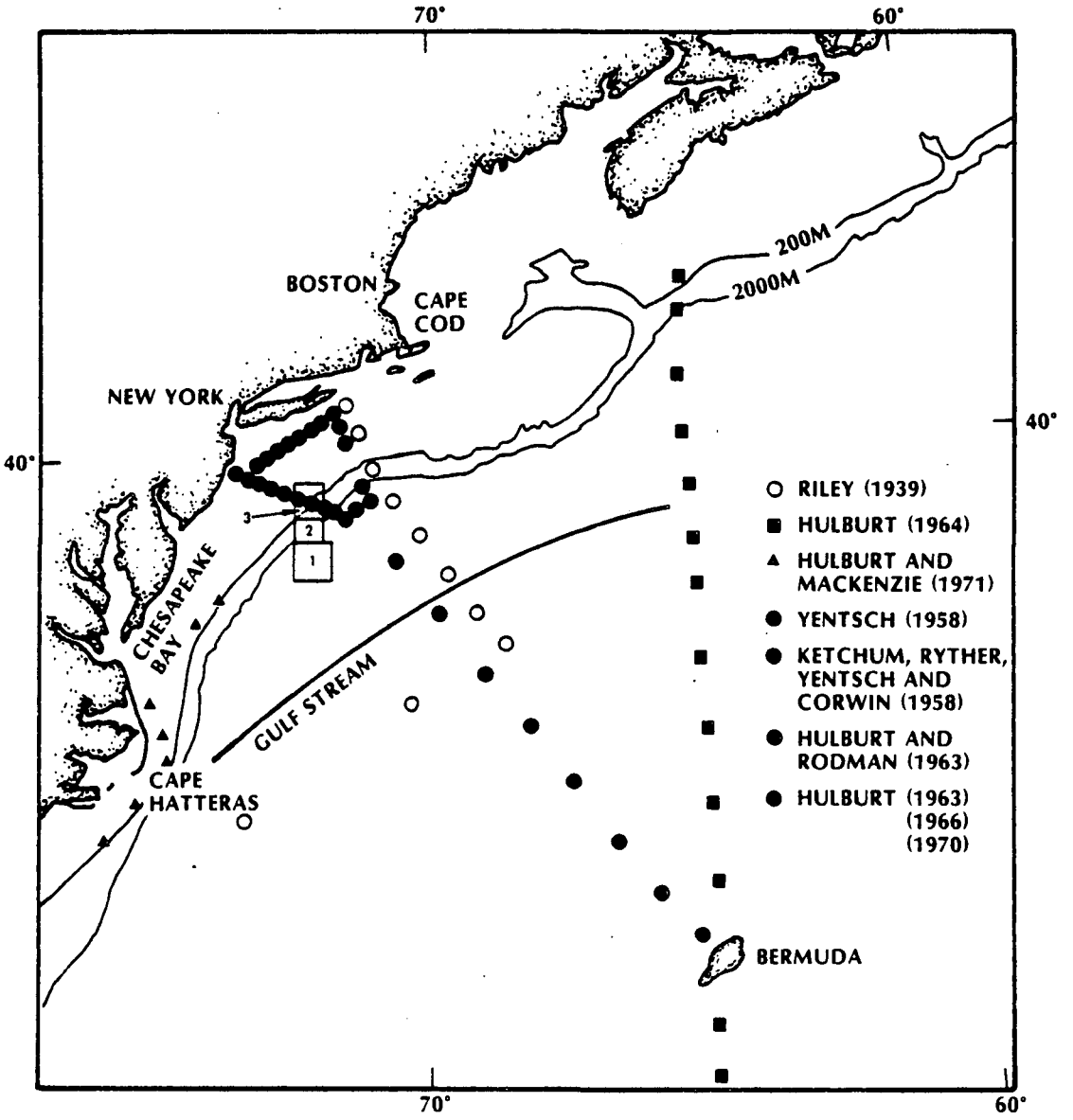


Figure A-15. Station Locations of Major Phytoplankton Studies in the Northeastern Atlantic
Source: Chenoweth, 1976b

diatom species: Skeletonema costatum, Asterionella japonica, Chaetoceros socialis, and Leptocylindrus danicus (Hulburt, 1963, 1966, 1970; Malone, 1977). Uniform distributions were exhibited by Rhizosolena alata in summer, and Thalassionema nitzschioides in winter. The flagellates Chilomonas marina, C. gracilis, Ceratium lineatum, Katodinium rotundatum, Oxytoxum variabile, and

Prorocentrum micans were locally abundant, but rarely dominant during summer. Maximum cell densities were observed in December, and minimum densities in July (Malone, 1977). Major changes in species composition occur inshore to offshore. Dominant coastal species are primarily chain-forming centric diatoms (Smayda, 1973), which require relatively high concentrations of nutrients to sustain high bloom populations and are subject to wide seasonal variations in abundance and diversity. Of secondary importance in coastal waters are the dinoflagellates and other flagellated groups. In contrast, oceanic waters under some influence of the Gulf Stream carry a phytoplankton community characterized by dominance of coccolithophorids, diatoms, dinoflagellates, and other mixed flagellates (Hulburt et al., 1960; Hulburt, 1963), all of which require somewhat lower nutrients and are subject to reduced or dampened seasonal variations in abundance.

Riley (1939) showed the vertical distribution of phytoplankton from a Slope Water station adjacent to the Continental Shelf and a station near the outer boundary (Figure A-16). The inner station is characteristic of Shelf Waters having higher surface abundance (2.5 µg/liter chlorophyll a) with the phytoplankton disappearing at about 100 m depth. The outer Slope station has relatively fewer surface phytoplankton (0.9 µg/liter chlorophyll a) but cells are found at a greater depth (200 m). This illustrates the transition, in terms of vertical abundance, between coastal and open ocean characteristics within the Slope Water (Chenoweth, 1976b). Mid-Atlantic Shelf Waters are well-mixed during winter and strongly stratified during summer. This sharp seasonal distinction is reflected in the seasonal changes in phytoplankton abundance. During summer, diversity is high, while at other times, when growth conditions are more favorable, diversity is lowered. In Slope Waters, the seasonal cycle is characterized by two equally intense pulses of chlorophyll - the spring and fall blooms (Yentsch, 1977). In Shelf Waters, the fall bloom is the most intense feature of the seasonal cycle. Chlorophyll concentrations vary regionally and seasonally from less than 0.5 mg/liter to about 6 mg/liter (Smayda, 1973). The seasonal variations in mean chlorophyll content for the inshore (less than 50 m depth) and offshore (greater than 1,000 m depth) stations are given in Figure A-17. The annual range in primary production (Figure A-18) does not differ appreciably between inshore

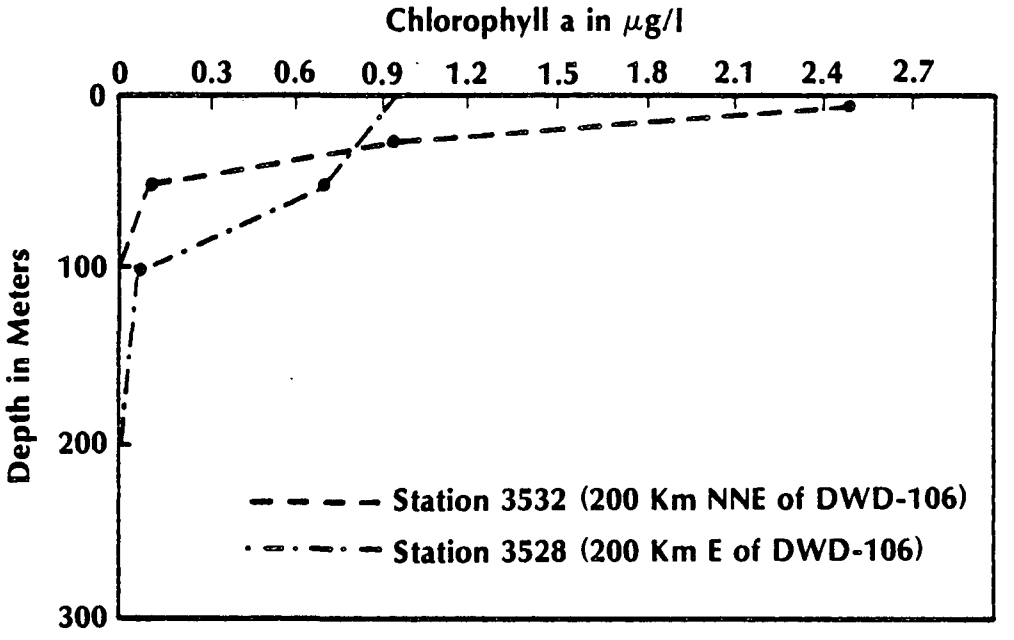


Figure A-16. Vertical Distribution of Chlorophyll a
Source: Riley, 1939

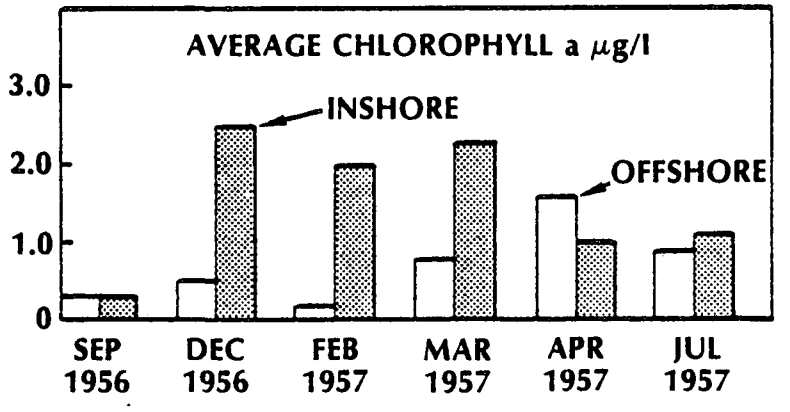


Figure A-17. Summary of the Average Chlorophyll a Concentrations at Inshore (less than 50 m depth) and Offshore (greater than 1,000 m depth) Sites in the Mid-Atlantic Bight
Sources: Ryther and Yentsch, 1958; Yentsch, 1963

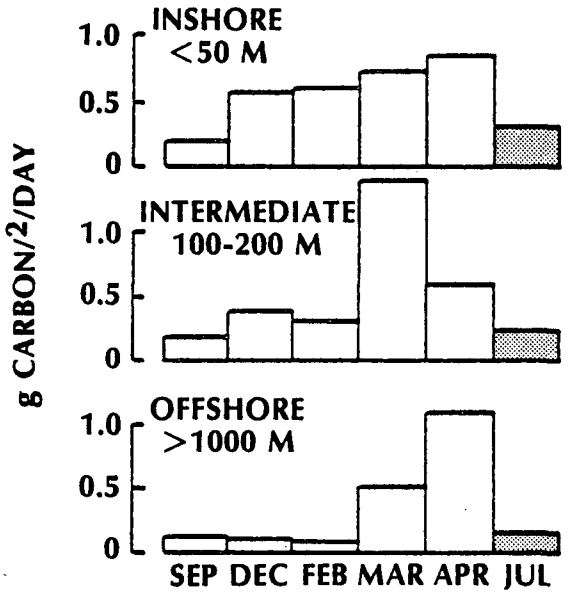


Figure A-18. Summary of Mean Daily Primary Production per Square Meter of Sea Surface at Inshore (less than 50 m depth), Intermediate (100 to 200 m depth), and Offshore (greater than 1,000 m depth) Sites in the Mid-Atlantic Bight
Source: Ryther and Yentsch, 1958; Yentsch, 1963

(0.20 to 0.85 g C/m^2/day) and offshore stations (0.10 to 1.10 g C/m^2/day) (Ryther and Yentsch, 1958). However, the total annual production differs over the Shelf and Slope, with an annual production of 160 g C/m^2 at the inshore stations (less than 50 m) decreasing progressively seaward to 135 g C/m^2 at the intermediate locations (100 to 200 m depth), and 100 g C/m^2 at the offshore stations (greater than 1,000 m depth).

Ketchum et al. (1958a) indicated that the nutrient-impoverished offshore areas (Slope Water) result in physiological differences between inshore and offshore phytoplankton. Results of their light and dark bottle experiments show differences in the ratio of net to gross photosynthesis; high ratios in September and February indicated healthy, growing populations, whereas lower ratios in December and March indicated less healthy populations. Geograph-

ically, the low ratio of offshore populations indicated poorer physiological conditons. Ketchum et al. (1958a) suggested that this variation of net gross photosynthesis ratios may be the result of nutrient deficiencies, particularly in the offshore waters.

The critical depth, the depth to which plants can be mixed and at which the total photosynthesis for the water column is equal to total respiration (of primary producers), accounts for the low total annual production in the offshore waters. Although compensation depth and the critical depth for mid-Atlantic waters are not precisely known, Yentsch (1977) estimates the depths to exist between 25 and 40 m depth and at 150 m depth, respectively. If this estimate is accurate, critical depths are not encountered on the Shelf, since the average water depth is about 50 m. Beginning in fall, extensive vertical mixing occurs with the cooling of surface waters and an increase in wind velocity. Since Shelf Waters are mixed to the bottom during fall and winter, the average plant cell within the water column receives adequate light for production. In addition, the plants have access to the nutrients dissolved within the entire water column, and, since production is limited by light only, production can proceed at a moderately high level.

Concentrations of chlorophyll decrease during fall and winter, moving from the Shelf to the Slope (Yentsch, 1977). As winter conditions intensify, Slope chlorophyll concentrations become much lower than Shelf Water concentrations. This is due to Slope Waters which are deep enough for critical depth conditions to occur, since these waters are mixed to a depth of 200 m or more. Therefore, although daily photosynthesis may equal or exceed that of Shelf Waters (Ryther and Yentsch, 1958), the average plant cell within the Slope Water column does not receive sufficient light to grow, and production proceeds at a low level.

In the spring, vertical mixing is impaired first in shallow waters and then progessively seaward into deeper waters (Yentsch, 1977). Following the development of the thermocline, there is a brief period of high production, since cells above the thermocline are now exposed to much greater radiation. Therefore, the spring bloom begins, and then is impaired, first on the Shelf and, later, progressively seaward to the Slope. The spring bloom is of

greater magnitude in Slope Waters than in Shelf Waters, since the nutrients have not been depleted by growth during the winter. Oligotrophic conditions prevail in Shelf and Slope Waters during the summer until the cooling and mixing processes of fall destroy the thermocline. The fall bloom occurs during the transition from a stratified to a mixed water column.

ZOOPLANKTON

Zooplankton are the passively swimming animals of the water column and contain members of nearly every phylum. Zooplankton represent the second trophic level of the food chain, since the group is dominated by herbivorous crustacea (copepods, euphausiids, amphipods, and decapods) which graze on the phytoplankton. Zooplankton studies performed at the 106-Mile Site (Austin, 1975; Sherman et al., 1977; Harbison et al., 1977) have confirmed the variable and transient nature of water masses in the area of the site. The composition of the zooplankton population was found to be the result of mixing of the Shelf, Slope, and Gulf Stream water masses. Even within areas for which the water mass could be identified, Sherman et al. (1977) could not differentiate species characteristic for the area. However, the contour of diversity indices was such that a differentiation could be made between Shelf and Slope Waters (Chenoweth, 1976c). Copepod populations in Shelf Waters were dominated by boreal assemblages characterized by high abundance and few species, while the Slope Waters contained a mixture of subtropical and boreal assemblages which resulted in lower abundance of individuals and a greater number of species.

The seasonal zooplankton biomass range was 7.7 to 1,780 ml/1,000 m^3 in summer and 5.5 to 550 ml/1,000 m^3 in winter. The displacement volumes are comparable with the literature values for Shelf and Slope Waters. The dominant zooplankton species found at or near the 106-Mile Site during various seasons of the year are listed in Table A-11. The most common copepod genera are Centropages, Calanus, Oithona, Euaugaptilus, Rhincalanus, and Pleuromamma. Centropages and Calanus predominate in the Shelf and also in areas where Shelf Water intrusions occur in the Slope Water. Calanus is least abundant in the offshore areas where water column stability suggests an oceanic origin.

TABLE A-11
DOMINANT ZOOPLANKTON SPECIES IN THE VICINITY OF THE 106-MILE SITE
(NUMBER OF SAMPLES IN WHICH THE SPECIES COMPRISED 50% OR MORE
OF THE INDIVIDUALS OF THAT GROUP/NUMBER OF STATIONS SAMPLED)
Source: Austin, 1975.

GROUP	SPECIES	Summer 1972	Winter 1973	Spring 1974	Winter 1976
Copepods	*Centropages* spp.			3/22	
	C. typicus	3/18			2/22
	Clausocalanus arcuicornis	2/18			
	Oithona similis				1/22
	O. spinirostris	4/18			
	Pleuromamma borealis			1/22	
	P. gracilis	5/18	4/16		10/22
	Pseudocalanus minutus		5/16		1/22
	Rhincalanus cornutus			1/22	
	Temora longicornis	1/18			
Euphausiids	*Euphausia americana*			2/21	
	Meganyctiphanes norvegica	1/16			
	Nyctiphane couchii			7/21	
	Stylocheiron elongatum			4/21	
	Thysanoessa gregaria				2/21
Chaetognaths	*Sagitta enflata*	4/16			
	S. serratodentata		1/17		
	S. spp.	2/16			2/21
Pteropods	*Limacina helicina*			1/21	3/21
	L. retroversa				3/21
	L. trochiformis		4/17		
	L. sp. (Juveniles)	1/16	4/17		

Mixing of waters has been demonstrated by the presence of Gulf Stream Water in the center of the disposal site study area, demonstrated by the abundance of *Rhincalanus*, *Euaugaptilus*, *Oithona*, and *Pleuromamma*. A copepod common to deep waters of the northwestern Atlantic, *Euchirella rostrata*, was found at all the stations.

The chaetognaths are dominated by Sagitta species and are most abundant over the Shelf (greater then $23/m^3$) and least abundant beyond the Shelf break (less than $10/m^3$). The euphausiids found at the 106-Mile Site are a mixture of boreal-arctic and subtropical species which were dominated by Nyctiphanes couchii, a cold-water form. Warm water species of the Euphausia and Stylocheiron genera were also dominant. Pteropods were dominated by species of Limacina.

Neuston organisms associated with the air-sea interface were sampled at the disposal site during various seasons. The results are summarized in Table A-12.

The zooplankton from Cape Cod to Hatteras have been studied more or less continuously for the past 50 years; the stations studied are shown in Figure A-19. However, results of many of these studies are not comparable due to the use of different techniques for sampling and the varied ways of expressing such parameters as abundance and biomass. Jeffries and Johnson (1973) point out that most of the studies were, at best, of only a few years' duration. Therefore, since few of the studies overlapped, the literature is sparse. The data clearly show, however, that fluctuations occur not only in the total mass of zooplankton, but in the abundance of some of the more common species.

The most striking feature of the mid-Atlantic zooplankton is the near-complete dominance of calanoid copepods, both numerically and volumetrically (Grice and Hart, 1962; Falk et al., 1974). Copepods also tend to show greater diversity than any of the other zooplankton groups (Falk et al., 1974). Nine species of copepods have been found to dominate the zooplankton at various times, viz., Centropages typicus, Metridia lucens, Paracalanus parvus, Pseudocalanus minutus, Oithona similis, Acartia tonsa, Temora longicornis, Clausocalanus furcatus, and Calanus finmarchicus. In addition, the ctenophore Pleurobrachia pileus and the pelagic tunicate Salpa fusiformis occasionally dominate.

TABLE A-12
DOMINANT NEUSTON SPECIES IN THE VICINITY OF THE 106-MILE SITE (NUMBER OF SAMPLES IN WHICH THE SPECIES COMPRISED 50% OR MORE OF THE INDIVIDUALS OF THAT GROUP/NUMBER OF STATIONS SAMPLED).
Source: Austin, 1975.

GROUP	SPECIES	Summer 1972	Winter 1973	Spring 1974	Winter 1976
Copepods	*Anomalocera patersoni*	3/18	3/15		
	Calanus finmarchicus		3/15		
	Candacia armata	1/18			
	Centropages typicus	5/18			1/18
	Clausocalanus arcuicornis	1/18			1/18
	Labidocera acutifrons	4/18			
	Metridia lucens		1/15		
	Oithona similis		1/15		
	Pleuromamma gracilis		2/15		12/18
	P. robusta				1/18
	Rhincalanus nasutus		1/15		
Euphausiids	*Eukrohnia hamata*				1/14
	Euphausia brevis	1/13			
	E. krohnii		1/15		
	E. spp.				1/14
	Meganyctiphanes norvegica				2/14
	Nematoscelis megalops		1/15		
	Nyctiphanes couchii			4/12	
	Stylocheiron robustum			5/12	
Chaetognaths	*Sagitta enflata*	7/13			
	S. serratodentata	1/13	1/15		2/14
	S. spp.	1/13	1/15		3/14
Pteropods	*Cavolina uncinata*			1/12	
	Creseis virgula conica			1/12	
	Limacina helicina		2/15		
	L. retroversa		1/15		
	L. sp. (Juveniles)	1/13	4/15		

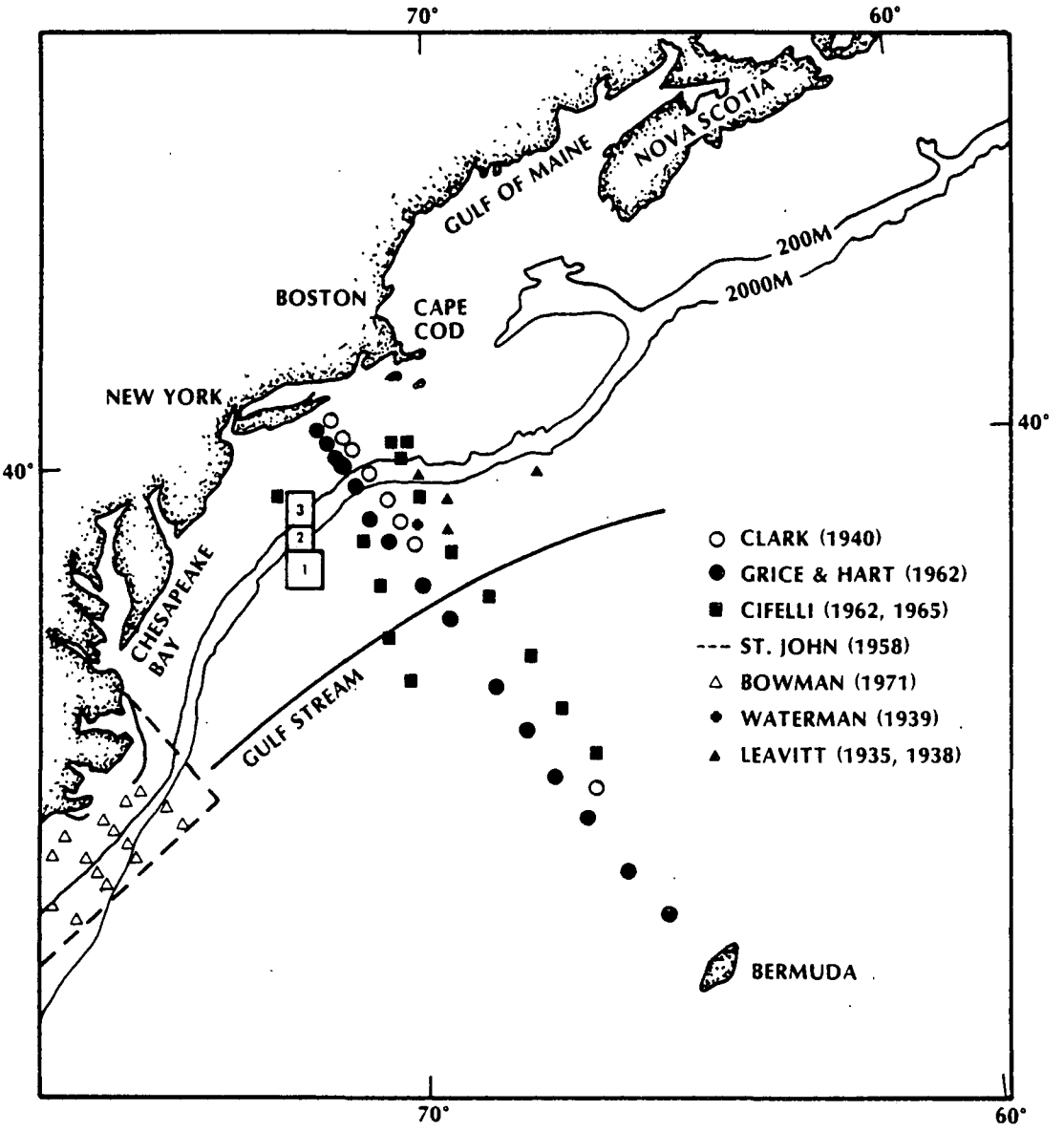


Figure A-19. Station Locations of Major Zooplankton Studies in the Northeastern Atlantic
Source: Chenoweth, 1976c.

The following information on the less abundant members of the zooplankton was reported by Chenoweth (1976c):

> Chaetognaths were the second most abundant numerically and volumetrically in Grice and Hart's (1962) transect study. In the four regions studied (shelf, slope, Gulf Stream, Sargasso Sea), chaetognath concentrations were highest in the shelf waters and lowest in the slope waters. The twelve species of

chaetognaths found in the slope water were of three distributional types: shelf species, Gulf Stream-Sargasso Sea species, and endemic slope water species. Sagitta elegans was the most abundant form in both the slope and shelf water. The two species endemic to the slope water (Sagitta maxima and Eukrohnia hamata) were found at a number of stations, mostly in March. They were cold-water forms that have been reported at a number of cold, (approximately 7.4°C) deepwater slope areas along the East Coast. Grice and Hart (1962) concluded that these species were indicative of cold waters in general and slope waters in particular.

The foraminifera are more closely associated with the hydrographic characteristics of water masses than any other zooplankton group and therefore, are often used as indicators of water mass mixing. The faunal composition of foraminifera included twenty recognizable species. The shelf and inner slope was characteristically temperate throughout the year and was dominated by species of Globigerina. Important species were Globigerina bulloides, G. pachyderma incompta, G. inflata, and G. aff. quinqueloba. Towards the Gulf Stream, the temperate fauna was gradually replaced by a diverse southern group dominated by Globigerinoides ruber, G. triloba, Globigerinella aequilateralis, Globorotalia truncatuli, and Pulleniatina obliquiloculata. The slope water yielded the highest abundance of foraminifera all year with the seasonal peak in the fall and the spring. The poorest concentration was found in the summer.

Euphausiids were not an important part of the total zooplankton collection of Grice and Hart, ranking fifth in mean displacement volume. However, they were a relatively important component in the slope waters (8.3 percent of the zooplankton volume with an average numerical abundance of 2.2/m). A succession of species indicated seasonal changes in the euphausiid population. September and December collections were characterized by a large number of diverse forms. Of the eleven species recorded, 6 were most typical of warmer Gulf Stream and Sargasso Sea water and indicated a mixing of these warmer waters in the slope area (Euphausia tenera, Stylocheiron abbreviatum, S. affine, S. carinatum, S. submii, and Nematoscelis microps). Two species were from neritic waters (Meganyctiphanes norvegica and Thysanoessa gregaria). Three species were practically endemic to the slope area (Nematoscelis megalops, Euphausia krohnii, and Euphausia pseudogibba). N. megalops was found to be breeding at most of the stations during March. The March and July samples produced few species and lower abundance. In March, the colder waters probably prevented the 6 warm-water species from occurring, and in July, large collections of salps may have affected euphausiid abundance.

Grice and Hart (1962) show that although the amphipods represented relatively low volumes and numbers, they were second only to the copepods in the number of species present. The number of species increased seaward with 8 recorded for the shelf, 15 for the slope water, 26 for the Gulf Stream, and 46 for Sargasso Sea. They were, however, relatively more abundant in the shelf waters than offshore. The most frequently occurring shelf and slope species were Parathemisto gaudichaudii and P. gracilipes. These were seasonally augmented by the occurrence of Gulf Stream and Sargasso Sea species.

Siphonophores were found to have more representation offshore than inshore. Of the 30 species recorded by Grice and Hart (1962), 17 were found in slope waters and only 4 in shelf waters. Volumetrically, they were more important in the Gulf Stream and Sargasso Sea. The molluscs are represented pelagically by the pteropods and heteropods. Grice and Hart (1962) reported 10 heteropod and 19 pteropod species from their transect, with very few found in the neritic environment. Of the cephalopods, squid larvae were a widely-distributed group of the oceanic component. However, their abundance never exceeded 6.2 per 1000 m^3.

Early investigators found that certain species of zooplankton were indicative of the continental region from which the samples were collected (Bigelow and Sears, 1939; Clarke, 1940). Grant (1977), employing cluster analysis, examined these indicator species and found that 3 distinct communities are present throughout much of the year: a coastal community, a central Shelf community, and a Slope boundary (oceanic) community. Grant found that the coastal community is identified in all seasons except spring by the great abundance of the copepod, Acartia tonsa. During spring, the coastal community is characterized by the simultaneous occurrence of Centropages hamatus and Tortanus discaudatus. Typical inhabitants of the central Shelf community include Centropages typicus, Calanus finmarchicus, Sagitta elegans, S. tasmanica, Nannocalanus minor, and Parathemisto gaudichaudii. C. typicus is the dominant organism, and, along with C. finmarchicus and S. elegans, is an indicator of this central Shelf community. A distinct faunal boundary exists at the Shelf break (200-m contour), with the organisms occurring offshore of this boundary being oceanic in nature. Useful indicators of this offshore water type include Metridia lucens, Pleuromamma gracilis, Euphausia krohnii, Meganyctiphanes norvegica, and Sagitta hexaptera. M. lucens has an extended distribution over the Shelf during winter and spring, as does M.

norvegica in spring (Grant 1977); however, other oceanic species are seldom found more than 16 to 24 km inside the 200-m contour (Sears and Clarke, 1940). Occasionally, Shelf Waters become temporarily "overridden" with an oceanic species (i.e., Salpa fusiformis) which reproduces rapidly, but this is due to local propagation and is not an indication of an unusually large mixture of Slope Water with Shelf Water, since other oceanic species occur only as traces (Sears and Clarke, 1940).

Although information is generally lacking, a preliminary description of the zooplankton seasonal cycle can be given. Grice and Hart (1962) noted that maximum displacement volume occurred in July (0.76 ml per m^3) and a minimum displacement in December (0.04 ml/m^3), a twenty-fold difference. Clarke (1940) reported a ten-fold seasonal difference; however, Grice and Hart (1962) considered their December values low because of a missing station and felt that it should be closer to 10 ml/m^3, which would be comparable to Clarke's value. The Shelf Water exhibited a much greater seasonal fluctuation (20- to 40-fold), whereas the Sargasso Sea volumes showed little seasonal variation. Similarly, the numerical abundance of zooplankton varied seasonally in the slope water but with lesser magnitude than neritic areas. Maximum average values ($571/m^3$) occurred in September and minimum values ($36/m^3$) in July. The March average ($504/m^3$) was similar to that of the Shelf Waters ($585/m^3$).

The available biomass data for the mid-Atlantic are summarized in Table A-13. Grice and Hart (1962) determined that the mean zooplankton standing crop in the Shelf Waters was about three times greater than in the Slope Waters, wherein it was three to four times greater than that of Gulf Stream and Sargasso Sea areas. If salps were included in the measurements, the Slope zooplankton were four times less abundant than those of the Shelf and nine to ten times more abundant than the zooplankton of the oceanic areas. This compares with Clarke's (1940) estimates (salps included) of the Slope Water zooplankton: four times less abundant than the Shelf zooplankton and four times more than oceanic areas. Examination of the numerical abundance and the displacement volumes of each taxonomic group indicates that this difference between Shelf and Slope Waters is not due to the disappearance or decline of any one group of organisms but apparently to the general reduction of zooplankton in Slope Waters (Grice and Hart, 1962).

TABLE A-13
ZOOPLANKTON BIOMASS IN THE MID-ATLANTIC

Region	Displ. Vol. $ml/1000m^3$	Wet wt. mg/m^3	Net Mesh mm	Depth Range m	Reference
Western North Atlantic					
Coastal	8100		0.158	0-25	Riley (1939)
Slope Water (spring)	4300		0.158	0-50	Riley (1939)
Slope Water (summer)		430-1600	0.158	0-400	Riley & Gorgy (1948)
Coastal (yearly mean)	540		10 strands/cm	0-85	Clarke (1940)
Offshore (yearly mean)	400		10 strands/cm	0-85	Clarke (1940)
Cape Cod-Chesapeake Bay					
Coastal					
(summer)	700-800			Variable	Bigelow & Sears (1939)
(winter)	400			Variable	Bigelow & Sears (1939)
Continental Slope 38°-41° N (autumn)	328		0.170	0-200 or less	Yashnov (1961)
New York-Bermuda					
Coastal Water (yearly means)	1070		0.230	0-200	Grice & Hart (1962)
Slope Water (yearly mean)	270		0.230	0-200	Grice & Hart (1962)

Several authors have noted that the most productive area for zooplankton seems to be near the edge of the Continental Shelf. The Grice and Hart (1962) data show the most consistent peaks of either biomass or numbers to be at the outer Shelf or inner Slope stations. During March, quantities for the inner Slope exceed (in biomass and abundance) that of any other area. Riley et al. (1949) also noted from their summary of existing data that the water at the edge of the Shelf was unusually rich in zooplankton.

The published biomass and abundance relationships from coastal to oceanic areas apply only to the surface zone since sampling in most surveys was at

depths less than 275 m. Examinations of the vertical distribution and diurnal migration of zooplankton in the Slope Waters indicates that significant numbers of organisms reside below the surface zone (Leavitt, 1935, 1938; Waterman et al., 1939). Leavitt's data show a series of peaks down to 2,000 m depth - the largest occurring at 600 to 800 m depth. From these data it was determined that between 40% and 90% of the animals were in depths less than 800 m; however, only one-half to one-fifth of the total volume occurred above 200 m depth. Waterman et al. (1939) determined that the malacostracan crustacea of the Slope Water migrated vertically from 200 to 600 m depth in response to light stimuli. This implies that there are a large number of zooplankton unaccounted for by the surface surveys. Leavitt (1938) concluded that the deep water zooplankton maximum was not due to the occurrence of a well-developed bathypelagic fauna, but was comprised of species such as Calanus finmarchicus and Metridia longa, which are abundant in boreal surface waters. He suggested that the deepest maximum resulted from the intrusion of water masses which originated in shallow waters of higher latitudes.

The neuston (organisms associated with the air-sea interface) of the mid-Atlantic comprise a unique faunal assemblage quite different from subsurface populations. The neuston is dominated during the day by the early life stages of fish, which are joined at night by the zoea and megalop stages of decapod crustacea, primarily Cancer sp., which migrate vertically into the neuston (Grant, 1977). The euneuston (organisms which spend their entire life cycle in the surface layer) is usually less abundant than the "facultative" neuston (organisms which spend only part of their life cycle in the surface layer). The euneuston is dominated by pontellid copepods and the isopod Idotea metallica.

NEKTON

Nekton are marine organisms (e.g., fish, cephalopods, and marine mammals) which possess swimming abilities sufficient to maintain their position and move against local currents. Nekton can be subdivided into three groups: micronekton, demersal nekton, and pelagic nekton. Micronekton consist of weakly swimming nekton (e.g., mesopelagic fish and squid) which are commonly collected in an Isaac-Kidd Midwater Trawl. Demersal nekton are the highly

motile members of the nekton associated with the bottom, whereas pelagic nekton inhabit the overlying waters. Nekton schools are highly mobile, migrate over long distances, and have unknown depth ranges, thus information on these organisms is limited and qualitative.

Investigations of midwater nekton at the 106-Mile Site by Krueger et al. (1975, 1977) have shown the community to be dominated by micronekton, gonostomatid, and myctophid fishes. During the day, most fishes are found at considerable depths (greater than 200 m), while at night, large numbers of the population migrate to the upper layers of the water column. During the day, between 50% and 80% of the catch in the upper 800 m was composed of Cyclothone species (family Gonostomatidae), while lanternfish (family Myctophidae) added 14% to 35%. Cyclothone species remain at depths greater than 200 m both day and night, but lanternfish migrate upwards at night, at which time they account for 95% of the catch in the upper 200 m. Above 800 m at night, the proportion of the population of Cyclothone species decreases, with a concomitant increase in the lanternfish portion, probably as a result of lanternfish migrating from below 800 m and becoming more easily caught at night. An estimated 20% of the population of lanternfish migrate from below 400 m during the day to the upper 200 m at night; one-third to two-thirds of these reach the upper 100 m (Krueger et al., 1977).

Most of the Cyclothone catch at the 106-Mile Site was attributable to C. microdon and C. braueri, the first and third most abundant species for all areas and seasons. C. microdon is most abundant below 500 m, whereas C. braueri predominates above 600 m. Both species appear to occur generally shallower in winter than in summer. Of the 50 species of lanternfish captured, only four were abundant. Krueger et al. (1977) reported Ceratoscopelus maderensis as the second most abundant species overall, but only by virtue of a single extremely large sample. Otherwise, this species was only moderately abundant during winter, and rare or absent during summer. Hygophum hygomi and Lobianchia dofleini were moderately abundant during summer but were virtually absent during winter. Adult Benthosema glaciale were abundant during winter, but during summer, the species was only moderately abundant and composed primarily of juveniles. Cyclothone and lanternfish contributed between 25% and 70% of the total biomass in the upper 800 m depending upon

area and diel period. Therefore, small numbers of larger species contribute greatly to the total fish biomass. Krueger et al. (1977) found that the larger fish inhabit depths greater than 300 m and speculated that these fish can concentrate toxic materials as a result of feeding on smaller fishes and larger zooplankton. Only five species, Benthosema glaciale, Lepidophanes guentheri, Cyclothone pallida, C. braueri, and C. microdon, were taken in all areas and seasons.

Krueger et al. (1977) concluded that the 106-Mile Site, in summer and winter, was characterized by a Slope Water fish fauna, upon which a Northern Sargasso Sea fauna, presumably transported to the disposal site by warm-core eddies, was superimposed. The Sargasso Sea species which were present in summer were less abundant in winter, suggesting that their presence and abundance are dependent upon eddy size, age, and/or core temperature.

The most common pelagic nekton in the 106-Mile Site include tunas, bluefin (Thunnus thynnus), yellowfin (T. albacares), big eye (T. obesus), and albacore (T. alalunga), swordfish (Xiphias gladius), lancetfish (Alepisaurus spp.), blue shark (Prionace glauca), mako shark (Isurus oxyrinchus), and dusky shark (Carcharhinus obscurus). All of these species are seasonal migrants north of Cape Hatteras and prey upon a variety of organisms (Casey and Hoenig, 1977). Approximately 50% and 30% of the tuna diet consist of fish and cephalopods, respectively. Crustaceans and miscellaneous organisms comprise the remainder of their diet. Swordfish feed on surface fish (e.g., menhaden, mackerel, and herring) and a variety of deepwater fish and cephalopods. Lancetfish feed on small fish and zooplankton. The blue and mako sharks feed mostly on small fish and cephalopods, while other sharks feed mainly on teleosts.

A considerable amount of information is available for mid-Atlantic nekton. The dominant micronekton groups are the (1) mesopelagic fish - myctophids, gonostomatids, sternoptychids; (2) crustaceans - penaeid and caridean shrimps, euphausiids, mysids; (3) cephalopods; and (4) coelenterates - medusae and siphonophores. These organisms form one of the major links in the pelagic food chain, since they provide forage for the animals of higher trophic levels. The mesopelagic fish occur in large schools which are continually changing depths. Characteristically, these fish are in the surface layers at

night and at great depths (1,200 meters) during the day. The general faunal composition of mesopelagic fishes in the Western North Atlantic consist of a few abundant and many rare species (Backus, 1970). Dominant, in terms of numbers of species and individuals, are the fishes from the families Myctophidae and Gonostomatidae.

The long-finned squid (Loligo pealei) and the short-finned squid (Illex illecebrosus) are two of the most abundant cephalopod species found in the mid-Atlantic. The former belongs to the family Loliginidae, which are primarily Continental Shelf species, and the latter is a member of the family, Ommastrephidae, which are oceanic squids. The long-finned squid migrates into shallow water in April to spawn. In October and November, as temperatures decrease in inshore areas, the long-finned squid moves offshore to the edge of the Continental Shelf. The short-finned squid spends January through April in rather dense aggregations along the outer Continental Shelf and Slope where the water temperatures are relatively warm. In the spring (April to May), when Shelf Waters begin warming, short-finned squid migrate shoreward. During the summer, fall, and early winter, they are widespread throughout the entire mid-Atlantic Continental Shelf. In November and December, they begin moving to deeper, warmer, offshore waters. Short-finned squid range throughout the water column to depths of at least 700 m.

The pelagic nekton include the large, oceanic fishes which are representatives of the family Scombridae (mackerels and tunas), Xiphiidae (swordfish), and Istiophoridae (marlins and sailfishes). The bluefin tuna (Thunnus thynnus) and the white marlin (Tetrapterus albidus) are the dominant species in the slope waters of the mid-Atlantic (Chenoweth et al., 1976a). Other common species include the swordfish (Xiphias gladius), albacore (Thunnus alalunga), and the skipjack tuna (Euthynnus pelamis).

The bluefin tuna is a highly migratory species which inhabits the waters of the New York Bight during critical periods of its life cycle. Giant bluefin (over 125 kg) pass northward annually through the Straits of Florida in May and June during or just after spawning. They follow the Gulf Stream northward and usually appear in mid-Atlantic Shelf Waters in June and July. Medium sizes (35 to 125 kg), which are believed to have spawned in the mid-Atlantic,

normally move inshore in June. All sizes have historically left these inshore feeding areas with the arrival of autumn storms. In winter, the species has generally been taken only by long-line fisheries over wide areas of the North Atlantic.

The movement of the white marlin follows a pattern similar to that of tuna, in that they move up the Florida current and Gulf Stream, into the mid-Atlantic Shelf and Slope Waters in the summer, and then return to the Lesser Antilles through the open ocean in the fall. The greatest summer abundance occurs off the New Jersey to Maryland coasts to about 1,800 m (Chenoweth et al., 1976a). These fish enter the area from the south about June and July, concentrate in the area during August, and then move directly offshore in September and October. The concentration of white marlin in summer is probably related to feeding habits, since spawning occurs in the Caribbean.

Swordfish range along the Shelf and Slope Waters of the mid-Atlantic coast during the summer months. In winter, the fish are confined to the waters of the Gulf Stream where surface temperatures exceed 15°C. In warmer months, they range over a much wider area by following the northern movement of the 15°C isotherm. Several components of the swordfish population are related to temperature. Females and larger, older individuals seem better able to tolerate cooler waters than males or small individuals. Swordfish populations at the edge of the Continental Shelf are, therefore, likely to consist primarily of large females.

The cetaceans (whales and dolphins) are wide-ranging marine mammals which transit mid-Atlantic Slope Waters. Data are sparse on species found in the Slope Water and the role that this region plays in their life history. The species of cetaceans found in the mid-Atlantic, with their range, distribution, and estimated abundance are summarized in Table A-14. From the data available on cetaceans in offshore waters, it appears that the Slope Waters serve as a migratory route between northern summering grounds and southern wintering grounds (Chenoweth et al., 1976). The proximity of rich feeding grounds along a north-south migration route would make the Slope Waters an extremely attractive region to the cetaceans. The 200-m isobath appears to be the inshore boundary for the distribution of some of the larger species.

TABLE A-14
WESTERN ATLANTIC CETACEANS

Family	Common Name(s)	Species Name	Western Atlantic Range and Distribution	Habitat	Estimated Abundance in Western North Atlantic
Balaenidae*	Right whale	Eubalaena glacialis	New England to Gulf of St. Lawrence; Possibly found as far south as Florida	Pelagic and coastal; not normally inshore	200-1000
Balaenopteridae*	Blue whale	Balaenoptera musculus	Gulf of St. Lawrence to Davis Strait: routinely sighted on banks fringing outer Gulf of Maine; Population much reduced from original number of about 1,100 in western N. Atlantic	Pelagic, deep ocean; however occasionally approaches land in deep water regions, e.g. the Laurentian Channel of the St. Lawrence River	Generally not common; some sightings expected in offshore regions; no estimates.
Balaenopteridae*	Sei whale	Balaenoptera borealis	New England to Arctic Ocean	Pelagic, does not usually approach coast	1,570 off Nova Scotia
Balaenopteridae*	Finback whale	Balaenoptera physalus	Population centered between 41°21'N and 57°00'N and from coast to 2000 m contour	Pelagic but enter bays and inshore waters in late summer	7,200
Balaenopteridae	Minke whale	Balaenoptera acutorostrata	Chesapeake Bay to Baffin Island in summer, eastern Gulf of Mexico, northeast Florida and Bahamas in winter	Pelagic, but may stay nearer to shore than other rorquals (except humpback)	No estimates
Balaenopteridae*	Humpback whale	Megaptera novaeangliae	Common near land but can be found in deep ocean	Approaches land more closely and commonly than other large whales; also found in deep ocean	800 - 1,500
Delphinidae	Killer whale	Orcinus orca	Tropics to Greenland, Spitzbergen Baffin Bay	Mainly pelagic and oceanic, however they do commonly approach coast	No estimates apparently not seen as commonly as in more northerly areas

TABLE A-14. (continued)

Family	Common Name	Species Name	Western Atlantic Range and Distribution	Habitat	Estimated Abundance in Western North Atlantic
Delphinidae	Saddleback dolphin	Delphinis delphis	Caribbean Sea to Newfoundland; very wide ranging; may be most widespread and abundant delphinid in world	Seldom found inside 100 m contour, but does frequent seamounts. esearpments, and other off shore features	Poorly known; probably more common than available records indicate; may be more common in Massachusetts Bay no estimates
Delphinidae	Atlantic Pilot whale	Globicephala melaena	New York to Greenland; Especially common in Newfoundland	Pelagic (winter) & coastal (summer)	No estimates; Most common whale seen in Cape Cod Bay; Schools of up to 300 on Georges Bank
Delphinidae	Bottle-nosed dolphin	Tursiops truncatus	Argentina to Greenland, but most common from Florida, West Indies, & Caribbean to New England	Usually close to shore & near islands; enters bays lagoons, rivers	Rare, especially in inshore regions; no estimates
Delphinidae	Grampus; Grey grampus, Risso's dolphin	Grampus griseus	Ranges south from Massachusetts	Coastal waters; habitat poorly known	Uncommon, but possibly not rare; no estimates
Physeteridae*	Sperm whale	Physeter catadon	Equator to 50°N (females & juveniles) or Davis Strait (males).	Pelagic, deep ocean	Estimated 22,000 inhabit North Atlantic Ocean
Physeteridae	Pygmy sperm whale	Kogia breviceps	Tropics to Nova Scotia	Pelagic in warm ocean waters	Very rare; only one record
Ziphiidae	Bottle-nosed whale	Hyperoodon ampullatus	Rhode Island to Davis Strait	Pelagic; cold temperate and subarctic waters	Poorly known; between 260-700 taken annually in North Atlantic Ocean, 1968-70
Ziphiidae	True's beaked whale	Mesoplodon mirus	Northern Florida to Nova Scotia	Nothing is known	Extremely rare; poorly known
Ziphiidae	Dense-beaked whale	Mesoplodon densirostris	Tropics to Nova Scotia	Probably pelagic in tropical and warm waters	Extremely rare: stray visitor

* Endangered Species

Source: From Chenoweth et al., 1976a.

TABLE A-14
WESTERN ATLANTIC CETACEANS

Family	Common Name(s)	Species Name	Western Atlantic Range and Distribution	Habitat	Estimated Abundance in Western North Atlantic
Balaenidae*	Right whale	Eubalaena glacialis	New England to Gulf of St. Lawrence; Possibly found as far south as Florida	Pelagic and coastal; not normally inshore	200-1000
Balaenopteridae*	Blue whale	Balaenoptera musculus	Gulf of St. Lawrence to Davis Strait: routinely sighted on banks fringing outer Gulf of Maine; Population much reduced from original number of about 1,100 in western N. Atlantic	Pelagic, deep ocean; however occasionally approaches land in deep water regions, e.g. the Laurentian Channel of the St. Lawrence River	Generally not common; some sightings expected in offshore regions; no estimates.
Balaenopteridae*	Sei whale	Balaenoptera borealis	New England to Arctic Ocean	Pelagic, does not usually approach coast	1,570 off Nova Scotia
Balaenopteridae*	Finback whale	Balaenoptera physalus	Population centered between 41°21'N and 57°00'N and from coast to 2000 m contour	Pelagic but enter bays and inshore waters in late summer	7,200
Balaenopteridae	Minke whale	Balaenoptera acutorostrata	Chesapeake Bay to Baffin Island in summer, eastern Gulf of Mexico, northeast Florida and Bahamas in winter	Pelagic, but may stay nearer to shore than other rorquals (except humpback)	No estimates
Balaenopteridae*	Humpback whale	Megaptera novaeangliae	Common near land but can be found in deep ocean	Approaches land more closely and commonly than other large whales; also found in deep ocean	800 - 1,500
Delphinidae	Killer whale	Orcinus orca	Tropics to Greenland, Spitzbergen Baffin Bay	Mainly pelagic and oceanic, however they do commonly approach coast	No estimates apparently not seen as commonly as in more northerly areas

TABLE A-14. (continued)

Family	Common Name	Species Name	Western Atlantic Range and Distribution	Habitat	Estimated Abundance in Western North Atlantic
Delphinidae	Saddleback dolphin	Delphinis delphis	Caribbean Sea to Newfoundland; very wide ranging; may be most widespread and abundant delphinid in world	Seldom found inside 100 m contour, but does frequent seamounts. esearpments, and other off shore features	Poorly known; probably more common than available records indicate; may be more common in Massachusetts Bay no estimates
Delphinidae	Atlantic Pilot whale	Globicephala melaena	New York to Greenland; Especially common in Newfoundland	Pelagic (winter) & coastal (summer)	No estimates; Most common whale seen in Cape Cod Bay; Schools of up to 300 on Georges Bank
Delphinidae	Bottle-nosed dolphin	Tursiops truncatus	Argentina to Greenland, but most common from Florida, West Indies, & Caribbean to New England	Usually close to shore & near islands; enters bays lagoons, rivers	Rare, especially in inshore regions; no estimates
Delphinidae	Grampus; Grey grampus, Risso's dolphin	Grampus griseus	Ranges south from Massachusetts	Coastal waters; habitat poorly known	Uncommon, but possibly not rare; no estimates
Physeteridae*	Sperm whale	Physeter catadon	Equator to 50°N (females & juveniles) or Davis Strait (males).	Pelagic, deep ocean	Estimated 22,000 inhabit North Atlantic Ocean
Physeteridae	Pygmy sperm whale	Kogia breviceps	Tropics to Nova Scotia	Pelagic in warm ocean waters	Very rare; only one record
Ziphiidae	Bottle-nosed whale	Hyperoodon ampullatus	Rhode Island to Davis Strait	Pelagic; cold temperate and subarctic waters	Poorly known; between 260-700 taken annually in North Atlantic Ocean, 1968-70
Ziphiidae	True's beaked whale	Mesoplodon mirus	Northern Florida to Nova Scotia	Nothing is known	Extremely rare; poorly known
Ziphiidae	Dense-beaked whale	Mesoplodon densirostris	Tropics to Nova Scotia	Probably pelagic in tropical and warm waters	Extremely rare: stray visitor

* Endangered Species

Source: From Chenoweth et al., 1976a.

Five species of sea turtles are known to be associated with mid-Atlantic coastal and Slope Waters (Table A-15). Three of the species (hawksbill, leatherback, and Atlantic ridley) are endangered, and the remaining two (green and loggerhead) are expected to soon be classified as endangered. Leatherbacks (Dermochelvy coriacea), loggerheads (Caretta caretta), ridleys (Lepidochelys kempi), and green turtles (Chelonia mydas) are regular migrants in East Coast waters, usually most numerous from July through October, at which time, the turtles follow their primary food (jellyfish) inshore. The exact migration route used by these organisms is not known.

The main components of the demersal nekton are flatfish (flounders, halibut, plaice, and sole), cartilaginous fishes (skates, rays, and torpedoes), and "roundfish" (cod, haddock, hake, and cusk). The diet of these groups consists mainly of bottom-dwelling animals (e.g., crustaceans, mollusks, echinoderms, and worms) although a number of the roundfish are predaceous on other fish and shrimp. Spawning activity occurs generally near the bottom, but in some cases the eggs, and in many instances the larvae, are pelagic.

Markle and Musick (1974) found 29 species and 17 families of benthic fishes in the Slope Waters of the region between Nantucket and Cape Hatteras. The dominant demersal fish in the mid-Atlantic were reported to be the synaphobranchid eel (Synaphobranchus kaupi), the macrourids (Mezumia spp.), the long-finned hake (Phycis chesteri), and the flatfish (Glyptocephalus cynoglossus). Schroeder (1955) reported that numbers and weights of fish caught increased between 400 and 1,000 m depth. Slope levels below 1,000 m were regions of reduced abundance, biomass, and diversity, with the 1,000-m isobath being the point at which a significant change occurs. The most significant species of demersal fish found in Slope Waters, and the average abundance, are listed in Table A-16. Generally, the deeper-water forms (e.g., the macrourids [grenadiers], offshore hakes, batfish, and stomiatoids) are found in low quantities scattered throughout the area. These species are probably never as abundant as the shallower water forms which are found in the upper Slope levels.

TABLE A-15

THREATENED AND ENDANGERED TURTLES FOUND IN MID-ATLANTIC SLOPE WATERS

Common Name	Species Name	Geographic-Bathymetric Range	Habitat	Reason for Decline
+Hawksbill turtle	Eretmochelys imbricata	tropical waters, rare in New England waters, nests on Carribean shores and along Atlantic coast to Brazil on undisturbed beaches.	deep ocean	heavily exploited for shell
+Leatherback turtle	Dermochelvy coriacea	New England waters summer-autumn. Closely associated with slope waters during migration	highly pelagic, feeds on pelagic jellyfish	some slaughter by fishermen, eggs collection on breeding grounds
*Loggerhead turtle	Caretta caretta	New England waters summer-autumn. Migrate Atlantic coast to/from Sargasso Sea	frequently signted in coastal waters, more littoral than leather-back or hawks-bill	predation by racoons and people, egg destruction of breeding beaches due to coastal development
*Green turtle	Chelonia mydas	occasionally seen in New England waters in summer. Tropical oceans. Rare north of Cape Cod.	deep slope waters between Gulf Stream and littoral feeding grounds	reduction of breeding grounds and commercial exploitation
+Atlantic ridley	Lepidochelys kempi	New England waters during summer months, breeds on more tropical beaches	more littoral than leather-back or hawks-bill	eggs plundered on breeding beaches

*proposed threatened status +endangered species

Water over the mid-Atlantic Continental Shelf contains few permanent residents. The fish fauna is composed primarily of continuously shifting populations which move north, many into the Gulf of Maine, during the warm months, and retreat south during the cold months (Larsen and Chenoweth, 1976). During the spring, along the Shelf edge and upper Slope, the weight and numbers of fishes are far greater than in the fall. This is particularly true of highly migratory forms such as silver hake (Merluccius bilinearis), spiny dogfish (Squalus acanthias), and red hake (Urophycis tenuis). The overall average of numbers of fish caught and their catch weight in the spring were 684 and 819 kg, respectively, in contrast to 374 and 140 kg in the fall.

BENTHOS

The benthos of the 106-Mile Site exists at abyssal depths on the lower mid-Atlantic Continental Slope and Rise. Research on the Slope faunal assemblages was begun only recently, and has centered around the contributions of comparatively few investigators. This accounts for the sparse amount of data with respect to Continental Slope benthic populations, particularly at the 106-Mile Site. There is substantial evidence, however, that the major components of faunal assemblages at various Slope depths do not change significantly throughout the mid-Atlantic and neighboring areas (Larsen and Chenoweth, 1976; Rowe et al., 1977; Pearce et al., 1977a). Thus, it is possible to use faunal data from adjacent areas in order to enhance the data and interpretations associated with the disposal site fauna.

Variations in sediment types are generally recognized as primary factors which influence benthic faunal distributions on the mid-Atlantic Shelf. These factors, however, are of doubtful importance in influencing benthic faunal distributions in the 106-Mile Site Slope area, due to minimal sediment variations within similar areas (Rowe and Menzies, 1969). Temperature can be discounted as an important factor since no seasonal changes or variations with depth occur below 1,000 m (Larsen and Chenoweth, 1976; Rowe and Menzies, 1969). It has not been determined to what extent species interaction within the site determines faunal composition and zonation, but competitive exclusion may be a critical factor (Sanders and Hessler, 1969).

TABLE A-16
AVERAGE NUMBER AND WEIGHT PER TOW OF DEMERSAL FISH TAKEN AT SHELF EDGE AND SLOPE DURING FALL AND SPRING TRAWL SURVEYS, 1969 - 1974

Common Name	Species Name	Shelf Break				Slope			
		Fall		Spring		Fall		Spring	
	Av. No.	Av. Wt.	Av. No. (kg)	Av. Wt.	Av. No. (kg)	Av. Wt.	Av. No. (kg)	Av. Wt.	(kg)
Silver Hake	*Merluccius bilinearis*	13	3	30	25	8	5	76	66
Offshore Hake	*M. albidus*	1	1	1	1	3	3	6	8
Red Hake	*Urophycis chuss*	2	2	7	9	1	1	36	32
White Hake	*U. tenuis*	1	1	1	1	1	2	2	16
Spiny Dogfish	*Squalus acanthias*	1	1	69	350	1	1	80	468
Mackerel	*Scomber scombrus*	1	1	99	158	1	1	5	8
Butterfish	*Poronotus triacanthus*	263	67	130	57	14	3	57	18
American Goosefish	*Lophius americanus*	2	3	1	12	2	14	2	44
Witch Flounder	*Glyptocephalus cynoglossus*	1	1	1	1	1	1	3	3
Black Bellied Redfish	*Helicolenus dactylopterus*	2	1	1	1	13	3	13	3
Northern Sea Robin	*Prionotus carolinus*								
Striped Sea Robin	*P. evolans*	1	1	169	67	1	1	2	1
Armored Sea Robin	*Peristedion miniatum*								
Batfish	*Ogcocephalus vespertilio*								
Pearlsides	*Maurolicus* spp.	187	1	3	1	24	1	7	1
Greeneye	*Chloropthalmus agassizii*								

Source: Adapted from Larsen and Chenoweth, 1976.

Deep-sea nutrition is probably the most important factor which influences benthic faunal distributions in the site vicinity. Larsen and Chenoweth (1976) hypothesize that the lower levels of available organic carbon at greater depths are key factors which determine faunal biomass and density in the deep benthos. The importance of competitive exclusion relates directly to the abundance and distribution of nutrients.

Food materials consumed by the benthic fauna of the 106-Mile Site, the associated food sources, and transport mechanisms are incompletely known. Several dominant species of fish in the site are known to feed only upon epibenthic and infaunal invertebrates, whereas other fish feed primarily on pelagic items (Cohen and Pawson, 1977; Musick et al., 1975). Most of these pelagic items were diurnal migrants, which correlated with the views of Sanders and Hessler (1969) with respect to the importance of these migrants in efficient transport of food from the euphotic zone to deeper layers. The majority of fish at the site are probably generalized feeders, since this is characteristic of the fish inhabiting greater depths (Haedrich et al., 1975) and many generalized feeding fish have been found at the site (Musick et al., 1975).

The dominant epibenthic and infaunal invertebrates of the site are deposit feeders whose abundance and distribution would depend upon the availability of detrital food items (Jones and Haedrich, 1977; Pearce, 1974). It is generally recognized that the food supply of the benthos originates from shallower areas, particularly the euphotic zone (Sanders and Hessler, 1969), but the primary mechanism by which the food is transported to the deeper layers is uncertain. The most important mechanism transporting detritus to the benthos of the site is probably the passive sinking of potential food items. Turbidity currents may also play some part, but their role has been discounted (Sanders and Hessler, 1969).

Many authors have recognized distinct quantitative and qualitative zones of distribution for the benthic fauna of mid-Atlantic Continental Slope areas. The number and demarcation of zones may vary between authors, but they all center their zones on an axis horizontal or vertical to the Slope. Cohen and Pawson (1977) describe a horizontal distribution pattern of benthic fish and

invertebrates in the site. They observed great variance in the abundance of the four most common epibenthic invertebrates from one site region to the next, but were hesitant to label this distribution as patchy.

Vertical distributions are more commonly recognized in the site, the general trend being one of decreasing numbers of taxa and individuals with increasing depth (Cohen and Pawson, 1977; Pearce et al., 1977a; Musick et al., 1975). This trend is typical for Slope and deep-sea areas (Haedrich et al., 1975; Rowe and Menzies, 1969; MacDonald, 1975). Musick et al. (1975) recognize the Shelf-Slope break above the site as an area of increased diversity, species richness, and biomass of benthic fish populations. This pattern remained stable down to the 2,200 m depth of the site, where it rapidly declined. Haedrich et al. (1975) also recognized these two zones in an area northeast of the site.

Surveys of the benthos in the site have found no species of present commercial importance and only a few of potential importance. The shellfish commonly harvested on the adjacent Shelf, including the surf clam, sea scallop, and southern quahog, do not extend their range onto the Continental Slope. The lobster, presently fished in canyon and Shelf areas above the site, is not found in the site (Pratt, 1973). The red crab, Geryon quinquidens, is a potential commercial species of the mid-Atlantic but is found only in Slope areas shallower than the site (Musick et al., 1975; Pratt, 1973).

No demersal fishes of commercial importance are presently being harvested from the site vicinity, and only a few potential species have been found there. Two dominant site species, Coryphaenoides cupestris and Alepocephalus agassizii, have been harvested experimentally by the Russian and British fishing industries from areas outside the site. Waters containing the site serve as a nursing ground for Glyptocephalus cynoglossus, the adults of which support a fishery elsewhere (Musick et al., 1975).

Musick et al. (1975) reported 48 species of demersal fishes from 12 trawl stations in and around the 106-Mile Site. They described the diversity of the fish community as being higher than that of estuarine and Shelf communities.

The dominant species of fishes were different at each deeper station within the site: Synaphobranchus kaupi at shallower depths, Nezumia bairdii and Antimora rostrata at mid-depths, and predominantly Coryphaenoides armatus at the deepest stations. At increasing depths, the smaller species decreased in number and the larger species increased in number. This resulted in the steady level of biomass observed throughout the site, as mentioned above, but with an increasingly smaller number of fish comprising the biomass at each depth.

Cohen and Pawson (1977) observed 55 species of fishes during 9 dives in the deep sea research vessel (DSRV) ALVIN. They described the overall distribution as patchy and noted that most of the species were rarely encountered. The six most common fishes included two of the dominant species in the above study: the eel, Synaphobranchus kaupi, and the morid, Antimora rostrata. The other four species were the rattails, Nematonurus armatus and Lionurus carapinus, the halosaur, Halosauropsis macrochir, and the lizard fish, Bathysaurus ferox. Densities of fishes in two depth zones were estimated by counting fish along six transects. There was a relative abundance of fish, showing patchy distribution, from 1,720 to 1,819 m depth. The range of densities for this depth zone was 5.7 to 32.8 fishes per 1,000 m^2. The density from 2,417 to 2,545 m depth was lower, ranging from 1.83 fishes per 1,000 m^2, and the fishes were distributed more evenly. The dominant species listed above are common dominants of the mid-Atlantic (Larsen and Chenoweth, 1976).

The epibenthic invertebrates of the 106-Mile Site have been described in two studies, by Cohen and Pawson (1977) and Rowe et al. (1977), both of which are based on visual and photographic observations from the DSRV ALVIN. These studies were limited by the observers' abilities to detect epibenthic invertebrates from the vantage point of the ALVIN'S viewports and in photographs. Animals which avoid submersible vehicles will be consistently missed by both methods. This is assumably what caused the "selectivity" of the former study; Cohen and Pawson do not indicate if other detectable invertebrates were selectively omitted from the report. Although it is

unknown how many species may be missing, the reported results most likely include all the dominant species and major contributors to the total biomass of epibenthic invertebrates in the site.

According to Cohen and Pawson (1977), the four most abundant invertebrates in decreasing order, and peak densities per 1,000 m^2, were Ophiomusium (brittle star), 2,445; Cerianthus sp. (tube anemone), 813; Echinus affinus (sea urchin) 259; and Euphronides (holothurian), 101. Rowe et al. (1977) reported identical results for numerical dominance with the exception of the substitution of Phormosoma placenta (sea urchin) for Euphronides. The average number of species was $2.36/m^2$, ranging from 0.25 to $5.15/m^2$. In studies of similar areas to the north of the site (Jones and Haedrich, 1977; Haedrich et al., 1975), Ophiomusium was consistently found to be the most numerically abundant species, with Echinus affinus as a major contributor. The major contributor to the biomass in each study was always one of the numerically dominant species common to each site.

It may be concluded, therefore, that there is little difference between the major epibenthic invertebrate faunal components of the site and those of other mid-Atlantic Continental Slope areas of similar depth (Jones and Haedrich, 1977; Haedrich et al., 1975). Echinoderms are generally the most important faunal component of these areas.

The macroinfauna collected at or near the 106-Mile Site is presented in Table A-17. The species are considered to be typical for the mid-Atlantic Slope region (Pearce et al., 1977a). Diversity and density of infauna decrease with increasing depth and distance offshore. Polychaetes are the dominant species, followed by bivalves, nematodes, and peracarids.* Pearce et al. (1977a) reported a range of densities for 22 stations in the site vicinity of 0 to 119 organisms/0.1 m^2. The number of taxa ranged from 0 to 34/0.1 m^2.

*Polychaetes and nematodes were common at all depths sampled, while peracarids and molluscs generally occurred shallower than 768 m.

Infauna data indicate that there are no significant differences in the species richness or abundance between the 106-Mile Site and control stations (Pearce et al., 1977a).

TABLE A-17

BENTHIC INFAUNA COLLECTED AT OR NEAR THE 106-MILE

TAXON	TAXON
Anthozoa	Polychaeta (cont.)
Pennatulacea	*Onuphis* (Nothia) sp. #1
Rhynchocoela	*Drilonereis longa*
Nematoda	*Amaena trilobata*
Oligochaeta	*Polycirrus* sp. #1
Polychaeta	Sabellidae #1
Notomastus latericius	*Tharyx* sp. #1
Heteromastus filiformis	*Spiophanes wigleyi*
Ampharete arctica	*Nicon* sp. #1
Ampharete sp. #1	*Cossura longocirrata*
Aricidea albatrossae	*Ownenia fusiformis*
Aricidea sp. #1	*Myriochele danielsseni*
Paraonis gracilis	Sipuncula
Paraonis cornatus	*Goldfingia flagrifera*
Paraonis abranchiata	Crustacea
Paraonis sp. #1	Peracarida
Syllis (Langerhansia) #1	Amphipoda
Polynoidae	*Harpinia cabontensis*
Antinoella sarsi	*Harpinia* n. sp.
Stenolepis tetragona	Gastropoda
Orbiniidae	*Olivella* sp.
Phylo michaelseni	Scaphopoda
Ancistrosyllis groenlandica	*Dentalium occidentale*
Ancistrosyllis sp.	*Dentallium* sp. #1
Glycera capitata	Bivalvia
Goniada maculata	*Malletia* sp.
Poraxillella gracilis	*Nucula tenuis*
Asychis biceps	*Thyasira trisinuata*
Axiothella sp. #1	Ophiuroidea
Leichone dispar	*Amphipholis squamata*
Paramphinome jeffreysii	Echinoidea
Lumbrineris tetraura	Spatangoidea
Lumbrineris sp.	Holothuroidea
Armandia sp.	Chaetognatha

Source: Adapted from Pearce et al., 1977a.

APPENDIX B

CONTAMINANT INPUTS TO THE 106-MILE OCEAN WASTE DISPOSAL SITE

CONTENTS

Title	Page
HISTORICAL USAGE (1973-1978)	B-1
PROJECTED INPUTS	B-5
WASTE CHARACTERISTICS	B-6
Du Pont-Grasselli	B-12
Du Pont-Edge Moor	B-17
American Cyanamid	B-19
Merck and Company	B-22

ILLUSTRATIONS

Number	Title	Page
B-1	Historical and Projected Dumping Activity at the 106-Mile Site	B-2

TABLES

B-1	Amounts of Material Dumped at the 106-Mile Site from 1973 to 1978	B-3
B-2	Projected Amounts of Wastes to be Dumped During 1979-1980 at the 106-Mile Site	B-5
B-3	Annual Estimated Mass Loading for Suspended Solids, Petroleum Hydrocarbons, and Oil and Grease at the 106-Mile Site, 1973-1978	B-7
B-4	Concentrations of Suspended Solids, Petroleum Hydrocarbons, and Oil and Grease in Industrial Waste Dumped at the 106-Mile Site	B-7
B-5	Suspended Solids, Petroleum Hydrocarbons, and Oil and Grease Released at the 106-Mile Site, 1973-1978	B-8
B-6	Estimated Annual Industrial Trace Metal Mass Loading	B-9
B-7	Average Metal Concentrations in Wastes at 106-Mile Site	B-11
B-8	pH, Specific Gravity, and Percent Solids in Industrial Waste Dumped at the 106-Mile Site	B-12
B-9	Characteristics of Typical Sewage Sludge Digester Cleanout Residue	B-12
B-10	Nonpersistent Organphosphate Insecticides Released by American Cyanamid, 1973-1978, at the 106-Mile Site	B-21

APPENDIX B

CONTAMINANT INPUTS TO THE 106-MILE OCEAN WASTE DISPOSAL SITE

HISTORICAL USE (1973-1978)

The 106-Mile Site was proposed for use in 1965 by the U.S. Fish and Wildlife Service as an alternative to the inland discharge of industrial chemical wastes which might contaminate potable water supplies. However, some chemical wastes were disposed at the site during 1961, 1962, and 1963. From 1961 to 1978, approximately 5.1 million metric tons of chemical wastes, 102,000 metric tons of sewage sludge, and 287,000 metric tons of sewage sludge digester cleanout residue were dumped at the site. In addition, munitions were dumped in the past at a location in the northwest corner of the site. During 1951 to 1956 and 1959 to 1962, 14,300 drums of radioactive wastes containing 41,400 curies of radioactivity were dumped 10 nmi (18.5 km) south of the southern edge of the 106-Mile Site.

When ocean waste disposal came under EPA regulation in 1973, 66 permittees were dumping wastes at the site. Since 1973, the number of permittees has steadily declined until, as of mid-February 1979, only four permittees remained: American Cyanamid (Linden, N.J.); E.I. du Pont de Nemours and Co., Inc., Edge Moor Plant (Edge Moor, Del.) and Grasselli Plant (Linden, N.J.); and Merck & Co. (Rahway, N.J.). Despite the decline in the number of permittees, the amount of waste increased 134% from 341,000 metric tons in 1973 to 797,000 metric tons in 1978. The increase in amount was primarily the result of the relocation of industrial waste generators from the New York Bight Sewage Sludge Site in 1974, Du Pont-Grasselli from the New York Bight

Acid Wastes Site in 1974, and Du Pont-Edge Moor from the Delaware Bay Acid Waste Site in 1977. The latter Du Pont plant discharged 380,000 metric tons, or 50% of total waste released in 1977, as compared to the previous year's total of 375,000 metric tons for all permittees. Waste from the City of Camden, New Jersey, was relocated by court action to the site in 1977. However, Camden contributed only 6% of the annual total or 48,000 metric tons. In 1978, the amount of dumped waste totalled 797,000 metric tons representing a 4% decrease from the high in 1977. Overall, approximately 75% of the waste discharged from 1973 to 1978 was from three industrial sources: American Cyanamid, Du Pont-Edge Moor, and Du Pont-Grasselli.

Figure B-1 illustrates the dumping trends at the 106-Mile Site from 1973 to 1978. The actual amounts dumped and percent contribution of each permittee appear in Table B-1.

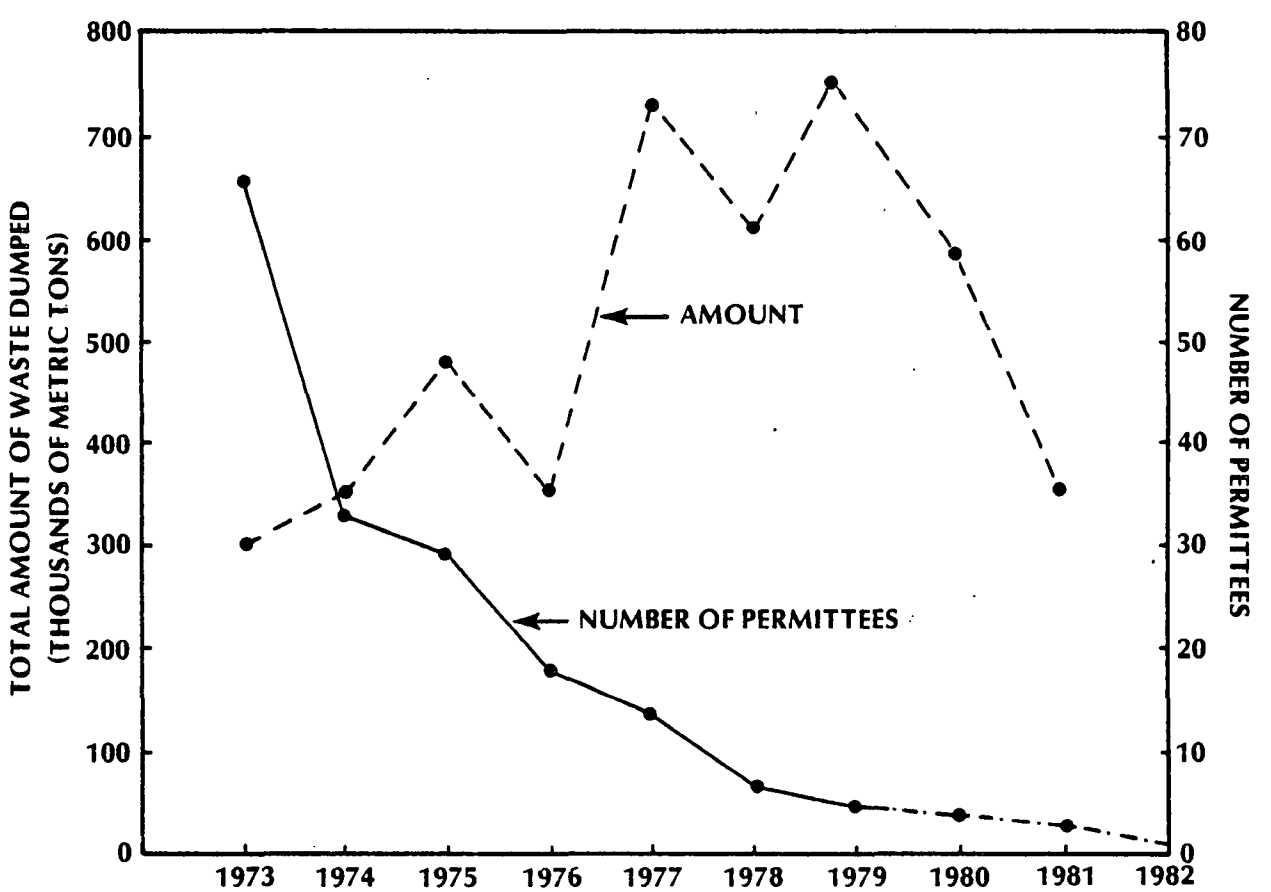


Figure B-1. Historical and Projected Dumping Activity at the 106-Mile Site

TABLE B-1
AMOUNTS OF MATERIAL DUMPED AT THE 106-MILE SITE FROM 1973 TO 1978*
(Thousands of Metric Tons)

Permittee	1973	1974	1975	1976	1977	1978	Totals
American Cyanamid Co.	118 (35)	137 (31)	116 (20)	119 (32)	130 (17)	111 (14)	731 (22)
Camden, N.J.	--	--	--	--	48 (6)	54 (7)	102 (3)
Chevron Oil Co.	25 (7)	26 (6)	22 (4)	--	--	--	73 (2)
Du Pont-Edge Moor	--	--	--	--	380 (50)	372 (47)	752 (23)
Du Pont-Grasselli	116 (34)	155 (35)	264 (46)	164 (44)	107 (14)	172 (22)	978 (30)
Hess Oil Co.	7 (2)	--	--	--	--	--	7 (0.2)
Mixed Industries†	34 (10)	35 (8)	78 (14)	67 (18)	85 (11)	72 (9)	371 (11)
Mixed Municipalities**	41 (12)	93 (21)	96 (17)	25 (7)	16 (2)	16 (2)	287 (9)
Totals	341	446	576	375	766	797	3,301

* Permittees' percentages of annual totals appear in parentheses.
† Crompton and Knowles, Merck and Co., and Reheis Chemical Co.
** Permittees using New York Bight Sewage Sludge Site (sewage sludge digester cleanout residue).

Over the years, Du Pont-Grasselli has been the primary contributor of waste to the site, releasing 978,000 metric tons, or approximately 30% of the total from 1973 to 1978. The amounts ranged from 107,000 metric tons in 1977 to 264,000 metric tons in 1975, averaging 163,000 metric tons annually. Du Pont-Grasselli dumps waste seven to nine times per month.

Du Pont-Edge Moor, the second major waste contributor, moved the dumping operation from the Delaware Bay Acid Waste Disposal Site to the 106-Mile Site in March 1977. Du Pont-Edge Moor has been dumping at the site for only two years; however, they have released approximately 752,000 metric tons, or 23% of the total volume of waste dumped between 1973 and 1978. Du Pont-Edge Moor barges waste to the site an average of seven times per month.

From 1973 to 1978, American Cyanamid disposed of approximately 731,000 metric tons of chemical waste, averaging 122,000 metric tons per year. American Cyanamid's volume constituted approximately 22% of the waste which was dumped at the site during that period. The volumes ranged from 111,000 metric tons in 1978 to 137,000 metric tons in 1974. American Cyanamid waste is barged to the site an average of seven times per month.

The mixed waste of a number of industries has been barged to the site. In 1973, 63 industrial permittees (besides the three already discussed) were dumping at the site, but now only Merck and Co. remains. From 1973 to 1978, approximately 371,000 metric tons of mixed industrial wastes were dumped, comprising 11% of the total volume released during that period. The mixed input ranged from 34,000 metric tons in 1973 to 85,000 metric tons in 1977, averaging 62,000 metric tons per year. Dependent upon the barge and the volume of waste, Merck's waste is dumped once or twice per month.

Sewage sludge has also been dumped at the site. The City of Camden sewage sludge disposal operation was relocated to the site in 1977. Camden discharged 102,000 metric tons, or 7% of the waste dumped during 1977 and 1978. Camden's waste volume represented 3% of the total waste dumped at the site from 1973 to 1978. Camden ceased ocean dumping on June 15, 1978.

Sewage sludge digester cleanout residues from many New York/New Jersey area municipal wastewater treatment plants were released at the site from 1973 to 1978. Approximately 287,000 metric tons were dumped, comprising 9% of the total dumped during this period.

PROJECTED INPUTS

Table B-2 summarizes the projected dumping amounts and scheduled phaseout dates for the current permittees at the 106-Mile Site.

TABLE B-2
PROJECTED AMOUNTS OF WASTES TO BE DUMPED DURING 1979-1980 AT THE 106-MILE SITE

Permittee	Scheduled Phaseout Date	Thousands of Metric Tons/Year		
		1979	1980	1981
American Cyanamid	April 1981	123	123	30
Du Pont-Edge Moor	May 1980	299	136	0
Du Pont-Grasselli	--	295	295	295
Merck	April 1981	36	36	10
	Yearly Totals	753	590	335

Du Pont-Grasselli has investigated several land-based alternatives, two in detail: biological treatment and incineration. These alternatives do not comply with state and/or Federal environmental regulations and, therefore, have been rejected in favor of ocean disposal. The waste has been demonstrated to comply with EPA's marine environmental impact criteria; however, EPA and the New Jersey Department of Environmental Protection (NJDEP) have recommended further detailed investigations of alternatives by Du Pont.

Du Pont-Grasselli has projected that its annual waste volumes will not exceed 295,000 metric tons. Du Pont-Grasselli's current permit expires January 14, 1981. It will be eligible for renewal at that time, assuming that Du Pont continues to demonstrate compliance with EPA's need and environmental impact criteria.

Du Pont-Edge Moor is currently complying with an EPA-imposed schedule to cease ocean dumping by May 1980 in favor of other alternatives. The iron chloride in the waste will be converted to ferric chloride and marketed as a water treatment chemical. The company is constructing facilities which will allow recycling of hydrochloric acid, a major component of the waste. The concept has been tested in the laboratory and at a pilot plant, and is expected to be fully operational in 1980 (Kane, 1977).

American Cyanamid will continue to ocean-dump according to its compliance schedule until April 1981, when the land-based treatment is operational. The land-based alternative waste disposal method selected by Cyanamid basically consists of on-site carbon treatment and off-site thermal oxidation of the balance of the wastes. Whether or not these alternative treatment technologies can comply with environmental regulations has not been determined at present.

Merck has determined that two feasible modifications of present ocean disposal methods can be implemented: (1) on-site pre-treatment of existing wastes followed by discharge to a municipal treatment plant, and (2) manufacturing process changes which would produce wastes dischargeable directly into a municipal treatment plant. Merck is complying with an EPA-imposed schedule to cease dumping by April 1981.

WASTE CHARACTERISTICS

The characteristics of wastes dumped at the site since 1973 are summarized in Tables B-3 to B-9. The future waste characteristics of the four remaining permittees are expected to follow historical trends. Merck waste, previously undifferentiated from the mixed industrial waste analyses, is characterized separately as data permit.

TABLE B-3
ANNUAL ESTIMATED MASS LOADING FOR SUSPENDED SOLIDS, PETROLEUM HYDROCARBONS, AND OIL AND GREASE AT THE 106-MILE SITE, 1973-1978

	Metric Tons/Year					
	1973	1974	1975	1976	1977	1978
Constituent						
Suspended Solids	1,200	400	2,300	10,400	2,500	4,300
Petroleum Hydrocarbons	5	30	600	30	200	50
Oil and Grease	200	200	100	200	700	100

TABLE B-4
CONCENTRATIONS OF SUSPENDED SOLIDS, PETROLEUM HYDROCARBONS, AND OIL AND GREASE IN INDUSTRIAL WASTE DUMPED AT THE 106-MILE SITE
(mg/liter)

Permittee	Suspended Solids		Petroleum Hydrocarbons		Oil and Grease	
	Mean	Range	Mean	Range	Mean	Range
American Cyanamid	312	2-2,375	314	5-5,270	872	10-6,214
Du Pont-Edge Moor	2,192	60-21,000	<0.3	--	4	1-24
Du Pont-Grasselli	760	5-15,090	16	1-108	17	1-108
Mixed Industries	81,000	12-771,000	1,361	1-57,600	1,088	6-4,850

TABLE B-5
SUSPENDED SOLIDS, PETROLEUM HYDROCARBONS, AND OIL AND GREASE RELEASED AT THE 106-MILE SITE, 1973-1978
(Metric Tons)

Permittee and Year	Total Suspended Solids		Petroleum Hydrocarbons		Oil and Grease	
	Amount Dumped	Permittee's Percent of Annual Total Dumped	Amount Dumped	Permittee's Percent of Annual Total Dumped	Amount Dumped	Permittee's Percent of Annual Total Dumped
American Cyanamid						
1978	97	2	34	73	75	65
1977	39	1	100	49	223	30
1976	27	1	15	51	74	43
1975	19	1	55	--	17	12
1974	60	15	18	--	97	46
1973	19	2	NR	--	NR	--
Du Pont-Edge Moor						
1978	1,100	25	0.1	<1	1.6	2
1977	68	3	0.1	1	0.9	1
Du Pont-Grasselli						
1978	53	1	0.6	1	2	2
1977	19	1	1	1	3	1
1976	45	1	2	6	2	1
1975	607	26	NR	--	6	4
1974	97	24	NR	--	2	1
1973	49	4	NR	--	NR	--
Mixed Industries*						
1978	3,048	72	12	26	36	31
1977	527	21	9	4	13	2
1976	10,300	99	12	43	98	56
1975	168	72	551	--	97	69
1974	226	57	7	--	108	51
1973	1,100	93	5	--	0.2	--
Camden, N.J.						
1977	1,815	74	93	46	505	68
Chevron Oil Co.						
1975	34	1	35	--	22	15
1974	14	4	2	--	3	1
1973	14	1	NR	--	2	--
Hess Oil Co.						
1973	0.3	1	--	--	214	--

NR - Not reported
* Crompton and Knowles, Merck and Co., and Reheis Chemical Co.

TABLE B-6
ESTIMATED ANNUAL INDUSTRIAL TRACE METAL MASS LOADING

Year/Volume	1973		1974		1975		1976		1977		1978	
Trace Metal/ Permittee	Volume Dumped (kg)	Total Dumped (%)	Volume Dumped (kg)	Total Dumped (%)	Volume Dumped (kg)	Total Dumped (%)	Volume Dumped (kg)	Total Dumped (%)	Volume Dumped (kg)	Total Dumped (%)	Volume Dumped (kg)	Total Dumped (%)
Cadmium												
American Cyanamid	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	3	2
Du Pont-Edge Moor	--	--	--	--	--	--	--	--	185	23	107	64
Du Pont-Grasselli	12	6	29	1	72	1	33	15	8	<1	25	15
Mixed Industries	197	93	5,484	99	19,430	99	180	84	529	65	33	19
Chevron Oil	1	<1	3	<1	1	<1	--	--	--	--	--	--
Hess Oil	<1	<1	--	--	--	--	--	--	--	--	--	--
TOTAL	211		5,516		19,503		213		812		168	
Chromium												
American Cyanamid	156	23	46	7	58	8	50	23	56	<1	23	1
Du Pont-Edge Moor	--	--	--	--	--	--	--	--	69,208	94	98,982	99
Du Pont-Grasselli	33	5	87	13	89	13	19	9	64	<1	21	1
Mixed Industries	483	71	552	79	557	79	146	68	3,909	5	934	1
Chevron Oil	1	<1	11	1	1	<1	--	--	--	--	--	--
Hess Oil	4	<1	--	--	--	--	--	--	--	--	--	--
TOTAL	677		696		705		215		73,845		99,960	
Copper												
American Cyanamid	11	1	5	1	5	<1	13	2	14	<1	156	8
Du Pont-Edge Moor	--	--	--	--	--	--	--	--	827	22	1,221	65
Du Pont-Grasselli	35	3	64	11	73	9	41	8	2,069	56	220	12
Mixed Industries	954	94	509	84	733	89	481	90	87	2	266	15
Chevron Oil	8	1	25	4	15	2	--	--	--	--	--	--
Hess Oil	3	1	--	--	--	--	--	--	--	--	--	--
TOTAL	1,011		603		826		535		3,695		1,863	

TABLE B-6 (Continued)

Trace Metal/ Permittee \ Year/Volume	1973		1974		1975		1976		1977		1978	
	Volume Dumped (kg)	Total Dumped (%)	Volume Dumped (kg)	Total Dumped (%)	Volume Dumped (kg)	Total Dumped (%)	Volume Dumped (kg)	Total Dumped (%)	Volume Dumped (kg)	Total Dumped (%)	Volume Dumped (kg)	Total Dumped (%)
Lead												
American Cyanamid	47	19	6	<1	13	1	2	<1	2	<1	8	<1
Du Pont-Edge Moor	--	--	--	--	--	--	--	--	13,663	89	12,573	97
Du Pont-Grasselli	54	22	115	12	386	36	104	11	38	1	229	2
Mixed Industries	142	57	759	81	674	62	822	89	96	1	200	1
Chevron Oil	4	1	53	6	12	1	--	--	--	--	--	--
Hess Oil	4	1	--	--	--	--	--	--	--	--	--	--
TOTAL	251		933		1,085		928		15,336		13,010	
Mercury												
American Cyanamid	11	24	2	14	1	1	3	<1	1	10	3	27
Du Pont-Edge Moor	--	--	--	--	--	--	--	--	4	40	6	55
Du Pont-Grasselli	1	2	2	14	2	1	1	<1	<1	5	1	9
Mixed Industries	22	49	9	64	1,622	98	960	99	<1	5	1	9
Chevron Oil	9	20	1	8	1	1	--	--	--	--	--	--
Hess Oil	2	5	--	--	--	--	--	--	--	--	--	--
TOTAL	45		14		1,626		964		10		11	
Nickel												
American Cyanamid	217	52	83	23	166	21	129	23	138	2	40	1
Du Pont-Edge Moor	--	--	--	--	--	--	--	--	7,315	91	11,119	96
Du Pont-Grasselli	83	20	114	32	199	25	110	19	59	1	133	1
Mixed Industries	100	24	142	40	418	53	332	58	413	5	287	2
Chevron Oil	18	4	16	4	2	1	--	--	--	--	--	--
Hess Oil	2	<1	--	--	--	--	--	--	--	--	--	--
TOTAL	420		355		785		571		8,009		11,579	
Zinc												
American Cyanamid	82	1	32	<1	18	<1	25	1	163	<1	77	<1
Du Pont-Edge Moor	--	--	--	--	--	--	--	--	20,796	89	51,800	98
Du Pont-Grasselli	49	1	154	1	141	2	41	1	27	<1	83	<1
Mixed Industries	11,985	99	15,549	98	7,087	97	3,165	98	133	<1	580	1
Chevron Oil	4	1	68	<1	33	<1	--	--	--	--	--	--
Hess Oil	5	1	--	--	--	--	--	--	--	--	--	--
TOTAL	12,125		15,803		7,279		3,231		23,382		52,540	

TABLE B-7
AVERAGE METAL CONCENTRATIONS IN WASTES AT THE 106-MILE SITE
(μg/l)

Metal	Seawater Concentration	Reference	American Cyanamid		Du Pont-Edge Moor		Du Pont-Grasselli		Mixed Industries	
			Mean	Range	Mean	Range	Mean	Range	Mean	Range
Arsenic	2-3	Kopp, 1969	620	20-2,600	140	5-525	7	1-30	30	1-130
Cadmium	0.15	Fleischer et al., 1974	4	1-150	320	20-900	170	3-700	3,200	20-15,600
Chromium	1	EPA, 1976	550	45-4,900	270,200	52,600-900,000	330	10-3,500	21,170	4-170,000
Copper	3.0	Mero, 1964	350	1-4,100	3,250	4-7,400	3,150	25-154,700	10,900	1-115,000
Lead	0.03	Horne, 1969	120	1-1,000	40,540	2,700-76,000	900	10-4,900	8,840	8-62,000
Mercury	0.05-0.19	Robertson et al., 1972	30	1-200	30	<1-500	7	<1-20	300	21-3,830
Nickel	5-7	NAS, 1974	1,100	145-6,400	29,060	200-65,000	730	30-2,000	4,900	20-31,500
Zinc	10	EPA, 1976	560	7-5,150	100,960	110-530,000	540	30-2,700	163,800	15-1,400,000

TABLE B-8
pH, SPECIFIC GRAVITY, AND PERCENT SOLIDS
IN INDUSTRIAL WASTE DUMPED AT THE 106-MILE SITE

Permittee	pH		Specific Gravity		Percent Solids
	Mean	Range	Mean	Range	
American Cyanamid	5.0	2.7 - 8.3	1.028	1.015 - 1.055	0.03
Du Pont-Edge Moor	0.6	0.1 - 1.0	1.135	1.085 - 1.218	0.16
Du Pont-Grasselli	12.9	12.4 - 13.6	1.109	1.036 - 1.222	0.07
Merck		5 - 7	1.28	-	0.08

TABLE B-9
CHARACTERISTICS OF TYPICAL
SEWAGE SLUDGE DIGESTER CLEANOUT RESIDUE*

Specific gravity	1.016
Total solids (mg/liter)	52,400
Volatile solids (mg/liter)	38,500
Petroleum hydrocarbons (mg/liter)	16
Liquid cadmium (mg/liter)	0.2
Solid cadmium (mg/kg)	45
Liquid mercury (mg/liter)	0.002
Solid mercury (mg/kg)	0.39

*From the barge analysis of Nassau County sewage sludge dumped on 10/26/78.

DU PONT-GRASSELLI

The principal process generating the Du Pont-Grasselli waste is the production of DMHA (N,O-dimethylhydroxylamine) and anisole. The Grasselli plant is authorized to dispose of approximately 295,000 metric tons annually (Table B-2). Disposal is accomplished by subsurface release of the waste at a rate not exceeding 200,000 liters (52,000 gallons) per nautical mile. This rate permits complete dumping of an average barge load of 1.5 million liters in approximately 70 minutes (assuming a barge speed of 6 knots), over a linear distance of approximately 7.4 nmi.

The major trace metals present in Grasselli waste, in decreasing order of input volume, are: copper, lead, nickel, zinc, chromium, and mercury.

The organic portion of the Grasselli waste is composed of sodium methyl sulfate (up to 50% of the organic phase), methanol (20%) and N,O-dimethylhydroxylamine (DMHA) plus other amines (1%). The remainder is in the form of phenols, anisole, and other compounds.

DMHA has been monitored in the Grasselli waste since 1975. Concentrations have ranged from 20 to 364 mg/liter, averaging approximately 115 mg/liter. Annual inputs average 17,000 kg annually, ranging from 10,000 kg in 1978 to 27,800 kg in 1977. Since the first report of volumes of the compound in 1975, Du Pont-Grasselli has released 69,000 kg of DMHA at the 106-Mile Site.

Monitoring of anisole also began in 1975. Concentrations in the Grasselli waste have ranged from 1 to 14 mg/liter, averaging approximately 5 mg/liter. Annual volumes have ranged from 600 kg in 1978 to 1,700 kg in 1975. The average annual input is 900 kg. The Grasselli plant has released approximately 3,000 kg of anisole at the 106-Mile Site since 1975. Du Pont-Grasselli is the only known source of anisole at this site.

Phenols have been monitored in the Grasselli waste since 1973. Concentrations have ranged from 0.2 to 3,550 mg/liter, averaging 209 mg/liter. Yearly inputs have ranged from 200 kg in 1978 to 204,000 kg in 1975. The average annual input of phenols by Grasselli is 45,000 kg. Du Pont-Grasselli has disposed of approximately 226,000 kg of phenols at the 106-Mile Site since 1973.

TOXICITY

Results of bioassay tests, which were conducted between 1973 and 1977, show that the toxicity of Grasselli waste to brine shrimp (*Artemia salina*) has varied between 48-hour LC50 values of 3,250 to 100,000 ppm. This variation may be due primarily to a change from nonaeration to aeration of the samples rather than to changes in the toxicity of the material. Bioassays conducted

since 1977 with Atlantic silversides (Menidia menidia) yield 96-hour LC50 values ranging between 560 ppm and 6,950 ppm for aerated tests and between 660 ppm and 6,170 ppm for nonaerated tests. Bioassays on diatoms (Skeletonema costatum) produce 96-hour EC50 values between 160 ppm and 8,600 ppm. Tests with copepods (Acartia tonsa) give 96-hour LC50 values ranging between 57 ppm and 238 ppm. Notwithstanding changes in required testing procedures, some of the observed variations may be due to differences in the character of the individual barge loads, despite originating from the same waste source.

In 1976, Du Pont sponsored an extensive series of studies to describe the in situ dispersion characteristics and biological effects of ocean-disposed waste waters from Grasselli plant (Falk and Gibson, 1977). The studies were prompted by Du Pont's desire to demonstrate to the EPA the validity of the time-toxicity concept, i.e., determining the maximum length of time in which wastes would remain at a sufficiently high concentration to cause acute toxic effects, considering wastewater dispersion and toxicity as functions of time. The studies demonstrated that:

(1) Under oceanographic conditions least likely to enhance dispersion, the peak wastewater concentration in the barge wake is, initially, about 450 ppm one minute after release.

(2) Wastewater concentrations decline to a peak of about 80 ppm within 4 hours after release, and to about 60 ppm after 12 hours.

(3) In 178-day chronic toxicity tests, the no-effect level for opossum shrimp (Mysidopsis bahia) and sheepshead minnow (Cyprinodon variegatus) were found to be 750 ppm.

(4) The wastewaters are not selectively toxic to a particular life stage of Cyprinodon or Mysidopsis.

(5) There is little difference in the toxicity of the wastewater to several species of marine organisms.

These results supported the discharge of Grasselli waste into the site over a 5-hour period, at a barge speed of 5 knots, without adverse impact.

DILUTION AND DISPERSION

Mixing of waste with seawater is a function of prevailing meteorological and oceanographic conditions. After discharge from the barge, immediate mixing (within the first 15 minutes) occurs primarily as a result of barge-generated turbulence. After immediate mixing, wind, waves, currents, and density stratification components dictate the rate and direction of dispersion and dilution.

Bisagni (1977b) studied the behavior of Du Pont-Grasselli wasted dumped at the 106-Mile Site in June, 1976, using Rhodamine-WT dye mixed with the waste as a tracer. Water column profiles showed that the surface mixed layer extended down to a depth of 20 m. Below the surface mixed layer, a seasonal thermocline was found between 20 and 50 m depth. The permanent thermocline was between 200 and 350 m depth. The waste remained in the upper 60 m of the water column.

The initial concentration of the undiluted waste within 15 minutes after release was 19.3 ppm. Water samples collected within an hour of commencement of dumping indicated that the dilution ranged from 18,000:1 to 4,600:1. After 70 hours, dilution was estimated to range from 210,000:1 to 45,000:1. During a second dilution study performed in June, minimum factors of 54:1 to 100:1 occurred within 10 minutes after the dumping had begun. After 30 hours, a dilution of about 110,000:1 was estimated.

Orr (1977a) tracked the precipitate formed by the Grasselli waste during June and September, 1976, using a multifrequency acoustic backscattering system. In June, a sharp density gradient in the water column was at a depth of 10 m. The data indicated that the particulates separated into two components: a lighter phase which was trapped in the upper 10 to 20 m of the water column, and a heavier phase which sank to the base of the mixed layer. These phases were observed to behave in two different ways: collecting in a thin layer on an isopycnal surface (i.e. a plane surface of equal density) or appearing as a diffuse cloud within patches of water having nearly constant density.

The study conducted in September, 1976, by Orr (1977a) used an acoustic system with improved sensitivity. In this study, acoustic and dye measurements were collected simultaneously. The waste was observed to spread over an area of 4 nmi^2 (13.7 km^2) by both methods. The results of this study show that the residence time of the suspended matter can exceed 24 hours. The particulates were heavily concentrated in the upper 15 m of the water column. The waste settled from an initial uniform distribution to collections of particles in dense layers. The particles which were trapped in the seasonal thermocline outlined the associated isopycnal surfaces, and were from 15 cm to 5 m in thickness. In at least one instance, particulates associated with the seasonal thermocline were observed to have penetrated it and appeared as a diffuse cloud extending down to a depth of nearly 80 m. The data also indicated that particles which penetrated the seasonal thermocline and were trapped at the base of the mixed layer, spread horizontally much faster than particles trapped by the seasonal thermocline.

Kohn and Rowe (1976) studied the dilution and dispersion of Du Pont-Grasselli waste during September, 1976, using Rhodamine-WT dye as a tracer. Dispersion of the waste was monitored by means of two fluorometers, one drawing water from a depth of 5 m and the other drawing from a depth of 10 m. Data were gathered for a period of 19 hours following the start of discharge. The initial dilution of the waste was 4250:1 at 5 m, while after 17 hours the dilution was 12,500:1. The waste plume movements following the dump were estimated on the basis of the movements of "window shade" current drogues and from fluorometer readings. In general, the plume moved in a semicircular path, returning to the starting position after about 20 hours. The Du Pont waste was observed to pass through the upper 5 m of the water column and stabilize between 10 m depth and the top of the thermocline.

Falk and Gibson (1977) described a dye dispersion study conducted by EG&G on the Grasselli waste in September, 1976, during a time when ambient conditions at the 106-Mile Site were least conducive to waste dispersion (i.e., calm seas, light winds, strong thermocline present). The results of the survey indicated that the waste material was limited to the surface mixed layer by the strong thermocline. The horizontal extent of the waste ranged from 35 m in width initially, to 300 m after 2 hours, to 600 m after 8 hours,

and to 1,000 m after 11 hours. Minimum waste dilutions were 5,000:1 initially, 15,000:1 after 2 hours, and 15,000 to 30,000:1 after 11 hours. The average waste dilutions were 10,000:1 initially, 20,000 to 40,000:1 after 2 hours, and 30,000 to 80,000:1 after 11 hours.

Hydroscience (1978c, 1978d, and 1979d) monitored dumps of Grasselli waste in May, July, and October 1978. In all surveys, the wastewater concentration after 4 hours was well below the chronic no-effect level for appropriate sensitive marine organisms of 750 ppm, a dilution of 1,300:1.

DU PONT-EDGE MOOR

Du Pont-Edge Moor waste is generated by the manufacture of titanium dioxide using the chloride process. The waste consists principally of an aqueous solution of iron and miscellaneous chlorides, and hydrochloric acid. Du Pont-Edge Moor is authorized to dump approximately 299,000 metric tons during 1979 and 136,000 metric tons during 1980 (Table B-2). Disposal of the waste is accomplished by subsurface release at a rate not exceeding 140,045 liters (37,000 gallons) per nautical mile. This rate permits complete dumping of an average barge load of 3.8 million liters of waste in approximately 4.5 hours (assuming a barge speed of 6 knots), over a linear distance of approximately 27 nmi (50 km).

Ten trace metals are usually reported in the analyses of Du Pont-Edge Moor waste. These are, ranked by decreasing input volume: iron, titanium, chromium, vanadium, zinc, lead, nickel, copper, cadmium, and mercury. Organic components are present in insignificant amounts of Edge Moor waste (Table B-4).

TOXICITY

Bioassays conducted since 1977 with Atlantic silversides (*Menidia menidia*) yield 96-hour LC50 values greater than 5,000 ppm for aerated tests and between 5,000 ppm and 14,400 ppm for nonaerated tests. Bioassays on diatoms (*Skeletonema costatum*) produce 96-hour EC50 values between 712 ppm and 3,450 ppm.

In 1976, Du Pont sponsored an extensive series of in situ studies to describe the dispersion characteristics and biological effects of ocean disposed waste waters from the Edge Moor plant (Falk and Phillips, 1977). The dispersion studies were conducted at the Delaware Bay Acid Waste Disposal Site.

A series of laboratory toxicity experiments conducted with the Du Pont-Edge Moor wastes gave the following results:

1. In 200-day chronic toxicity tests, no-effect levels for opposum shrimp (*Mysidopsis bahia*) and sheepshead minnow (*Cyprinidon variegatus*) were found to be in the range of 25 to 50 ppm.

2. pH-adjusted waste produces mortalities only at concentrations several orders of magnitude above the unaltered waste.

3. Pulsed exposure of grass shrimp (*Palaemonetes pugio*) to initial wastewater concentrations of 250 ppm, followed by dilution slower than that observed in the barge wake, produced no mortalities.

4. Maximum waste concentrations in the barge wake were calculated to be approximately 150 ppm within 2 hours, and about 5 ppm within eight hours. The two-hour calculated wake concentrations is well below the acute LC50 value range of 240-320 ppm and the eight-hour wake concentration is well below the calculated chronic no-effect level of 25 to 50 ppm for unaltered waste.

Based upon these results, Falk and Phillips (1977) reached the conclusion that the Edge Moor wastewaters can be discharged into the marine environment over a 5-hour period, at a barge speed of 6 knots, without adverse impact, and without violating the requirements of Section 227.8 of the EPA Ocean Dumping regulations.

DILUTION AND DISPERSION

In September 1976, EG&G conducted a dispersion study of Edge Moor wastewater at the Delaware Bay Acid Waste Site (EG&G, 1977). A well-defined thermocline was present at a depth of 20 m, winds were blowing at 8 to 12 m/sec (15.5 to 23.2 kn), and waves were 1 to 2 m. The waste concentrations were monitored over 8 hours using pH and iron concentrations. Minimum

dilutions were 7,000:1 within 2 hours and 200,000:1 within 8 hours. The 2-hour concentration was well below acute LC50 values reported for the organisms tested, and the 8-hour concentration was well below the chronic no-effect level of 25 to 50 ppm (dilutions of 40,000:1 and 20,000:1, respectively).

In May 1978, Hydroscience, Inc. (1978a) studied the dilution and dispersion of the Du Pont-Edge Moor waste following its release at the site. A weak thermocline was present at a depth of 13 m. Based upon a comparison of undiluted and post-dumping (after 4 hours) seawater concentrations of particulate iron, minimum dilutions were estimated at 75,000:1. Measurements indicated that the Du Pont-Edge Moor waste did not significantly penetrate the seasonal thermocline and the waste was diluted and dispersed only within the upper 13 m of the water column. Surveys conducted during July and October did not yield dilution values; however, the waste was estimated to have been diluted below the chronic no-effect level (Hydroscience, 1978b, 1979a). These observations are compatible with observations made at the Delaware Bay Acid Waste Site while Edge Moor was still dumping its waste there (Falk and Phillips, 1977).

AMERICAN CYANAMID

American Cyanamid produces industrial wastes which are generated during the manufacture of approximately 30 different organic and inorganic compounds. The broad categories which comprise the waste are approximately 25% chemical, 35% equipment and floor wash, 25% vacuum jet condensate and 15% from overhead and bottom distillate units. The chemical products manufactured include rubber, mining and paper chemicals; nonpersistent organophosphate insecticides; surfactants; and various intermediates.

American Cyanamid is authorized to dispose of approximately 123,000 metric tons annually (Table B-2). Disposal is accomplished by subsurface release of waste through automatic and/or manual vent valves at a rate not exceeding 113,500 liters (30,000 gallons) per nautical mile. This rate permits complete offloading of an average barge load of 1.5 million liters of waste in approximately 2 hours (assuming a towing speed of 6 knots), over a linear distance of approximately 13.5 nmi (25 km).

American Cyanamid waste is routinely analyzed for trace metals. In order of decreasing input volume, they are: nickel, arsenic, chromium, zinc, lead, copper, mercury, and cadmium.

Because the American Cyanamid waste mixture is complex, it is extremely difficult to characterize all of the organic compounds present in the waste. Thus, the organic content of American Cyanamid waste is known only in general terms. Table B-10 lists the various nonpersistent organophosphate insecticides released by American Cyanamid since 1973.

TOXICITY

Results of bioassays conducted since 1977 show that the toxicity of the waste to Atlantic silversides (*Menidia menidia*) has varied between 96-hour LC50 values of 0.24 ppm to 2,900 ppm for aerated tests and between 0.10 ppm to 2,900 ppm for non-aerated tests. Bioassays conducted from 1973 to 1977 with brine shrimp (*Artemia salina*) yielded 48-hour LC50 values of 670 ppm to 21,000 ppm. Bioassays on diatoms (*Skeletonema costatum*) gave 96-hour EC50 results which varied between 10 ppm and 1,900 ppm. Additional tests with copepods (*Acartia tonsa*) gave 96-hour LC50 values which varied between 19.5 ppm and 3,500 ppm. These variations may be due to the differences in the toxicity of the individual barge loads, although from the same waste source. However, such variation is not outside the ranges applied to bioassay results of this type.

DILUTION AND DISPERSION

In August, 1976, Kohn and Rowe (1976) studied the dilution and dispersion of the American Cyanamid waste after release at the site. Enough Rhodamine-WT fluorescent dye was added to the waste in a barge to yield an undiluted dye concentration of 9.36 ppm. For 17 hours following the start of the waste discharge from the barge, a continuous flow of water was pumped from a depth of 5 m into an onboard fluorometer. The initial dilution of the American Cyanamid waste was 115:1, and the dilution after 17 hours was 2,500:1.

TABLE B-10
NONPERSISTENT ORGANPHOSPHATE INSECTICIDES
RELEASED BY AMERICAN CYANAMID, 1973-1978, AT THE 106-MILE SITE

Constituent	Description	Metric Tons/Year					
		1973	1974	1975	1976	1977	1978
Malathion	General Insecticide	188	183	13	39	117	10
Thimet	Systemic Insecticide	92	133	12	34	73	11
Counter	Soil Insecticide	0	0	2	37	28	3
Abate	Manufacturing Concentrate Insecticide	0	0	0	0	14	0
Cytrolane	Technical Systemic Insecticide	15	9	0	18	3	3
Cygon	Systemic Insecticide	73	54	12	0	2	0
Cyolane	Technical Systemic Insecticide	0	0	0	0	0	1

The waste plume movements following the dump were estimated from the movements of "window shade" current drogues and from the fluorometer readings. In general, the plume moved in a semicircular path, returning to the starting position after about 20 hours. American Cyanamid waste remained in the upper few meters of the water column.

Hydroscience, Inc. (1978e, 1978f, 1979c) studied the dilution of the American Cyanamid waste in several seasonal surveys. Comparisons of undiluted waste concentrations and postdump concentrations 4 hours following the dump indicated minimum dilutions of approximately 25,000:1 in May, 14,000:1 in July, and 9,200:1 in October. Hydroscience (1978f) studied the dispersion of the waste in July 1978, using Rhodamine WT dye. The maximum distance that the plume traveled from the dump location was 675 m in 4 hours, and at this point, the concentration of the waste was near detection limits.

MERCK AND COMPANY

Merck's aqueous waste is generated in the manufacture of thiabendazole, a pharmaceutical product. Previous discussion in this appendix included Merck among the mixed industrial wastes permittees.

Merck is authorized to dispose of approximately 36,300 metric tons annually. Disposal is accomplished by subsurface release of the waste at a rate not exceeding 378,000 liters (100,000 gallons) per nautical mile. This rate permits complete dumping of an average barge load of 5.7 million liters in approximately 6 hours (assuming a towing speed of 6 knots), over a linear distance of approximately 38 nmi (70.3 km).

The six major trace metals present in the Merck waste are, in order of decreasing input volume: nickel, lead, vanadium, beryllium, chromium and cadmium.

TOXICITY

Bioassays conducted on mixed industrial wastes between 1973 and 1977 with brine shrimp (*Artemia salina*) yielded 48-hour LC50 values of 1,525 ppm to 100,000 ppm. Bioassays conducted since 1977 with Atlantic silversides (*Menidia menidia*) give 96-hour LC50 values ranging between 650 ppm and 100,000 ppm for aerated tests, and between 150 ppm and 100,000 ppm for non-aerated tests. Bioassays on diatoms (*Skeletonema costatum*) produce 96-hour EC50 values between 65 ppm and 12,000 ppm. Tests with copepods (*Acartia tonsa*) yield 96-hour LC50 bioassay values ranging between 29.7 ppm and 5,300 ppm. Some of the observed variations may be due to the differences in the characteristics of the individual barge loads.

DILUTION AND DISPERSION

Hydroscience, Inc. (1978g) performed the dilution study in May 1978 for the mixed industrial waste generated by Merck and Reheis Chemical. Based upon comparisons between the concentrations of aluminum and carbon in the barge wastes and the concentrations of these same parameters found in the seawater samples collected after 4 hours following the disposal, minimum dilution factors of 20,000:1 and 52,000:1 were observed. A July 1978 survey yielded a minimum dilution at 4 hours of 150,000:1; the plume was barely detectable at 1,000 m from the site of release. An October survey also yielded a minimum dilution of 150,000:1 after 4 hours (Hydroscience, 1979d).

APPENDIX C

MONITORING

CONTENTS

Title	Page
SHORT-TERM MONITORING	C-2
LONG-TERM MONITORING	C-4

TABLES

Number	Title	Page
C-1	Short-Term Monitoring Requirements	C-3

APPENDIX C

MONITORING

The Final EPA Ocean Dumping Regulations and Criteria (40 CFR 220 to 229) discusses monitoring requirements (Section 228.9):

(a) The monitoring program, if deemed necessary by the Regional Administrator or the District Engineer, as appropriate, may include baseline or trend assessment surveys by EPA, NOAA, other Federal agencies, or contractors, special studies by permittees, and the analysis and interpretation of data from remote or automatic sampling and/or sensing devices. The primary purpose of the monitoring program is to evaluate the impact of disposal on the marine environment by referencing the monitoring results to a set of baseline conditions. When disposal sites are being used on a continuing basis, such programs may consist of the following components;

(1) Trend assessment surveys conducted at intervals frequent enough to assess the extent and trends of environmental impact. Until survey data or other information are adequate to show that changes in frequency or scope are necessary or desirable, trend assessment and baseline surveys should generally conform to the applicable requirements of Section 228.13. These surveys shall be the responsibility of the Federal government.

(2) Special studies conducted by the permittee to identify immediate and short-term impacts of disposal operations.

(b) These surveys may be supplemented, where feasible and useful, by data collected from the use of automatic sampling buoys, satellites or in situ platforms, and from experimental programs.

(c) EPA will require the full participation of other Federal and State and local agencies in the development and implementation of disposal site monitoring programs. The monitoring and research programs presently supported by permittees may be incorporated into the overall monitoring program insofar as feasible.

Further in Section 228.10, the Ocean Dumping Regulations delineate specific types of effects upon which monitoring programs must be built:

> (1) Movement of materials into estuaries or marine sanctuaries, or into oceanfront beaches, or shorelines;
>
> (2) Movement of materials toward productive fishery or shellfishery areas;
>
> (3) Absence from the disposal site of pollution-sensitive biota characteristic of the general area;
>
> (4) Progressive, non-seasonal, changes in water quality or sediment composition at the disposal site, when these changes are attributable to materials disposed of at the site;
>
> (5) Progressive, non-seasonal, changes in composition or numbers of pelagic, demersal, or benthic biota at or near the disposal site, when these changes can be attributed to the effects of materials disposed of at the site;
>
> (6) Accumulation of material constituents (including without limitation, human pathogens) in marine biota at or near the site.

Thus, the regulations identify two broad areas which must be taken into account in monitoring:

(a) Short-term or acute effects immediately observable and monitored at the time of disposal, and before disposal of the waste itself.

(b) Long-term or progressive effects measurable only over a period of years and indicated by subtle changes in selected characteristics over time.

SHORT-TERM MONITORING

The permit program administered by EPA Region II has provided the means for monitoring immediate effects of disposal. The program acts as an important check on the variable chemical characteristics of the waste, the biological influence as measured by bioassays and the cumulative totals of known potential toxicants (see Appendix B, Tables B-5, B-6, and B-7). This program provides information about the environment at the time of disposal and the dispersion and dilution of the wastes under varying oceanographic conditions. Table C-1 summarizes the parameters measured at sea for each permittee.

TABLE C-1
SHORT-TERM MONITORING REQUIREMENTS

Permittee	Parameter to be Monitored
	General
All Dumpers	Temperature Dissolved oxygen to 100 m Conductivity
	pH Chlorophyll a Total mercury 1, 15, 30 m Total cadmium Total organic carbon
	Secchi disk to extinction point
	Special
Merck	Sulfonate
Du Pont-Grasselli	Phenol Total Kjeldahl nitrogen
Du Pont-Edge Moor	Total iron Total vanadium
American Cyanamid	Pesticides in the waste at the time of the dump

In 1978, three seasonal surveys were made at the site:

- May - no upper thermocline
- July - strong upper thermocline (28 m)
- October - weak upper thermocline (68 m)

A dye dispersion study was made for each waste type during the July survey (see Appendix B, page B-13, for results). For each survey a drogue was set at the thermocline in the waste plume, where the wastes were expected to accumulate. Samples were taken at 4-, 6-, 8-, and 10-hour intervals at various depths (Table C-1). Two stations were sampled immediately before the waste release to establish the background levels. Samples from the barge were analyzed for the same parameters, so that minimum dilution factors could be calculated.

This program will be continued as one of the permit requirements. The sampling program is the minimum design sufficient to detect changes resulting from the disposal of chemical wastes. The effects documented at the site are transitory (see Chapter 4), and have not caused measurable long-term damage to populations of organisms indigenous to the site or adjacent areas. This sampling program periodically confirms that the wastes are diluted well below the chronic "no-effect" concentrations (as determined by the monthly bioassays) within the allowable short period of initial mixing.

The physical and chemical variables monitored were chosen, based upon the composition of the wastes and the possible effects of waste discharge. Water column sampling is adequate to detect unusual, adverse effects of disposal; benthic samples are not required since the wastes apparently do not penetrate the thermocline, and would not reach the bottom in measurable amounts at this deep site. Therefore, no changes in the existing permittee monitoring program are recommended.

LONG-TERM MONITORING

As discussed in Chapter 3 and Appendix B, extensive research effort has been directed to determine the fate of wastes released at the 106-Mile Site. Nevertheless, there are many aspects of waste disposal at this site which are poorly understood and which must be refined before a meaningful trend assessment and long-term monitoring program can be accomplished. Studies must provide further information on the following factors:

- The penetration of seasonal and permanent thermoclines by different wastes
- The fractionation of wastes in the water column and the association of potentially toxic substances with different fractions
- The fate of wastes related to Gulf Stream eddies and general current patterns
- The refinement and selection as monitoring tools of acoustical tracking, dye or trace metal dispersion data, and organic markers (methyl sulfate)

Studies on these and other important aspects of monitoring at the 106-Mile Site are part of a continuing effort of NOAA's Ocean Dumping Program (National Ocean Survey), supplemented by permittee-supported work.

Further impetus to a formal monitoring program resulted from the passage of PL 95-273, which empowers NOAA to develop a five-year plan for ocean pollution research and monitoring. On a broader scale of time and space, the "Ocean Pulse" program of the National Marine Fisheries Service should provide valuable monitoring data. Thus, long-range monitoring and trend assessment of waste disposal in complex deep oceanic regions (e.g., the 106-Mile Site) are feasible only through the combined resources of several agencies under the future NOAA five-year plan.

APPENDIX D

CHAPTER III, FINAL EIS ON OCEAN DUMPING OF SEWAGE SLUDGE IN THE NEW YORK BIGHT

CONTENTS

Title	Page
ALTERNATIVES TO THE PROPOSED ACTION	D-1
OCEAN-DUMPING ALTERNATIVES	D-2
LAND-BASED ALTERNATIVES	D-17

ILLUSTRATIONS

Number	Title	Page
8	Coliforms in New Jersey Coastal Waters	D-4
9	Coliforms in Long Island Coastal Waters	D-5

APPENDIX D

CHAPTER III, FINAL EIS ON OCEAN DUMPING OF SEWAGE SLUDGE IN THE NEW YORK BIGHT

This Appendix is Chapter III of the Final Environmental Impact Statement on sewage sludge dumping in the New York Bight (EPA, 1978). It is reproduced here to document the earlier considerations of using the 106-Mile Site as an alternate sewage sludge site. Included are discussions on land-based alternatives to ocean dumping of sewage sludge.

ALTERNATIVES TO THE PROPOSED ACTION

Alternatives to the proposed action considered in this EIS fall into two categories: other ocean-dumping alternatives (short-term) and land-based sludge disposal alternatives (long-term).

Since implementation of land-based disposal methods in the metropolitan area is still some years off, a suitable interim ocean dumping alternative is needed. In addition to the proposed action, the ocean-dumping alternatives are:

- Continued use of the existing dump site (No Action or Phased Action),
- Use of an alternate dump site other than the Northern or Southern Area, including sites off the continental shelf, and
- Modification of dumping methods to mitigate potential marine and shoreward impacts.

The land-based sludge disposal alternatives are:

- Direct land application,
- Incineration,
- Pyrolysis, and
- Use as a soil conditioner.

These land-based alternatives have been studied by the Interstate Sanitation Commission (ISC) under a grant from EPA. The ISC sludge disposal management program was issued in October 1976. Since that time, EPA has awarded grants to most of the ocean dumping permittees for specific studies of land-based sludge management alternatives within their geographic areas. The EPA has also placed a condition on the ocean dumping permits issued in August 1976, requiring that ocean dumping be phased out by December 31, 1981. This phase-out date was legislatively mandated in November 1977, by amendment to the Marine Protection Research and Sanctuaries Act of 1972.

Alternatives to the proposed action are discussed in Chapter III.

CHAPTER III

ALTERNATIVES TO THE PROPOSED ACTION

Generally, sewage sludge can be either dumped in the ocean or disposed of by land-based methods. The latter constitute the only legitimate long-range solution to the New York-New Jersey metropolitan area's sludge disposal problem, and they will have to be implemented as ocean dumping is phased out. The background studies for land-based sludge disposal management in the metropolitan area were completed by ISC in 1976. The testing and implementation phases have begun. Current predictions are that land-based sludge disposal methods can be implemented in time to meet the December 31, 1981 deadline for phasing out ocean dumping of sewage sludge.

Until this full-scale, land-based sludge disposal program can be implemented, however, ocean dumping will continue to be the only practical method of disposing of the volumes of sludge produced in the metropolitan area. Within the ocean-dumping alternative, options are available with regard to where the sludge is dumped and how it is dumped. The proposed action, immediate designation and use of an alternate dump site in either the Northern or Southern Area is described in detail in Chapter IV. Chapter III discusses the other ocean-dumping alternatives and summarizes the results of the ISC studies of land-based sludge disposal methods.

OCEAN-DUMPING ALTERNATIVES

In addition to the proposed action, the ocean-dumping alternatives considered in this EIS are: 1) continued use of the existing dump site (No Action and Phased Action), 2) use of an alternate dump site other than the Northern or Southern Area, and 3) modification of dumping methods to mitigate potential marine and shoreward impacts. The phasing out of ocean dumping by the end of 1981 would not be compromised under any of these alternatives.

Continued Use of the Existing Dump Site

The No Action alternative involves continued use of the existing dump site until land-based methods of sludge disposal can be implemented. Under this alternative, the existing dump site would have to accommodate in 1981 more than one and a half times the volume of sludge dumped in 1977; moreover, the site would have to accommodate the increased volume without endangering public health or the marine environment. The primary argument for the No Action alternative is that it limits environmental impacts to the existing site rather than spreading them to another area of the marine environment.

The original argument for moving the sewage sludge dump site was that greatly increased volumes of sludge might impair the recreational quality of Long Island and New Jersey's beaches. As discussed below, current studies tend to show that this argument is largely invalid, lending support to the No Action alternative.

A variation on the No Action alternative is the Phased Action alternative, under which sewage sludge would continue to be dumped at the existing site until a comprehensive monitoring program indicated an impending hazard to public health or damage to recreational water quality. Under the phased alternative, an alternate dump site would have to be designated and held in reserve for possible future use. Since this alternative would maximize use of the existing dump site, adverse impacts on an alternate dump site would be minimized, and sludge hauling costs would not be increased unnecessarily.

This was the alternative recommended in the draft EIS. However, when the fish kill and beach closure incidents discussed in Chapter II occurred, doubts were raised about the acceptability of continuing to use the existing dump site. Studies of the fish kill and beach closure incidents found that sludge dumping was at most a minor contributing factor. Those findings were reconfirmed at a public hearing held in Toms River, New Jersey, on May 31 and June 1, 1977, to consider possible relocation of the New York and Philadelphia sewage sludge dump sites. On the basis of the evidence presented, the hearing officer recommended that neither dump site be moved.

With specific reference to sludge dumping in the New York-New Jersey metropolitan area, the hearing officer also recommended: 1) strict enforcement of existing phase-out schedules and deadlines, 2) inclusion in the sludge dumping EIS being prepared by EPA-Region II of specific criteria for determining the need for relocation of the dump site, 3) intensified monitoring of the existing dump site, and 4) immediate designation of the alternate 60-mile site (this would be the site in the Northern Area recommended in the draft EIS). The report of the Toms River hearing officer, which was issued on September 22, 1977, is presented in Appendix C.

On March 1, 1978, the EPA's Assistant Administrator for Water and Hazardous Materials issued his decision on proposals to relocate the New York and Philadelphia sewage sludge dump sites. The decision report is presented in Appendix D. In all important respects, the Assistant Administrator's decision is in agreement with the findings, conclusions, and recommendations of the Toms River hearing officer:

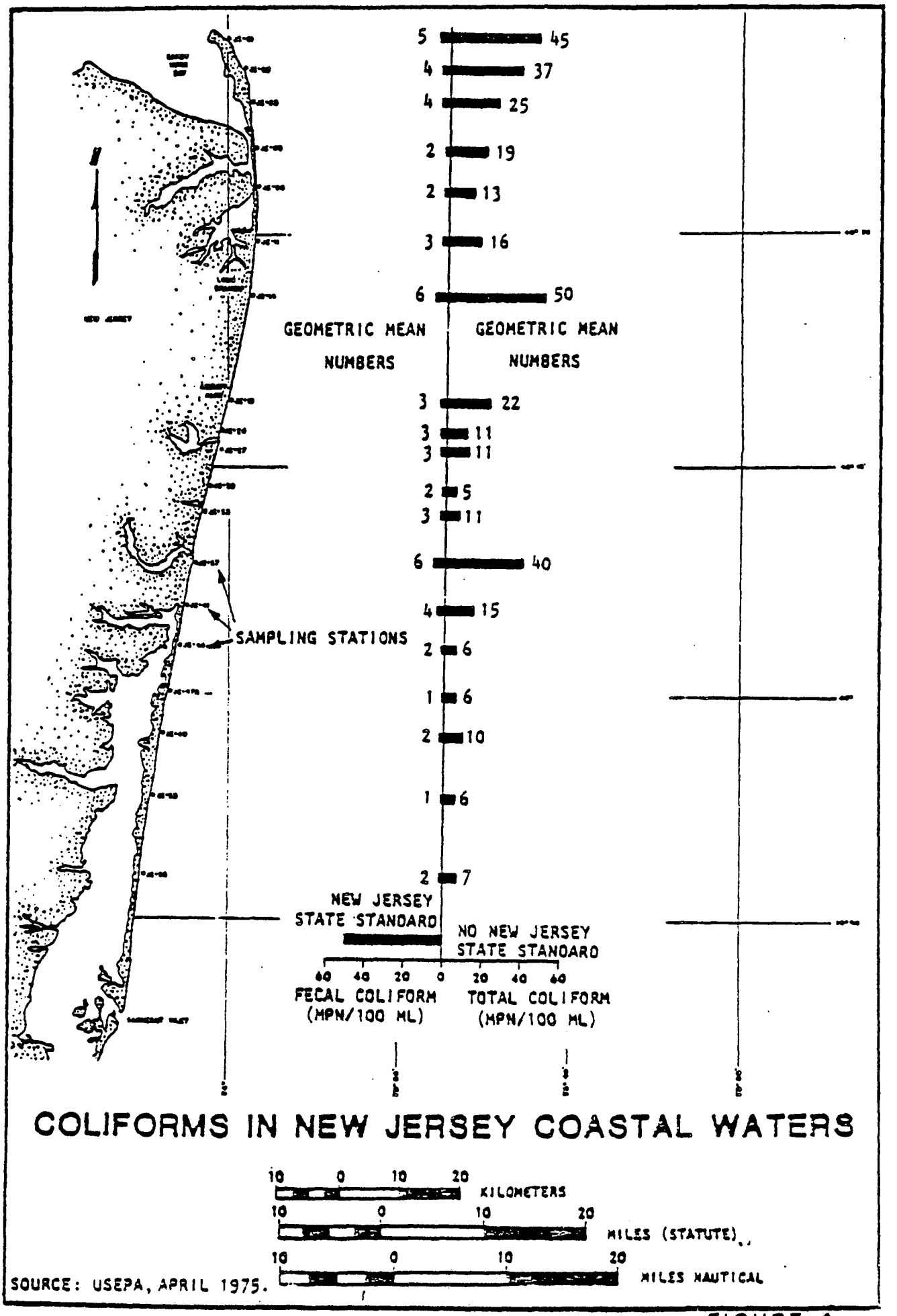
> It is my determination that sewage sludge dumping by these municipalities [in the New York-New Jersey metropolitan area] should not be relocated at the present time; however, efforts should begin immediately to designate the 60-mile site for the disposal of New York/New Jersey sewage sludge in the event such sludge cannot be dumped at the New York Bight site for public health reasons prior to December 31, 1981.

In accordance with this decision, EPA intends to designate the existing site for continued use, as well as the 60-mile site in the Northern Area for possible future use. An intensified monitoring program has already been implemented; it is described in detail in the Monitoring and Surveillance section of Chapter XI. Criteria that can be used to determine whether public health reasons require moving sludge dumping operations from the existing to the alternate site at any time between now and December 31, 1981 have been drawn up by EPA-Region II, and are presented in Appendix E. Finally, a Regional Enforcement Strategy, designed to insure that ocean dumping of sewage sludge is replaced by environmentally acceptable land-based disposal methods by the legislatively mandated deadline of December 31, 1981, has been developed by EPA-Region II, and is presented in Appendix F.

EPA Monitoring Studies. In April 1974, EPA initiated a program to investigate the quality of the water and bottom sediments in the New York Bight and along the Long Island and New Jersey beaches (USEPA, July 1974, April 1975). Data from the surf and near-shore waters indicate that water quality remains excellent in terms of total and fecal coliform density, and that it is acceptable for contact recreation (Figures 8 and 9). Although the data show a few random elevated coliform counts, no violation of state standards is indicated nor does there appear to be any systematic degradation of water quality. Sediment data indicate slightly elevated bacterial counts at certain near-shore sampling stations, but these can be attributed to inland runoff or to wastewater outfalls.

Sampling is continuing along transects between the existing dump site and the following points: the Long Island shore, the entrance to New York Harbor, and the New Jersey shore. Results to date indicate that a clean water and sediment zone, about 10 to 11 km (5.5 to 6 n mi) wide, separates the area affected by sludge from the Long Island coast. As a supplement to the sampling program, EPA has expanded the monitoring and review process to insure protection of public health and welfare and prevention of coastal water quality degradation (see the Monitoring and Surveillance section of Chapter XI).

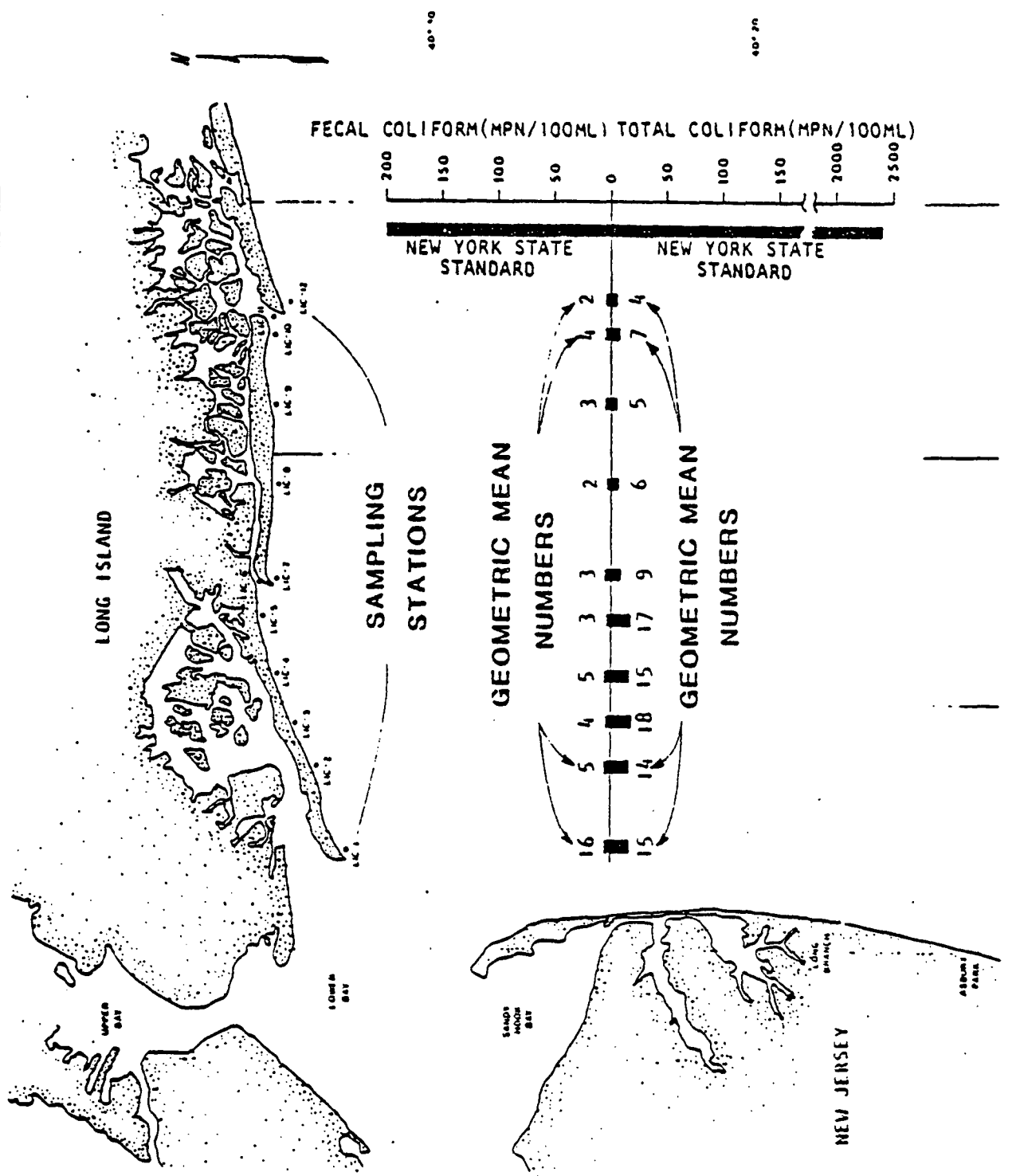
NOAA-MESA Studies. On the basis of two comprehensive reports prepared by NOAA-MESA (March 1975, February 1976), there seems to be no significant accumulation of sewage sludge at the existing dump site, although some sludge particles may be mixing with natural fines in the Christiansen Basin, northwest of



COLIFORMS IN NEW JERSEY COASTAL WATERS

SOURCE: USEPA, APRIL 1975.

FIGURE 8



COLIFORMS IN LONG ISLAND COASTAL WATERS

10 0 10 20 KILOMETERS

10 0 10 20 STATUTE MILES

10 0 10 20 NAUTICAL MILES

SOURCE: USEPA, APRIL 1975.

FIGURE 9

the site. Both reports also note that the general ecological effects of sewage sludge dumping are indistinguishable from those associated with other sources of pollutants in the Bight Apex (the dumping of dredged material and acid wastes, contaminants from the plume of the Hudson estuary, shore-zone pollutant contributions, and atmospheric fallout of contaminants).

However, sludge dumping does exert significant local effects. The catch of groundfish appears to be reduced in areas with high-carbon sediments, such as the area of the existing sludge dump site. Furthermore, it is apparent that very few surf clams reach commercial size within the area now impacted by sludge dumping. Although some fish in the Bight Apex are afflicted with fin rot, this disease is not thought to be attributable solely or even primarily to sludge dumping.

The NOAA-MESA reports do not indicate any shoreward movement of coliform contamination as a result of sludge dumping at the existing site, but they do note the apparent persistence of coliform bacteria in the vicinity, especially in bottom sediments. There is no evidence that under current FDA regulations the cessation of sewage sludge dumping at the existing site would permit reopening of the immediate area to shellfishing. The complete text of NOAA-MESA's conclusions and recommendations from the February 1976 report is presented in Appendix G.

At the Toms River hearing in 1977, NOAA concurred with EPA's recommendation of continued use of the existing dump site based on the fact that there is no demonstrated need for relocation (see Appendix C).

Related Studies. The most recent study of the area (Mueller *et al.*, 1976) indicates that sludge dumping accounts for 0.04 to 11 percent, at most, of the total pollutant loading in the Bight Apex; pollutant loadings from non-dumping sources (wastewater discharges, runoff, and atmospheric fallout) far outweigh those from all current ocean-dumping sources (sewage sludge, dredged material, acid wastes, and cellar dirt).

A study by the Town of Hempstead (1974) supports the conclusion that sewage sludge dumped at the existing site does not significantly affect the quality of the waters or beaches of Long Island.

Use of an Alternate Dump Site Other Than the Northern or Southern Area

Besides the Northern and Southern Areas, possible locations for an alternate sewage sludge dump site include: the other existing dump sites in the Bight Apex (the dredged material, acid wastes, cellar dirt, and wreck sites); other areas in the New York Bight; and areas off the continental shelf, notably the chemical wastes dump site. These locations are discussed below.

Other Existing Dump Sites in the Bight Apex. Dumping sewage sludge at one of the other existing sites in the Bight Apex (the dredged material, acid wastes, cellar dirt, or wreck site) would violate the original concept of segregating wastes by dump site. It would be extremely difficult to isolate the true cause of adverse environmental effects at a site where two or more types of wastes were dumped. The end result would probably be several seriously contaminated dump sites in the Bight Apex, instead of the two that now exist (the sewage sludge and dredged material sites). Use of the existing dredged material site for sludge dumping would be particularly ill-advised because the site is only about 9 km (5 n mi) from the New Jersey shore; the existing sludge dump site is about 20 km (11 n mi) offshore.

Other Areas in the New York Bight. Solely in terms of minimizing potential environmental impacts, a site located offshore, 148 to 158 km (80 to 85 n mi) from the Sandy Hook-Rockaway Point transect, and within the depression of the Long Island Shelf Valley, about 80 m (264 ft) deep, would be preferable. In this area, the tendency is towards bottom transport off the continental shelf, which would minimize the potential for sludge transport to adjacent biological resource areas, including the Hudson Shelf Valley and near-shore shellfisheries. In addition, the greater depth would provide maximum dilution and dispersion of the sludge, minimizing any adverse effects.

The one major drawback to use of this area is that it is beyond the maximum 120 km (65 n mi) range of the existing barge fleet. It would be difficult to justify the greatly increased costs of transportation and possible fleet capitalization in terms of concomitant benefits. Benefits to public health would not increase proportionally with distance. Both the Northern and Southern Areas appear to be far enough from the Long

Island and New Jersey coasts, and in deep enough water, to minimize potential impacts on public health and marine life.

Areas Off the Continental Shelf. In the draft EIS, the alternative of dumping sewage sludge in areas off the continental shelf, such as at the existing chemical wastes dump site, was quickly dismissed because of the prohibitive transportation costs and because of the unknown effects of dumping sewage sludge in those waters. Developments since that time, the 1976 fish kill and beach closure incidents (see Chapter II) and the 1977 public hearing on possible relocation of sludge dump sites (see Appendices C and D), have indicated the need for a more extensive evaluation of this alternative.

The decision report issued by EPA-Headquarters on proposals to relocate the New York and Philadelphia sewage sludge dump sites specifies six major factors that must be considered in determining the feasibility of using an off-the-shelf site for sewage sludge disposal: known environmental acceptability, ability to monitor impact, surveillance of dumping activities, economic burden, logistics, and the effect of utilizing such a site on the ability of dumpers to meet the December 31, 1981 deadline for the termination of harmful sewage sludge dumping (Appendix D). Briefly, the chemical wastes site does not appear favorable on any of these six counts. The environmental acceptability of dumping sewage sludge there is unknown, and scientific opinion by and large recommends against use of this site for sludge dumping. Monitoring and surveillance capabilities are substantially reduced, primarily because of the great distance to the chemical wastes site. Distance is also the primary factor in making the chemical wastes site economically and logistically disadvantageous. The prohibitive cost in turn diminishes the ability of dumpers to meet the 1981 deadline by diverting the available economic resources from the development of acceptable land-based disposal methods. Each of these factors is explored in more detail below.

Environmental Acceptability – Although the MPRSA recommends that the dumping of wastes be done in areas off the continental shelf, *wherever feasible*, the limited information available on this area suggests otherwise. At a 1971 ocean disposal conference, cosponsored by the Woods Hole Oceanographic Institution (WHOI) and the COE, the panel on biological effects stated:

> Disposal should not occur in the deep sea, i.e. beyond the continental shelf. A fundamental reason for this suggestion is the following. The deep sea is an area where biological decomposition rates are apparently very low in comparison with other ocean regions. It is an area of great constancy with respect to the physical-chemical environment and it is thought that the fauna living there is finely tuned to small environmental changes. Thus, the fauna may be quite susceptible to large environmental perturbations such as might be expected with the introduction of dredge spoils. If deleterious effects occur in the deep sea, the opportunities to alter the course of events is [sic] minimal. We therefore suggest that the deep sea should be off limits for disposal activities at least until other information is brought to bear which would render the possible dangers non-existent. (WHOI, 1971).

A similar view was expressed at a 1974 workshop at Woods Hole, sponsored by the National Academy of Sciences (NAS):

> Data for the evaluation of the deep sea as a disposal site are inadequate. This is due to: difficulties in conducting bioassays; slow rates of mixing and diffusion potentially resulting in anaerobic conditions; slow organic degradation; and narrow tolerance ranges for sensitive assemblages of organisms. Although the area is relatively stable in comparison to the shelf and nearshore, the much greater scientific uncertainty, and consequently increased risk associated with off-shelf disposal, dictate that any but the most innocuous use of the area should be approached with extreme caution. (NAS, 1976).

In 1974, NOAA, in cooperation with EPA and with several academic/research institutions, began gathering background information on conditions at the chemical wastes site. Three baseline survey cruises (1974, 1975, and 1976) and several field studies (February, June, August, and September 1976; July 1977; and February and April 1978) have been conducted. A report on the baseline survey cruises has been published (NOAA, June 1977); the Introduction and Summary from that report, which deals with the chemical wastes

site's physical, biological, and chemical characteristics and its contaminant inputs, are presented in Appendix H.

The chemical wastes site has been in use since 1965. Therefore, at the time of NOAA's first baseline survey cruise, the site had been in use for about nine years, making it impossible for NOAA to obtain a pure pre-dumping baseline. Most of the data gathered by NOAA concern chemical wastes dumping by American Cyanamid and by DuPont's Grasselli Plant since these two companies accounted for 80 percent of the total volume of material dumped at the chemical wastes site. The applicability of these data to an assessment of sewage sludge dumping at the chemical wastes site is limited because particulate sewage sludge bears little resemblance to dissolved chemical wastes.

After EPA authorized the dumping of sewage sludge from Camden, New Jersey, at the chemical wastes site in early 1977, NOAA began making plans to study the possible effects. That opportunity to study the possible effects of sewage sludge dumping at the chemical wastes site ended on June 12, 1978, when Camden terminated its ocean dumping operations, a few days short of the expiration of its permit. Camden now disposes of its sludge through a composting process that is described later in this chapter (see the section on Land-Based Alternatives).

While Camden was using the chemical wastes site, NOAA conducted a coliform test and a tracking study. Although data collection and analysis are in a preliminary stage, some information on sludge dumping at the chemical wastes site has been furnished by NOAA.

In June 1977, researchers from WHOI collected samples of seawater during, and for some time after, the release of primary sewage sludge from Camden, New Jersey. The samples were tested for the presence of total and fecal coliform bacteria:

> Positive results were limited to the first hour of surface sampling from within the plume area. Regarding total coliforms, 75 percent of the samples collected proved positive and gave a most probable number range of 1–240 total cells per 100 ml. Measurements on these same samples for fecal coliforms were positive at the 25 percent level and provided a range of 1–120 cells per 100 ml.
>
> No positive results from either test were obtained from any of the subsurface samples. Possibly these results might have differed given the opportunity for continuous sampling over the entire plume. However, the necessary gear was not available at this time and we had to rely on a stationary ship to acquire water samples from beneath the surface.
>
> There are strong indications that the bacterial population associated with sewage sludge is rapidly dispersed by the turbulence and sinking associated with sludge release. Most of the bacterial load appears to remain associated with solid material which rapidly descends to the deeper portions of the water column where a positive sampling becomes highly dubious. (Vaccaro and Dennet, 1977).

In July 1977, sewage sludge released at the chemical wastes site was acoustically monitored to determine its qualitative dispersion characteristics. Preliminary results of the tracking study show a slow, wide distribution of the waste material:

> A sharp thermal gradient (≥1°C/m) existed between 18 and 24 m. The waste field on either side of the dump axis was observed to be distributed through the first 18 m of the water column. On the dump axis, the waste was observed to penetrate to a depth of 60 m. The deeper penetration was of limited horizontal extent, conical in shape (apex at the point of deepest penetration), and was distributed continuously from near the surface to the 60 m depth. The heaviest particle concentration appeared to be in the first 40 m of the water column. A shear with a velocity maximum between 15 and 20 m advected the waste field in the horizontal. Thus, the waste was slowly distributed over an increasing area as material sank from the mixed layer to the seasonal thermocline. During the 32 hr experimental period, the particle field became distributed over the first 45 m of the water column. The distribution was not uniform. Heavy concentrations of backscattering, hence particles were found to be associated with one or two strong thermal gradients [sic]. The thickness of the heavy scattering areas ranged from 5 to 10 m. The layers were periodically displaced by as much as 15 m by the internal wave field. The horizontal distribution of the waste field will be determined as our data reduction progresses. The column of material which penetrated to 60 m was observed several hours after the dump. There appeared to be little change in its depth of penetration or size. (Orr, unpub.).

Although increased dilution and dispersion are generally considered to be positive aspects of dumping in deeper waters, there are serious drawbacks as well. In testimony at the Toms River hearing in 1977, Dr. Carol Litchfield, a marine microbiologist, cautioned that moving the dump site to deeper waters would significantly increase the time required for sludge decomposition:

> The very factor which is appealing to many people in moving and relocation of the dump site in the deeper waters is the very factor which is going to assure that there will be a longer residence time of the sludge and a greater accumulation of the material that is dumped.
>
> Another concern...is what happens to the organisms that are introduced along with the sewage sludge.
>
> Unfortunately, there is very little information on the survival of coliforms in deeper waters.
>
> It has been repeatedly shown, however, that decreased temperatures aid the survival of coliform bacteria in the increased salinities and slightly increased pressures that they would encounter at the deeper dump site, therefore, automatically assuming that deeper waters will "take care of" potential pathogens more efficiently than that which occurs at the present location, could lead to a very false sense of security.
>
> In summary, based solely upon the scientific data available through numerous other studies we know that only about ten percent of the problem would be relieved by moving of the dump site.
>
> This would probably have little positive effect on decreasing the survival of potentially pathogenic micro-organisms, and would definitely result in slower decomposition, and hence, greater accumulation of the dumped organic matters. (in USEPA, June 1, 1977; see also Appendix C).

Another point that must be considered is the unknown consequences of dumping sewage sludge and chemical wastes at the same site. As previously mentioned, combining different types of wastes at one dump site makes it extremely difficult to isolate the true cause of any adverse environmental effects. This would be an especially difficult problem at the chemical wastes site because the effects of chemical wastes dumping alone are not yet well understood:

> The chemical behavior of the substances discharged at DWD-106 [the chemical wastes site] and their impact on the marine environment are unknown. A research group consisting of investigators from Woods Hole Oceanographic Institution, University of Rhode Island, National Marine Fisheries Service, and the Smithsonian Institution have developed a multidisciplinary oceanographic study at DWD-106 to consider the physical, biological, and chemical factors associated with dumping of chemical wastes. The primary chemical questions to be considered in this program are:
>
> 1. Does the discharge of wastes at DWD-106 produce elevated concentrations of potentially toxic metals in the seawater?
> 2. What are the horizontal and vertical extents of chemical impact at the dumpsite?
> 3. What are the chemical forms of metals which may be toxic to marine organisms?
> 4. To what extent are the metals discharged at DWD-106 taken up by organisms, suspended particles, and seafloor sediments?
>
> Answers to these questions will provide a basis for evaluating the consequences of chemical waste disposal at DWD-106 and for designing a future monitoring program to assure that this ocean dumping does not materially degrade the quality of the marine environment. (Hausknecht and Kester, December 1976).

Despite the limited information available on the chemical wastes site, it has been suggested as an alternate sewage sludge dump site. The hope of avoiding a recurrence of the fish kill and beach closure incidents discussed in Chapter II is the reason most often cited for this suggested move. However, as reported in Chapter II, results of the studies of the fish kill and beach closures have shown that both incidents were basically the result of atypical atmospheric and hydrographic conditions, and that sludge dumping was at most a minor contributing factor. Therefore, moving the sludge dumping operations to the chemical wastes site would have no value as a preventive measure.

During its investigation of the fish kill and beach closures, EPA-Region II sought the opinion of other federal and state agencies about the relationship of sludge dumping to these incidents. Specifically, EPA-Region II asked NOAA, the USCG, FDA, ISC, the Fish and Wildlife Service, the New York State Department

of Environmental Conservation (NYSDEC), and NJDEP whether they thought sludge dumping was responsible for the incidents and whether they would recommend relocation of the dump site:

> In that during this past spring and summer, there have been several environmental episodes, mainly the wash-up of floatables and trash on Long Island and New Jersey beaches, an extensive kill of benthic organisms in the New York Bight, and considerable press and political pressure to associate dumping practices as a direct cause of these episodes, we would appreciate your comments regarding the following:
>
> 1. Does your Agency believe that dumping is the direct cause of these episodes? If so, do you have any technical evidence to support this claim?
> 2. Do you maintain, as you have indicated in the past, the position that sludge dumping at the existing site should be continued? If not, what would be your position on moving to either of the two sites studied by NOAA and located roughly 60 miles offshore? What would be your opinion of moving the dump site off the Continental Shelf to the present chemical wastes site? If you believe that the dump site, on the basis of the recent incidents, should be relocated, what environmental factors do you consider appropriate in that decision? (See Appendix I.)

In general, there was a lack of enthusiasm for any move from the existing dump site. Only one agency, NJDEP, favored relocation; it recommended a gradual shift to the chemical wastes dump site, but only after a thorough evaluation of the potential impacts in accordance with NEPA. Copies of the individual responses can be found in Appendix I.

At the Toms River hearing in 1977, NJDEP restated its recommendation for a gradual shift to the chemical wastes site after a thorough environmental assessment of the consequences. At the same time, NOAA slightly modified its position. In general, NOAA continues to strongly recommend against any move from the existing dump site based on the fact that there is no demonstrated need for such a move. Nevertheless, if an alternate site must be chosen, NOAA would prefer the chemical wastes site to a site in either the Northern or Southern Area. However, NOAA's acceptance of the chemical wastes site as an alternate sludge dump site is conditioned on the demonstration that "the net adverse environmental effects are (or are likely to be) less as a result of dumping the material at DWD-106 [the chemical wastes site] than at the original dump site." (in USEPA, May 31, 1977).

After reviewing all of the testimony submitted at the Toms River hearing in 1977, the hearing officer briefly recounted the reasons why sludge dumping at the chemical wastes site would be environmentally unacceptable:

> The preponderance of informed scientific opinion urges extreme caution in dumping wastes in the deep ocean, particularly wastes containing solid materials, because of the many unknowns about this part of the environment. There is a strong feeling among marine scientists that it would be possible to start long-range trends which would be undetectable until it was too late to take corrective measures.
>
> Specific concerns with the dumping of sewage sludge in the deep ocean are the possible persistence of pathogens for long periods of time, the accumulation of biodegradable materials which could ultimately float up undecayed to contaminate seas and beaches, the development of anaerobic deep sea environments, and the damage to deep sea organisms which are used to extremely stable conditions.
>
> Based on this informed scientific opinion, it is concluded that dumping of sewage sludge at the 106-mile site [the chemical wastes site] has a potential for irreversible, long-range, and therefore unreasonable degradation of the marine environment, and that the use of this site for this purpose would be contrary to the intent of the Act [the MPRSA] and the Convention [the International Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter]. (See Appendix C.)

Monitoring and Surveillance – Although precise information is not available, indications are that both monitoring and surveillance of sewage sludge dumping at the chemical wastes site would be more difficult, far more expensive, and perhaps less reliable than at the existing site. As NOAA observed in its baseline

survey report on the chemical wastes site, monitoring is far more complicated at off-the-shelf sites:

> The environmental effects of disposal in deeper waters are...more difficult to measure and, hence, to predict. This is due to factors such as greater depths of water and distances from shore and also to the general paucity of environmental and biological information in off-the-shelf areas. In the case of DWD-106 [the chemical wastes site] this situation is further complicated by the interactions of major water masses, Shelf Water, Slope Water, and Gulf Stream eddies. The DWD-106 is a complex oceanographic area in which to assess natural environmental conditions and the impact of man's activities upon those conditions (NOAA, June 1977; see Appendix H).

In testimony at the Toms River hearing, Kenneth Kamlet, representing the National Wildlife Federation, expressed serious doubts about the feasibility of monitoring sludge dumping operations at the chemical wastes site:

> Relocation of sludge dumping to the 106-site [the chemical wastes site] would essentially deny the opportunity to monitor the situation and render it vitually impossible to alter the course of events should corrective action be necessary.
>
> This is a frequently cited concern. For example, at the EPA workshop on "Evaluation of Ocean Dumping Criteria" convened at Airlie House, August 31 - September 1, 1973, a group chaired by Dr. Edward D. Goldberg, and including among others, Drs. Dean F. Bumpus, Gilbert T. Rowe, and David Menzel, concluded that, although off-Shelf dumpsite locations "would be amenable to mixing of liquids, it is not possible to predict the effect and fate of solids at great depths and it would be difficult to monitor their effects." Dr. Holger Jannasch has pointed out that "the feasibility of short-term studies (on deep-sea biodegradation) is very limited," and that, for this and other reasons, "it will probably be difficult or impossible "to show" — not because there will be no harm..." (but because) (s)cientific evidence for or against such an effect will be very difficult to obtain" (in USEPA, May 31, 1977).

In connection with the Toms River hearing, NOAA was asked by the hearing officer to provide information on the feasibility of developing a program to monitor the effects of sludge dumping at the chemical wastes site. In reply, NOAA stated that such a program would be possible but also very expensive:

> The techniques required for a monitoring program are available. It is, however, more time-consuming and thus more expensive to monitor a site which is 100 miles from shore and 2,000 meters deep than one which is nearshore and shallow.
>
> An effective monitoring program would be built upon our existing knowledge. Initial work directed specifically at sewage sludge would be to define the volume of water through which the sludge settles, the area of the bottom accepting the waste, the rate of water renewal, and rates of deep-sea sludge oxidation. The effects of sludge on deep-sea biota would be addressed through field sampling and by application of specialized techniques for observation at low temperature and high pressure.
>
> It is estimated that such a program would require about $2.5 million for each of its first two years and, thereafter, about $1.0 million per annum (Martineau, October 11, 1977).

After evaluating all of the information presented at the Toms River hearing, the hearing Officer concluded that it would not be feasible to design an effective monitoring program for sewage sludge dumping at the chemical wastes site (see Appendix C).

Similar problems arise in terms of surveillance at the chemical wastes site. As previously reported, the USCG has responsibility under the MPRSA for surveillance and other appropriate enforcement activity with regard to ocean dumping, and the USCG - Third District is responsible for surveillance of ocean dumping in the New York Bight.

At the Toms River hearing, Commander Mullen, representing the Third Coast Guard District, testified about the difficulties of conducting a thorough surveillance program if sludge dumping is moved from the existing site to either the 60-mile site or the chemical wastes site:

Surveillance of sewage sludge disposal operations at the New York Bight Site (11-mile site) is conducted by four Coast Guard vessels which are of the 82 foot and 95 foot classes. These are relatively small vessels.

An average of four vessel patrols per week are conducted at this site. The patrols occur both daytime and nighttime and are intended primarily to detect and to deter dumping outside of the dumpsites, although other EPA requirements, affecting rate of discharge, discharge of floatables, and so forth are also monitored.

In addition, a daily schedule of multi-mission helicopter patrols by Coast Guard Air Station Brooklyn is also conducted which in part, monitor the same activities.... [The helicopters used in this program] are of the type HH-52A, with an operational limitation of approximately 25 miles from shore.

Surveillance at the Industrial Waste Site [the chemical wastes site] is conducted by shiprider.

Currently, five petty officers at New York and two at Philadelphia are involved. It should be noted at this point that the departure times of the vessels and barges are subject to substantial changes as a result of mechanical failures or weather and tidal conditions.

As a result, shipriders are often tied up for considerable periods of time awaiting departure for a particular disposal trip.

Considerable time is also involved in transporting the shiprider to the barge, which requires a vehicle and an additional man.

Coast Guard National Policy is to provide 75% surveillance of toxic chemical dumps which are disposed of at the Industrial Waste Site. With regard to surveillance of sewage sludge and other material ocean dumped, Coast Guard policy is to provide 10% surveillance.

Now let us consider the feasibility of surveillance at each of the alternative sewage sludge disposal sites.

As I mentioned earlier, surveillance at the 106-mile site [the chemical wastes site] is conducted entirely by shipriders. Disposal of all the area's sewage sludge at the 106-mile site would cause a dramatic increase in the number of dumps occurring there.

In order to provide the 10% level of surveillance presently maintained over sewage sludge, Coast Guard shipriders would have to be utilized for these additional missions.

This would require the allocation of new personnel at the Captain of the Port offices and extensive use of reserve petty officers.

The use of reserve petty officers as shipriders is a concept that has recently been tested by the Captain of the Port, Philadelphia. Some of the problems encountered included a lack of expertise with all types of navigational equipment.

The reservists generally have to be provided with refresher training in the use of Loran A, Omega, dead reckoning etc. Delays in vessel and barge departures due to weather and mechanical failure caused the reservist to spend considerable time in stand-by status.

This tends to be a serious problem in terms of manpower utilization due to the short active duty period of each reservist.

Helicopters would have the capacity to check vessels in transit to the 106-mile site, but surveillance at the dump site is beyond the capabilities of the shore based HH052A [sic].

In the near future, we hope to implement an automated ocean dumping surveillance system.

This system is presently being field tested. Such a system would greatly facilitate our ability to monitor dumps at any of the dump sites far offshore.

It is anticipated that regulations requiring installation of ODSS will be issued within six months.

Three modes of surveillance are being considered for the 60-mile site [in the Northern or Southern Area], should sludge dumping be moved there. Shipriders could be utilized as at the Industrial Waste Site and essentially the same problems would be encountered.

Although the time required to complete a mission would be less, the departure delays and time required to transport the shiprider to and from the vessel would still exist.

In considering use of the 95 and 82 foot patrol boats for surveillance at the 60-mile site, new problems arise that do not exist for surveillance at the present sludge dump.

The 82 and 95 foot class vessels are ill adapted to cruising during rough waters encountered on the high seas.

Larger class vessels have been committed to offshore fisheries patrol and are fully utilized while assigned to that program. While the possibility exists that the larger vessels used on fisheries patrol could occasionally pass in the vicinity of the 60-mile dump site, it is unlikely that the frequency of this happening could result in an effective surveillance program.

The proximity of the 11-mile site [the existing sewage sludge dump site] to Groups Sandy Hook and Rockaway allows for easy access to the site and keeps the 82 and 95 foot patrol boats "close to home" in an excellent position to respond to other missions most importantly search and rescue.

It is important to note, that the 82 and 95 foot patrol boats are the primary SAR [search and rescue] boats for Coast Guard Surveillance goal of 10% [sic].

As mentioned earlier, Coast Guard safety policy is to utilize the HH-52A helicopter up to 25 miles from shore.

The proposed 60-mile site is 33 miles from Long Island, 8 miles beyond the aircraft's normal range. In other words, the HH-52As could be used for occasional surveillance of barges and vessels in transit to the 60-mile site, but actual surveillance of disposal operations at the site would by necessity be limited.

The Automated Ocean Dumping Surveillance System (ODSS) once available, would provide an additional alternative to monitoring at the 60 mile site.

In conclusion, the resulting surveillance programs for sewage sludge dumped at either the 60 mile site or the 106 mile mile site would not be as effective as they are presently, unless sufficient lead time were available to acquire additional shipriders, or unless implementation of the automated ocean dumping surveillance system were to first take place.

In the interim period, while attempts are being made to obtain additional resources, it is recommended that a requirement be added to all permits issued for the 60 or 106 mile site for daytime and nighttime that the master of the ocean dumping vessel prepare at the time of occurrence a navigational overlay of the dumping vessel's trackline during the dumping operation, indicating the times and positions at entry and exit of dumpsite and beginning and end of dump.

It is our intention to make every effort to acquire the needed extra persons as soon as any decision is made to move the sludge site, but the extent of lead time needed to actually obtain the needed resources is not known at this time (in USEPA, May 31, 1977).

In summary, Commander Mullen's assessment was that there would be no insurmountable technological problems associated with providing the standard 10 percent surveillance of sewage sludge dumping, at the chemical wastes site. However, until the electronic surveillance device being tested by the USCG is approved and installed on vessels engaged in ocean dumping, an effective surveillance program would be economically and logistically burdensome, requiring substantial increases in equipment and personnel as well as the lead time to acquire the needed equipment and to adequately train Coast Guard reservists in its use.

In his report on the Toms River hearing, the hearing officer acknowledged the difficulties pointed out by Commander Mullen, but concluded, "there is no indication that surveillance of dumping at the 106-mile site [the chemical wastes site] would not be feasible" (see Appendix C).

Logistics and Economics – Even if there were enough data to determine the potential effects on the marine environment of dumping sewage sludge at the chemical wastes site, and even if those effects were found to be acceptable, the logistical and economic drawbacks associated with the distance to the chemical wastes site would probably preclude this alternative. At its closest point, the chemical wastes site is 210 km (115 n mi) from the Sandy Hook-Rockaway Point transect. The limitations of the existing fleet are such that a maximum distance of 120 km (65 n mi) was made one of the criteria for selecting an alternate sewage sludge dump site. Transporting sludge to the chemical wastes site or to some other area off the continental shelf would necessitate upgrading and expansion of the existing fleet.

As shown in Table 7, only twelve vessels are actually in use in the New York Bight, and one of those, the barge *Westco I*, is not seaworthy for use beyond the existing sludge dump site. This reduces the total fleet to eleven and the total carrying capacity to 41,374 cu m (54,112 cu yd) or about 91 percent of the carrying capacity of the full thirteen-vessel fleet.

At an average speed of 13 km/hr (7 knots), a tanker would take approximately 54 hours to make a round trip to the chemical wastes site (see Table 29). At an average speed of 9 km/hr (5 knots), a barge would take approximately 72 hours. These time estimates include 10 hours per trip for docking and loading and 5 hours per trip for discharging the sludge. The 5-hour discharge limitation was imposed by the USCG for safety reasons at the existing dump site. It is used here to facilitate time comparisons between the existing dump site and the chemical wastes site. If the chemical wastes site were actually to be used, the time required for discharge would be substantially greater because the USCG safety limit would not apply and the discharge rate would have to be established in accordance with section 227.8 of the current ocean dumping regulations (see Appendix B). Thus, the round trip time to the chemical wastes site would be 54 hours plus

for a tanker and 72 hours plus for a barge. A round trip to the existing sewage sludge dump site takes about 26 hours for a tanker and 30 hours for a barge.

Given the time constraints associated with the chemical wastes site and assuming that necessary overhauls would put each vessel out of service for about one month per year, the maximum number of annual trips to the site would be 147 for each tanker and 111 for each barge. It is most unlikely that the maximum number of trips could actually be made, however, because this would require that each vessel be in round-the-clock service for the other eleven months of the year.

Even if optimum conditions prevailed, the total volume of sludge that could be transported to the chemical wastes site by the available eleven-vessel fleet (six tankers and five barges) would be 5.0 million cu m (6.6 million cu yd) per year. Almost 4.0 million cu m (5.3 million cu yd) of sludge were dumped at the existing site in 1977, and over 6.0 million cu m (7.9 million cu yd) are projected to be dumped in 1978 (see Tables 6 and 9).

The situation could be improved somewhat by the addition of the *Liquid Waste No. 1*, which is now in use in Puerto Rico. This would bring the number of vessels to twelve (six tankers and six barges) and the total hauling capacity to about 5.3 million cu m (7.0 million cu yd) per year. However, since this volume will probably be surpassed in 1978, fleet augmentation cannot be avoided if a site off the continental shelf is chosen for sludge dumping.

The sludge dumping fleet could be enlarged either by hiring or by constructing the needed vessels. Both of these options would be prohibitively expensive, and the latter would also be infeasible considering the time required to construct the needed vessels and the scheduled phase out of ocean dumping in 1981.

Expanding the fleet of dumping vessels and increasing the travel time for each vessel in order to make use of the chemical wastes site would dramatically raise the cost of sludge dumping for those municipalities that now hold ocean dumping permits (see Table 6):

Dump Site	Cost per Wet Ton	Cost per cu m	Cost per cu yd
Existing	$1.25	$1.95	$1.47
Northern or Southern Area	4.00 to 5.00	6.30 to 7.80	4.70 to 5.90
Chemical Wastes	8.00 to 10.00	12.50 to 15.60	9.40 to 11.80

Thus, the cost of using the chemical wastes site would be twice the cost of using a dump site in the Northern or Southern Area, and six to eight times the cost of continuing to use the existing sewage sludge dump site. Had the chemical wastes site been used for sludge dumping in 1977, it would have cost the municipal permittees somewhere between $49.0 million and $61.0 million instead of the $7.6 million that it cost to use the existing site. By 1981, use of the chemical wastes site for sludge dumping would cost the municipal permittees somewhere between $124.0 million and $154.0 million. The cost to New York City alone could be as much as $64.0 million; currently, sewage sludge dumping at the existing site costs the city $2.2 million per year (Samowitz, June 14, 1977).

Other costs would rise as well, including the cost of monitoring the dump site and the cost of the USCG's surveillance operations.

Its dubious environmental acceptability and its extreme cost are the major but not the only drawbacks to dumping sewage sludge at the chemical wastes site. Greater navigation hazards would result from the dumping vessels' increased travel time on the open ocean. Short dumping, including emergency dumping, would almost certainly increase. Added to this is the fact that using the chemical wastes site for sludge dumping would be of negligible benefit to the water quality of the Bight Apex. Of all of the pollutant sources in the Bight Apex, sludge dumping is hardly the most significant, and its removal to the chemical wastes site could not by itself effect a substantial change in water quality.

Effect of Using the Chemical Wastes Site on the Ability of Dumpers to Meet the December 31, 1981 Deadline - The prohibitive cost associated with using the chemical wastes site for sewage sludge disposal would threaten the ultimate objective of terminating sludge dumping by December 31, 1981. The

economic resources of the communities involved are finite, and if they are spent on transporting sludge to the chemical wastes site, they will not be available for implementing land-based disposal methods. This particular aspect of using the chemical wastes site is a matter of concern not only to the communities that would have to bear the cost, but to federal agencies, to environmental groups, and to some of the Congressmen who were instrumental in amending the MPRSA to specify the 1981 deadline (see Appendices C and D).

Although NOAA would prefer that the chemical wastes site rather than a site in the Northern or Southern Area be used in an emergency between now and 1981, NOAA opposes summarily moving sludge dumping from the existing site to the chemical wastes site:

> NOAA is not in agreement with the proposal to move the sludge dump site which serves the New York-New Jersey metropolitan area from the Apex to the deep water site at 106 miles [the chemical wastes site].
>
> Our position is that no need has been established to require moving the existing dump site, and that all sewage sludge dumping should be halted by 1981.
>
> We are concerned that an open door policy of sewage sludge could ultimately lead to the situation in which most or substantial amounts of east coast municipal and industrial waste dumping is carried out at that site.
>
> *Such a policy would seriously undermine efforts to encourage ocean dumpers to seek land based alternatives to ocean dumping* [emphasis added] (in USEPA, May 31, 1977).

A similar view was expressed by Kenneth Kamlet, representing the National Wildlife Federation, at the Toms River hearing in 1977. In responding to the argument that the increased cost of using the chemical wastes site would make land-based disposal more cost-competitive with ocean dumping and therefore more attractive to the municipalities involved, Mr. Kamlet stated:

> In the first place, any significant increment between now and the end of 1981 (the deadline for completing the phase-out of sewage sludge ocean dumping) in the cost of sewage sludge disposal could as easily discourage as encourage the expedited phase-out of sludge dumping, *if it had the effect of diverting into continued ocean dumping limited funds which would otherwise be available to implement a dumping phase-out* [emphasis added].
>
> In the second place, if the cost increment for relocating the dumpsite were not substantial enough to jeopardize the implementation of land based alternatives, chances are they would also not be substantial enough to provide much if any incentive to accelerate a dumping phase-out (in USEPA, May 31, 1977).

Congressman Edwin Forsythe, the ranking minority member of the House Subcommittee on Oceanography, also testified against moving sludge dumping to an alternate site, particularly the chemical wastes site:

> A decision regarding the location of municipal sewage sludge dumping is a critical resource management problem. Since the environmental and fiscal resources at stake are extremely valuable, our decision-making must be based on rationality. Attempts to sensationalize the issue, and politically expedient pressure to move the problem "out of sight", "out of mind", must be resisted.
>
> The net effects at present of a dumpsite move would be the following: a new site would be contaminated, with little recovery of existing dumpsites.
>
> *Municipalities will exhaust their financial resources on increased transportation costs and ocean dumping barge construction while alternative treatment methods go unfunded* [emphasis added]. The government will investigate and monitor new dumpsites at the time when Congress has reaffirmed its unequivocal intent to end ocean dumping of sewage sludge by 1981.
>
> Finally, responsible parties seeking permanent solutions to the region's waste disposal problem will have their efforts diffused if a quick-fix, "out-of-sight", "out-of-mind" non-solution is adopted.
>
> I am particularly concerned about the possiblity of dumping sewage sludge at Deepwater dumpsite 106 [the chemical wastes site].
>
> The sensitivity of biota, the likely impact on fisheries, the difficulty of policing, the high probability of short dumps, and the impossible task of thoroughly monitoring adverse impacts at the site clearly indicate that dumping at the 106-site could be an environmental nightmare (in USEPA, May 31, 1977).

Congressman Forsythe and the Chairman of the House Subcommittee on Oceanography later reiterated these same concerns during EPA's 1978 ocean dumping authorization hearings (see Appendix D).

The estimated cost to municipalities of using the chemical wastes site for sludge dumping is shown in Table 30. An increase of 641 to 800 percent over the cost of using the existing dump site between 1978 and 1981 is projected. This large an increase would almost certainly detract from the search for alternative land-based disposal methods. As the hearing officer's report for the Toms River hearing concludes:

> None of the municipalities stated that they could not meet the added costs, but they did point out that there would be difficulties in funding, and that *these costs might have to come from funds presently allocated for implementing alternatives* [emphasis added]. (See Appendix C.)

Modification of Dumping Methods

Current sludge dumping procedures, as set forth in each ocean dumping permit, require that the sludge be discharged within the designated dump site, at a uniform rate of 15,500 gallons per n mi (27,441 liters per km) and a speed of at least 3 knots (5 km/hr). Vessel traverses must be at least 0.5 n mi (1 km) apart. These requirements have been stipulated by the USCG for safety reasons in this heavily trafficked area. They would not be applicable if sludge dumping were moved to a site outside the Bight Apex.

Methods of sludge release considered in this EIS include simple overboard dumping, jet discharge, and discharge in the vessel's wake (the present method).

Overboard Dumping. This method consists of simply releasing the sludge from the vessel; the material descends by its own momentum. Since its vertical motion is affected by buoyancy, the initial distribution is mainly within the surface water layers.

Jet Discharge. This method involves pumping the sludge from the vessel through an opening beneath the surface. It is effective in passing the material through the surface layers, but it results in a more confined initial distribution, usually at the depth of neutral buoyancy of the sludge.

Discharge in the Vessel's Wake (Present Method). This method results in high initial mixing and dilution, but the sludge's vertical motion is still dependent on density differences between it and the receiving waters.

Considering the 30 to 60 m (100 to 200 ft) depths and the flow patterns in the Northern and Southern Areas, the present dispersive method of sludge dumping should be continued at an alternate dump site for the following reasons:

- Sewage sludge dumped at or near the surface will settle over a wide area because of its low bulk density, 1.01 g/cu cm.
- Differences in the thermohaline (temperature and salinity) density structure of the ocean would probably slow the settling of sludge under stratified conditions and would negate the effectiveness of a pumped subsurface discharge.
- Dispersion at either the Northern or Southern Area is primarily a function of sea state, depth, and water mass movements. As such, it is not likely to be improved by altering the present dumping technique.
- Given the volumes of dumped sludge projected through 1981 and the limitations of the present fleet, use of sophisticated dumping techniques would probably be both technically impossible and economically prohibitive. Moreover, such techniques would be of little value in improving dispersion patterns.
- Monitoring of the dump site would be facilitated if dumping were limited to a specific surface area.

LAND-BASED ALTERNATIVES

Although an immediate changeover to land-based disposal of sewage sludge in the New York-New Jersey metropolitan area is not feasible, current predictions are that land-based methods can be implemented in time to meet the December 31, 1981 deadline for phasing out ocean dumping of sewage sludge.

In June 1975 and June 1976, ISC issued reports on Phases 1 and 2, respectively, of a three-phase sludge management study funded by EPA. In October 1976, the study was completed with the publication of ISC's sludge disposal management plan for the New York-New Jersey metropolitan area. The study's purpose was to describe the feasible land-based alternatives for sludge disposal and methods of implementing them. As the study progressed and more information was gathered, ISC modified its recommendations accordingly; the final report, published in October 1976, sets forth ISC's current position on the question of sludge management in the metropolitan area.

ISC Phase 1 Report

The Phase 1 report was primarily concerned with the following land-based methods of sewage sludge disposal: direct land application, incineration, pyrolysis, and use as a soil conditioner or fertilizer.

Direct Land Application. Sewage sludge in its liquid form can sometimes be applied to the land as a soil conditioner or fertilizer. Those characteristics of sludge that affect its suitability for direct land application include the organic matter content, the available nutrients (nitrogen, phosphorous, potassium, and trace elements), the quantities of heavy metals, and the toxic organics (especially chlorinated hydrocarbons). In general, three factors limit the immediate implementation of direct land application of metropolitan area sludge.

First, the sludge generated by metropolitan wastewater treatment facilities contains high concentrations of heavy metals (cadmium, chromium, copper, lead, mercury, nickel, and zinc) and significant quantities of toxic organics (chlordane, dieldrin, endrin, heptachlor, lindane, and mirex). If these substances leached into the soils underlying a land-application site, they would be harmful to adjacent streams and groundwater aquifers.

Second, metropolitan area sludge is low in nutrients (as are most domestic sewage sludges) in comparison with commercial fertilizers.

Finally, land is not available in the metropolitan area for a large-scale land-application program. The cost of transporting large quantities of sludge to suitable sites outside the metropolitan area appears to be prohibitive.

Incineration. Sewage sludge incineration results in waste gases, particulates, and a relatively small quantity of sterile ash that retains most of the heavy metals originally present. Air pollution controls, such as wet scrubbers, are necessary to remove the particulates, odors, nitrogen oxides, sulfur oxides, volatile toxic organics, and airborne heavy metals (cadmium, lead, and mercury). Multiple-hearth incineration has the least potential for air pollution; it can burn without auxiliary fuel (gas, oil, or coal), and it is compatible with a phased change-over to pyrolysis. The ash, of course, which contains heavy metals, must ultimately be disposed of in an environmentally acceptable manner.

To burn without auxiliary fuel, sludge must generally be dewatered, that is, the liquid content must be reduced from its usual range of 93 to 97 percent to less than 65 percent.

Although the air pollution problems posed by this method of sludge disposal could be minimized by incinerating the material on ships or offshore platforms, the costs cannot be justified since other, more economical, methods of sludge disposal are available.

Pyrolysis. Destructive distillation, or pyrolysis, is the process of breaking down organic matter, such as sewage sludge, by heating it in the absence of oxygen. The resulting by-products are a number of gases, a carbon/ash char, and a liquid waste containing a wide variety of organic compounds. Pyrolysis is generally cheaper than incineration because it produces fewer particulates and thus requires less in the way of air pollution controls. The by-products, char and gases, can be used as fuels. To date, however, no large-scale pyrolysis tests have been conducted on sewage sludge alone, so prior to implementation of this alternative, a pilot demonstration plant would have to be built and successfully operated.

Use as a Soil Conditioner. Problems with the use of sewage sludge as a soil conditioner or fertilizer are much the same as those with direct land application: the high concentrations of heavy metals and toxic organic compounds must be removed or reduced. In addition, the sludge must be dried to 5 or 10 percent moisture content and fortified with nutrients before it can be used as a fertilizer. Finally, there is the problem of promoting consumer acceptance.

Conclusions and Recommendations. The ISC Phase 1 report (1975) drew the following conclusions regarding land-based sludge disposal methods for the metropolitan area and the eventual, phased implementation of those methods.

The most feasible alternative to ocean dumping would be pyrolysis (the sludge having been dewatered with filter presses). This conclusion was based on considerations of environmental impact, economic feasibility, and energy recovery. Pyrolysis has the least potential for negative impacts on water, air, or land resources. It could be implemented within ten years.

Multiple-hearth incineration could be implemented sooner than pyrolysis, and the incinerators could be converted to pyrolysis units once that process was demonstrated to be successful. Incinerators, however, would face more difficult siting problems because of their potential for air pollution and because of the possibility of local community resistance. The incinerators needed to handle the volumes of sludge projected for the year 2000 would cost on the order of $400 to $500 million (in 1975 dollars).

Direct land application could be implemented only in fringe areas (outside the metropolitan area), where population density is low and large tracts of land are available, and where agricultural enterprises would provide a market for sludge-based fertilizers and soil conditioners.

A small-scale pilot study should be undertaken immediately with the aid of an equipment manufacturer who is familiar with both pyrolysis technoloigy and multiple-hearth furnace construction. The purpose would be to identify and define the required engineering parameters prior to full-scale demonstration plant construction.

The complete text of the Phase 1 report's conclusions and recommendations is presented as part of Appendix J.

ISC Phase 2 Report

The object of the Phase 2 report (ISC, 1976a) was to develop and recommend a specific, coordinated disposal program based on the technical findings of the Phase 1 report (ISC, 1975). In sum, the Phase 2 report recommends the construction of regional pyrolysis plants at six separate locations in the metropolitan area and only limited land application of sludge.

Incineration and Pyrolysis. To date, pyrolysis of sludge alone has been studied only in pilot-scale tests; large-scale demonstrations have utilized solid wastes. The ISC's Phase 1 report indicated that multiple-hearth furnaces could be built by 1981, initially operated as incinerators, and then converted to pyrolysis units as that technology developed. Between the publication of the Phase 1 and Phase 2 reports, it was learned that such furnaces could be designed and constructed as pyrolysis units directly during the same time span; incineration was therefore not considered further.

The ISC evaluated the retention of anaerobic digestion capabilities at individual plants because a number of operating wastewater treatment plants have, or plan to construct, these digesters. It was found that maintenance of existing anaerobic digesters was cost-effective, but that new digesters should not be built if sludge was to be pyrolyzed.

Land Application, Composting, and Landfilling. Land application and composting are feasible sludge disposal alternatives for outlying plants in the metropolitan area. These plants could form regional groups for direct land application or for sludge composting.

Landfilling of stabilized, dewatered sludge is cost-effective only for the smaller suburban wastewater treatment facilities, and only if landfill sites are available. Landfilling, however, should be considered a short-term solution, to be used while long-term direct land application or composting programs are instituted. In addition, landfilling was found not to be feasible for sludges produced by treatment plants in highly urbanized portions of the metropolitan area because of the larger quantities of sludge produced and the limited lifespans of available landfill sites.

Sludge Management. The plan recommended in ISC's Phase 2 report calls for pyrolysis of sludge produced in urban treatment plants and land application or composting of sludge produced in outlying plants. The recommended pyrolysis sites and areas to be served are:

1. Port Newark (New Jersey regional), serving Bergen, Hudson, and Union counties, and the Passaic Valley Sewerage Commissioners.
2. Sayreville, serving the Middlesex County Sewerage Authority.
3. Cedar Creek, serving Nassau County.
4. Twenty-Sixth Ward, serving Coney Island, Jamaica, Rockaway, and Twenty-Sixth Ward.
5. Hunts Point, serving Bowery Bay, Hunts Point, Tallmans Island, and Wards Island.
6. Fresh Kills (New York regional), serving Newtown Creek, North River, Owls Head, and Port Richmond.

Conclusions and Recommendations. Pyrolysis is favored as a particularly promising means of disposing of the large volume of municipal sewage sludge expected to be produced by the year 2000. The ISC Phase 2 report concludes that if future federal policies prohibit or significantly curtail the ocean dumping of sludge, pyrolysis is the best alternative for its disposal. The report also recommends the construction of six regional pyrolysis facilities (listed above). Only limited amounts of sludge are seen as suitable for direct land application.

The ISC concludes that direct land application of either treated or untreated sludge in quantities sufficient to dispose of the expected volumes would be dangerous because of the large heavy metal and toxic organic content, and the threat of surface and groundwater contamination. Pyrolysis is also preferred to incineration because units could be more easily decentralized. While pyrolysis equipment capable of reducing sludge is not yet in commercial operation, recent technological advances make it appear that the method could be in practical use by the early 1980s.

While the ISC acknowledges the urgent need for the cessation of ocean dumping, it considers EPA's phase-out date of December 31, 1981 to be somewhat optimistic.

The complete text of the Phase 2 report's summary chapter is presented as part of Appendix J.

ISC Sludge Disposal Management Program

The latest ISC report (1976b) presents ISC's plan for sewage sludge management in the New York-New Jersey metropolitan area. It combines the Phase 1 and Phase 2 reports with an examination of legal-institutional implementation problems.

In general, the sludge management plan currently recommended by ISC is very similar to the one recommended in the Phase 2 report. The major difference, is that ISC now places a greater emphasis on composting followed by land spreading. The sludges produced by several treatment plants in the metropolitan area are now suitable for composting and land spreading. Other sludges are still unsuitable, primarily because of their heavy metal and synthetic organics content. However, pretreatment of industrial wastewaters could resolve these problems.

Relative to pyrolysis, the ISC recommends five facility sites rather than the six given in the Phase 2 report:

1. Port Newark (New Jersey regional), serving Bergen, Hudson, and Union counties, and the Passaic Valley Sewerage Commissioners.
2. Sayreville, serving the Middlesex County Sewerage Authority.
3. Cedar Creek, serving Nassau County.
4. Twenty-Sixth Ward, serving Newtown Creek, Owls Head, Coney Island, Jamaica, Rockaway, and Twenty-Sixth Ward.
5. Hunts Point, serving Bowery Bay, Hunts Point, Tallmans Island, and Wards Island.

The ISC makes no recommendation relative to the North River or Red Hook treatment plants that are being constructed in New York City; both plants are scheduled to go into operation in the mid-1980's.

The complete text of the summary chapter of the October 1976 report is presented as part of Appendix J.

Testing and Implementation

As noted at the start of this chapter, the testing and implementation phases of the sludge disposal management program have begun. Since no large-scale pyrolysis test had been conducted on sewage sludge alone, ISC recommended, in its Phase 1 Report, that a pilot demonstration plant be built and successfully operated. In 1976, EPA funded such a pilot test. Nichols Engineering and Research Corporation was contracted to test sludge pyrolysis at its Belle Mead, New Jersey, research facility. Sludges from several treatment plants were chemically conditioned, dewatered, and pyrolyzed under various design conditions in a Nichols Herreshoff Multiple Hearth Furnace. Nichols has reported that pyrolysis can be used as a commercially feasible and cost effective thermal destruction method for sludge disposal without using fuel, including afterburning at 759°C (1400°F) (ISC, 1978).

In December 1976, a sludge composting project in Camden, New Jersey, was funded by EPA and NJDEP. This project uses a technique developed by the U.S. Department of Agriculture's experimental sludge composting station in Beltsville, Maryland. During the process, which takes a total of thirty days, dewatered sludge is mixed with a bulking agent, such as wood chips, corn cobs, or waste paper, and stacked in piles. The piles are blanketed with an inert material, and air is drawn through the piles. Aerobic biological degradation increases temperatures within the piles to 82°C (180°F), thus destroying most pathogenic bacteria.

The Camden composting facility, which was dedicated in June 1978, established several major environmental precedents. It is the largest composting operation of its type in the United States. It is also the first such municipal undertaking in the New York-New Jersey area. Most important, it is the first instance of cessation of ocean dumping by a large municipal sewage treatment plant (58,118 cu m or 76,471 cu yd per year).

All municipal permittees in EPA-Region II are required by permit condition to select and implement an environmentally acceptable alternative to ocean dumping on or before December 31, 1981. Each permittee has been given a final phase-out date based upon the individual permit implementation schedule. Each of the permittees is on a strict implementation schedule, and is closely monitored by EPA-Region II. All permittees are afforded the opportunity to comply with this condition using federal funds available through the FWPCA (the Clean Water Act), and most have chosen this path. Examples of the technologies being considered or currently being implemented are:

Camden	
Middletown Township	
Northeast Monmouth	Composting
Linden-Roselle	

Nassau County	
Bergen County	Composting of sludge and use as landfill cover as an interim solution; co-recovery with solid wastes as a long-term solution
Joint Meeting of Essex and Union Counties Rahway Valley Wayne Township Lincoln Park Pequannock Township Pompton Plains Oakland	Incineration
Middlesex County	Multiple hearth incineration or starved air combustion
Glen Cove	Co-incineration with solid wastes
New York City	Composting or landfilling of digested dewatered sludge as an interim solution; utilization of other technology (pyrolysis, co-recovery, etc.) or shipment out of the city area for composting as a long-term solution
Westchester County	Use of existing excess capacity in solid waste incinerators and composting of remainder

APPENDIX E

COMMENTS ON THE DRAFT EIS

CONTENTS

Title	Page
REVIEWERS OF THE DRAFT EIS	E-2
LETTERS COMMENTING ON THE EIS	E-9
RESPONSES TO LETTERS	E-79
HEARING RESPONSES	E-103

APPENDIX E

COMMENTS ON THE DRAFT EIS

The draft EIS (DEIS) was issued on June 25, 1979 and a public hearing was held on August 21, 1979 at Mercer County Community College, New Jersey. The public was encouraged to participate in the hearing and to submit written comments. This appendix contains copies of all verbal and written comments received by EPA on the DEIS. There was a great variety of comments received, thus EPA presents several levels of response:

- Comments correcting facts presented in the EIS, or providing additional information, were incorporated into the text without further response. Most of Du Pont's and NOAA's comments were handled in this manner.
- Specific comments, which were not appropriately treated as text changes, were numbered in the margins of the letters, and responses prepared for each numbered item.
- Comments orginating at the public hearing were excerpted from the hearing transcript, and responses prepared.

Some written comments were received after the end of the comment period and the close of the public hearing record. In order to give every consideration to public concerns, the Agency took all comments received up to the date of final production of the final EIS under advisement.

The EPA sincerely thanks all those who commented on the draft EIS, especially those who submitted detailed criticisms that reflected a thorough analysis of the EIS.

REVIEWERS OF THE DRAFT EIS

The following persons submitted written comments:

Edwin B. Forsythe
Ranking Minority Member
Subcommittee on Fisheries and Wildlife Conservation
and the Environment
U.S. House of Representatives
Committee on Merchant Marine and Fisheries
Room 1334 Longworth House Office Building
Washington, D.C. 20515
(August 24, 1979)

P.A. DeScenza
Chief, Engineering Division
U.S. Department of the Army
New York District, Corps of Engineers
26 Federal Plaza
New York, NY 10007
(August 2, 1979)

Sidney R. Galler
Deputy Assistant Secretary for Environmental Affairs
U.S. Department of Commerce
Assistant Secretary for Science and Technology
Washington, D.C. 20230
(August 31, 1979)

George C. Steinman
Chief, Environmental Activities Group
Office of Shipbuilding Costs
U.S. Department of Commerce
Maritime Administration
Washington, D.C. 20230
(July 26, 1979)

David W. Saxton
Center for Environmental Assessment Services
U.S. Department of Commerce
National Oceanic and Atmospheric Administration
Environmental Data and Information Service
Washington, D.C. 20235
(August 15, 1979)

Allen E. Peterson, Jr.
U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Federal Building, 14 Elm Street
Gloucester, MA 01930
(August 28, 1979)

P. Kilho Park
U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Ocean Survey
Rockville, MD 20852
(August 10, 1979)

Frank S. Lisella
Chief, Environmental Affairs Group
Environmental Health Services Division
Bureau of State Services
U.S. Department of Health, Education, and Welfare
Public Health Service
Center for Disease Control
Atlanta, GA 30333
(August 21, 1979)

Larry E. Meierotto
Assistant Secretary
U.S. Department of the Interior
Office of the Secretary
Washington, D.C. 20240
(September 14, 1979)

R.L. McFadden, LCDR
Chief, Surveillance and Monitoring Branch
U.S. Department of Transportation
U.S. Coast Guard
Washington, D.C. 20590
(August 13, 1979)

F.P. Schubert, Captain
Chief of Staff
U.S. Department of Transportation
U.S. Coast Guard
Third Coast Guard District
Governors Island
New York, NY 10004
(September 10, 1979)

Nathan Hayward III
Director
Delaware, State of
Executive Department
Office of Management, Budget, and Planning
Dover, DE 19901
(August 6, 1979)

Edward H. White III
Development Officer
Maryland, State of
Department of Economic and Community Development
Division of Local and Regional Development
2535 Riva Road
Annapolis, MD 21401
(July 19, 1979)

Thomas A. Deming
Acting Assistant Attorney General
Council to Secretary
Maryland, State of
Office of the Attorney General
Department of Natural Resources
Tawes State Office Building
Annapolis, MD 21401
(August 21, 1979)

Lawrence Schmidt
Chief Office of Environmental Review
New Jersey, State of
Department of Environmental Protection
John Fitch Plaza
P.O. Box 1390
Trenton, NJ 08625
(September 21, 1979)

Marwan Sadat and Theresa Van Rixoort
New Jersey, State of
Department of Environmental Protection
Office of Sludge Management and Industrial Pretreatment
Trenton, NJ 08625
(August 21, 1979)

Sandra Ayres
Assistant Deputy
Public Advocate
New Jersey, State of
Department of the Public Advocate
520 E. State St.
Trenton, NJ 08625

Terence P. Curran
Director
Division of Regulatory Affairs
New York, State of
Department of Environmental Conservation
50 Wolf Road
Albany, NY 12233
(September 6, 1979)

Richard A. Heiss
Supervisor
Pennsylvania, Commonwealth of
Pennsylvania State Clearinghouse
Governor's Office
Office of the Budget
P.O. Box 1323
Harrisburg, PA 17120
(August 24, 1979)

J.B. Jackson, Jr.
Administrator
Virginia, Commonwealth of
Council on the Environment
903 Ninth Street Office Building
Richmond, VA 23219
(August 8, 1979)

Dale E. Wright
Pollution Control Specialist
Bureau of Surveillance and Field Studies
Virginia, Commonwealth of
State Water Control Board
2111 Hamilton Street
P.O. Box 11143
Richmond, VA 23230
(August 2, 1979)

Robert D. Halsey
Director of County Planning
Monmouth County Planning Board
Court Street and LaFayette Place
Freehold, NJ 07728
(October 7, 1979)

Harry W. Kelley
Mayor
Ocean City, Town of
Mayor and City Council
Ocean City, MD 21842
(August 3, 1979)

Martin Neat
Grantsman
Ocean City, Town of
Mayor and City Council
Ocean City, MD 21842
(July 24, 1979)

Gerald M. Hansler
Executive Director
Delaware River Basin Commission
P.O. Box 7360
West Trenton, NJ 08628
(August 14, 1979)

H.W. McDowell
Environmental Coordinator
E.I. du Pont de Nemours & Company, Inc.
Grasselli Plant
Linden, NJ 07036
Chemical Dyes and Pigment Department
(August 24, 1979)

L.L. Falk
Engineering Service Division
E.I. du Pont de Nemours & Company, Inc.
Wilmington, DE 19898
Engineering Department
Louviers Building
(September 26, 1979)

Leon J. Sokol
Greenstone and Sokol
Counsellors at Law
39 Hudson Street
Hackensack, NJ 07601
(August 21, 1979)

Kathleen H. Rippere
Natural Resources Chairman
League of Women Voters
Monmouth County, NJ
934 Navesink River Road
Locust, NJ 07760
(August 10, 1979)

John C. Bryson
Executive Director
Mid-Atlantic Fishery Management Council
Room 2115 Federal Building
North and New Streets
Dover, DE 19901
(October 4, 1979)

Kenneth S. Kamlet
Counsel, and Assistant Director
for Pollution and Toxic Substances
National Wildlife Federation
1412 16th St., N.W.
Washington, D.C. 20036
(August 31, 1979)

The following persons attended the hearing held August 21, 1979 at Mercer County Community College, New Jersey:

Thomas O'Connor
U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Ocean Survey
Rockville, MD 20852

Norma Hughes
U.S. Environmental Protection Agency
Oil and Special Materials Control Division
Marine Protection Branch
Washington, D.C. 20460

T. William Musser
U.S. Environmental Protection Agency
Oil and Special Materials Control Division
Marine Protection Branch
Washington, D.C. 20460

Barbara Ramsey
U.S. Environmental Protection Agency
Oil and Special Materials Control Division
Marine Protection Branch
Washington, D.C. 20460

Alan Hill
U.S. Environmental Protection Agency
Oil and Special Materials Control Division
Ocean Programs Branch
Washington, D.C. 20460

Peter W. Anderson
U.S. Environmental Protection Agency
Region II, Surveillance and Analysis Division
Edison, NJ 08817

Paul Birmingham
U.S. Environmental Protection Agency
Region II
New York, NY

Theresa Van Rixoort
New Jersey, State of
Department of Environmental Protection
Office of Sludge Management and Industrial Pretreatment

Sandra T. Ayres
New Jersey, State of
Department of the Public Advocate
520 E. State Street
Trenton, NJ 08625

D.W. Bennett
American Littoral Society
Highlands, NJ 07732

William M. Dunstan
Interstate Electronics Corporation
1745 Jefferson Davis Highway, Suite 601
Arlington, VA 22202

Kathleen M. King
Interstate Electronics Corporation
707 E. Vermont Ave.
P.O. Box 3117
Anaheim, CA 92803

Kenneth S. Kamlet
National Wildlife Federation
1412 16th Street, N.W.
Washington, D.C. 20036

Phyllis Allen
Plainfield, NJ

1

NINETY-SIXTH CONGRESS

JOHN M. MURPHY, N.Y., CHAIRMAN

THOMAS L. ASHLEY, OHIO
HERMAN E. TALMADGE, GA.
WALTER B. JONES, N.C.
WILLIAM M. ... N.J.
... CALIF.
... TEX.
... N.Y.
... MASS.
DAVID R. BOWEN, MISS.
CARROLL HUBBARD, JR., KY.
DON BONKER, WASH.
LES AUCOIN, OREG.
NORMAN Y. MINETA, CALIF.
JAMES L. OBERSTAR, MINN.
WILLIAM J. HUGHES, N.J.
BARBARA A. MIKULSKI, MD.
DAVID E. BONIOR, MICH.
DANIEL K. AKAKA, HAWAII
MICHAEL DIZZIE MYERS, PA.
JOE WEAVER, TEX.
MIKE LOWRY, WASH.
EARL HUTTO, FLA.
EDWARD J. STACK, FLA.
BRIAN DONNELLY, MASS.

PAUL N. MC CLOSKEY, JR., CALIF.
GENE TAYLOR, MO.
EDWARD J. ROUSSELOT, N.J.
DAVID C. DREIER, CALIF.
JOEL PRITCHARD, WASH.
DON YOUNG, ALASKA
ROBERT E. BAUMAN, MD.
NORMAN F. LENT, N.Y.
DAVID F. EMERY, MAINE
ROBERT H. DOHNAN, CALIF.
THOMAS B. EVANS, JR., DEL.
PAUL S. SPIBLE, JR., VA.
ROBERT W. DAVIS, MICH.
WILLIAM CARNEY, N.Y.
MELVIN H. EVANS, V.I.

CHIEF OF STAFF
CARL L. PERIAM

CHIEF COUNSEL
ERNEST J. CORRADO

CHIEF CLERK
FRANCES STILL

MINORITY COUNSEL
JACK E. GANDS

U.S. House of Representatives
Committee on
Merchant Marine and Fisheries
Room 1334, Longworth House Office Building
Washington, D.C. 20515

August 24, 1979

Mr. T. A. Wastler, Project Officer
U.S. Environmental Protection Agency
Oil and Special Materials Control Division
Marine Protection Branch
Washington, D.C. 20460

RE: DEIS for 106-Mile Ocean Waste
Disposal Site Designation

Dear Mr. Wastler:

I wish to commend you for the exhaustive Draft Environmental Impact Study for the 106-Mile Ocean Waste Disposal Site Designation.

As a member of the Merchant Marine and Fisheries Committee which has legislative jurisdiction over the Marine Protection, Research and Sanctuaries Act (Ocean Dumping Act), I have long been concerned with the practice of ocean dumping. The Ocean Dumping Act authorization bill pending before the House of Representatives contains an amendment I offered to require the cessation of ocean dumping of municipal waste by December 31, 1981.

I am particularly concerned about the possibility of dumping sewage sludge at the 106-Mile Dumpsite. The sensitivity of biota, the likely impact on fisheries, the difficulty of enforcement, the high probability of short dumps, and the almost-impossible task of thoroughly monitoring adverse impacts at the site clearly indicate that large-scale dumping of sewage sludge at the 106-site could be an environmental nightmare.

I would therefore strongly encourage EPA to allow the ocean dumping of sewage sludge at the 106-site only under the conditions mentioned in the DEIS:

(continued)

- when the existing New York Bight Sewage Sludge Site cannot safely accomodate more sludge disposal without endangering public health, severely degrading the marine environment, or degrading coastal water quality;

- under strict controls and surveillance; and

- with close monitoring of both short- and long-term impacts on the marine environment.

1-1 Congress has made it eminently clear that the practice of ocean dumping should cease as soon as possible. I hope you will continue to do whatever you can to ensure that environmentally-sound alternatives are in place in the very near future.

I appreciate the opportunity to submit these comments.

Sincerely,

Edwin B. Forsythe
Ranking Minority Member
Subcommittee on Fisheries and Wildlife
Conservation and the Environment

EBF:dw

2

DEPARTMENT OF THE ARMY
NEW YORK DISTRICT, CORPS OF ENGINEERS
26 FEDERAL PLAZA
NEW YORK, N. Y. 10007

NANEN-E

2 August 1979

RECEIVED 8/10

Mr. John T. Rhett
Deputy Assistant Administrator
For Water Program Operations
U.S. Environmental Protection Agency
Oil and Special Materials Control Division
Marine Protection Branch
Washington, D.C. 20460

Dear Mr. Rhett:

The New York District appreciates the opportunity to review the Draft Environmental Impact Statement for the 106-Mile Ocean Water Disposal Site Designation.

The District has no comments to make at this time.

Sincerely yours,

P. A. DeSCENZA
Chief, Engineering Division

3

UNITED STATES DEPARTMENT OF COMMERCE
The Assistant Secretary for Science and Technology
Washington, D.C. 20230
(202) 377-4335

August 31, 1979

RECEIVED 9/6

Mr. John T. Rhett
Deputy Assistant Administrator for
Water Program Operations (WH-546)
Environmental Protection Agency
Washington, D. C. 20460

Dear Mr. Rhett:

This is in reference to your draft environmental impact statement entitled, "106-Mile Ocean Waste Disposal Site Designation." The enclosed comments from the National Oceanic and Atmospheric Administration and the Maritime Administration are forwarded for your consideration.

Thank you for giving us an opportunity to provide these comments, which we hope will be of assistance to you. We would appreciate receiving eight (8) copies of the final environmental impact statement.

Sincerely,

Sidney R. Galler
Deputy Assistant Secretary
for Environmental Affairs

Enclosures Memos from: Mr. P. Kilho Park
National Ocean Survey -NOAA

Capt. George C. Steinman
Chief, Environmental Activities
Group - MarAd

4

UNITED STATES DEPARTMENT OF COMMERCE
The Assistant Secretary for Science and Technology
Washington, D.C. 20230
(202) 377-XXXX 4335

September 11, 1979

9/18

Mr. John T. Rhett
Deputy Assistant Administrator for
Water Program Operations (WH-546)
Environmental Protection Agency
Washington, D. C. 20460

Dear Mr. Rhett:

The Department of Commerce reviewed the draft environmental statement by the Environmental Protection Agency relative to the "106-Mile Ocean Waste Disposal Site Designation", and forwarded comments to you in our letter of August 31, 1979.

Since that time, additional information has developed which is pertinent to the project. This additional information is offered for your consideration.

We are pleased to have been offered the opportunity to review this statement.

Sincerely,

Sidney R. Galler
Deputy Assistant Secretary
for Environmental Affairs

Enclosure Memo from: Mr. Allen E. Peterson, Jr.
National Marine Fisheries
Service - NOAA

E-12

5

9909.05

UNITED STATES DEPARTMENT OF COMMERCE
Maritime Administration
Washington, D.C. 20230

July 26, 1979

MEMORANDUM FOR: Dr. Sidney R. Galler
Deputy Assistant Secretary for Environmental Affairs

Subject: EPA Draft Environmental Impact Statement for the 106-Mile Ocean Waste Disposal Site Designation (June 1979)

The subject document has been reviewed, and the following comments are submitted for your consideration:

5-1 1. Incineration at sea

It is noted on page I-13 that one of the six types of ocean dumping permits is the Incineration at Sea Permit. The subject discussion does not indicate whether the 106-Mile Disposal Site will be used to incinerate toxic waste chemicals aboard incinerator ships. Since proper incineration of many combustible wastes would satisfy EPA's rigid marine environmental impact criteria, it is recommended that this possible omission be clarified.

2. International considerations, page I-15

It is recommended that the discussion of the Ocean Dumping Convention be expanded to indicate that the Convention has been recently amended incorporating international regulations for the control of incineration of wastes at sea to be enforced nationally.

GEORGE C. STEINMAN
Chief, Environmental Activities Group
Office of Shipbuilding Costs

Rec'd 8/20/79

6

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
ENVIRONMENTAL DATA AND INFORMATION SERVICE
Washington, D.C. 20235
Center for Environmental Assessment Services

August 15, 1979 OA/Dx61

TO: PP/EC - R. Lehman

FROM: OA/D2 - David Saxton D W Saxton

SUBJECT: DEIS 7907.05 - 106-Mile Waste Disposal Site Designation

Page A-34, last sentence, paragraph three: The notion that silicate is not ever a growth limiting nutrient in the marine environment is incorrect. (see F. A. Richards, J. Mar. Res., 17, 449-465 (1958), see also R. W. Eppley, et al., Limnol. & Oceanogr., 18, 534-551 (1973) (esp. pg. 543)).

The section on trace metals, pg. A-30, should have included the role of phytoplankton in the cycling of cadmium in the sea (K. W. Bruland, et al., Limnol. & Oceanogr., 23, 618-625 (1978) since this cycle may be the first of many phytoplankton-heavy metal cycles to be found. Furthermore, the geochemical relationship between cadmium and phosphate in the sea should have been discussed (E. Boyle and J. M. Edmond, Nature, 263, 42-44 (1976)) since it has implications for the primary productivity induced transfer of Cd to higher trophic levels. 6-1

Biological Chemistry, pg. A-40, paragraph one: The statement that "The uptake of contaminants (e.g., trace metals) and their incorporation into phytoplankton may have no apparent effect on the organisms" is incorrect. My guess is that the authors have done an inadequate literature survey. Cadmium, for example, decreases the growth rate of an Asterionella species (diatom); whereas arsenic had no effect (H. L. Conway, J. Fish. Res. Brd. of Canada, 35, 286-294 (1978). Other examples could surely be found if an adequate literature survey was made.

Biological Chemistry, pg. A-40: Since petroleum concentrations are discussed earlier (i.e., pg. A-36, A-37), the effects of petroleum on phytoplankton should be discussed (for starters, see W. M. Dunstan, et al., Mar. Biol., 31, 305 (1957); D. C. Gordon, Jr., and J. J. Prouse, Mar. Biol., 22, 329 (1973); R. F. Lee and J. W. Anderson, Bull. Mar. Sci., 27 127 (1977), W. M. Pulich, Jr., et al., Mar. Biol., 28, 87 (1974); C. Soto, et al., Can. J. Bot., 53, 118 (1975), K. Winters, et al., Mar. Biol., 36, 269 (1976)).

E-12

Rec'd PP/EC
AUG 16 1979

Pg. A-34, second paragraph, last sentence. Plants can also utilize organic phosphorus, which is hydrolyzed by the plant to orthophosphate (see, for example, E. T. Kuenzler and J. P. Perras, Biol. Bull., 128, 271 (1965), E. R. S. Talpasayi, Biochem, Biophys. Acta.), 59, 710 (1962), and Yentsch, et al., Limnol. and Oceanogr., 17, 772 (1970)). Note that the implication of the Talpasayi paper is that the organic phosphorus hydrolyzing ability of algae can be inhibited by trace metals.

Page A-34, paragraph 1. The role of urea as a nitrogen source for marine phytoplankton should have been mentioned. The urea cycle is a phytoplankton/zooplankton/nekton medicated cycle, and oceanic and estuarine concentrations of urea are often higher than the sum of nitrate plus nitrite. A wide spectrum of marine phytoplankton are capable of growth on urea as a sole nitrogen source. For example, see: D. S. Berns, et al., Science, 15, 1077-1078 (1966), S.A.M. Conover, Mar. Biol., 32, 247-261 (1975), E.D.S. Cormer and A. G. Davis, Adv. Mar. Biol., 9, 101-204 (1971), E.D.S. Cormer and B. S. Newell, Mar. Biol., 47, 113-120 (1967), R. W. Eppley, et al., Limnol. and Oceanogr., 16, 741-751 (1971), R. W. Eppley, et al., Limnol. and Oceanogr., 14, 194-205 (1969), B. R. Grant, Aust. J. Mar. Fresh Wat. Res., 18, 129-136, (1967), R. R. L. Guillard, in C. H. Oppenheimer (ed.), Marine Microbiology, Thomas, pp. 93-104 (1963), C. D. Jeffries, Nature, 202, 930 (1964), J. W. Leftley and P. J. Syrett, J. Gen. Microbiol., 77, 109-115 (1973), J. J. McCarthy, Limnol. and Oceanogr., 15, 309-313 (1970), C. C. Remsen, Limnol. and Oceanogr., 16, 732-740 (1971), H. W. Smith, J. Biol. Chem., 81, 727-742, (1929). 6-2

Page 5-16, Survival of Pathogens. The discussion in this section is too general and could be improved. In particular, there is literature which deals with the survival of pathogens in the marine environment, particularly in shellfish. The absence of positive test results from subsurface samples is not convincing. The dumping of sludge should not be considered without intelligent research on pathogens. In particular, shellfish should be examined for coliform bacteria in all seasons. Bacteria attached to small sludge particles could be eaten by zooplankton, so zooplankton in the region should be examined for pathogens, particularly since these might be transmitted to other trophic levels. There is also some literature on viral pathogens in the sea and their longevity. Some laboratories are currently involved in this research area. The possibility of viral contamination or infection of shellfish, zooplankton, and nekton should be dealt with, since viruses might be more stable in the marine environment than bacteria, particularly in living organisms, and since the human health hazards of viruses in shellfish may be as great as that from bacteria. 6-3

7

Rec'd PP/EC SEP 06 1979

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Federal Building, 14 Elm Street
Gloucester, Massachusetts 01930

AUG 2 5 1979

TO: EC - Richard Lehman

FROM: FNE - Allen E. Peterson, Jr. Marvin F. Beaussu

SUBJECT: Comments on Draft Environmental Impact Statement -- 106-Mile Ocean Waste Disposal Site Designation (EPA) (DEIS #7907.05)

The draft environmental impact statement for 106-Mile Ocean Waste Disposal Site Designation that accompanied your memorandum of July 10, 1979, has been received by the National Marine Fisheries Service for review and comment.

The statement has been reviewed and the following comments are offered for your consideration.

General Comments

We generally agree that chemical waste disposal at the 106-Mile Site is preferable to alternative ocean sites examined in the EIS. Deepwater areas provide a greater potential for dilution and dispersion of wastes, and are generally less biologically productive than nearshore coastal waters.

We believe, however, that the potential adverse impacts at site have been understated. It has been assumed that because no significant impacts have been identified to date, that none have occurred. Data collection at site has been inhibited because of the difficulty and expense associated
7-1 with sampling deepwater areas. The situation has been further complicated due to the complexity of circulation patterns at site. Consequently, we do not believe that adequate data currently exist to warrant such a conclusion. Furthermore, the biological effects of long-term, sub-lethal exposure to contaminants cannot be adequately assessed with available data.

7-2 The EIS fails to discuss all potential alternatives to the proposed action. Although relocating the 106-Mile dumpsite is thoroughly explored, no consideration was given to limiting its size, such as restricting dumping to less biologically productive areas.

Specific Comments

Specific comments, for the most part, have been limited to those sections which address the subject dumpsite, the 106-Mile Site. Few remarks have been made regarding deficiencies in descriptions pertaining to alternative sites, since it is unlikely that they will replace the 106-Mile Site.

Chapter 3 AFFECTED ENVIRONMENT

THE PROPOSED 106-MILE SITE

Biological Conditions

7-3 Other than recognizing that plankton, fish, invertebrates, mammals, and turtles exist at the 106-Mile Site, this section provides no biological information for the reader. The reader is not so much as referred to Appendix A for additional information! Some description of basic biological assemblages should be discussed. The reader is given the impression that Continental Slope areas in general, and the dumpsite in particular, are biologically depauperate, which is not the case.

7-4 Page 3-7, para. 1: This paragraph does not describe the meroplankton component of the planktonic community, which often contains the larval stages of economically important species. In the May 1974 Baseline Investigation of Deepwater Dumpsite 106 (NOAA Dumpsite Evaluation Report 75-1), it was reported that the larvae of several commercial finfish were collected; larvae of shelf-spawning bluefish and hake were particularly abundant. Larval forms of economically important invertebrates, such as lobster, red crab, and squid, are also expected to occur in the dumpsite and vicinity. As stated on page 4-10, last paragraph, acid wastes can cause embryonic malformations; therefore, some degree of impact to commercial species can be anticipated.

7-5 Page 3-7, para. 4: The treatment of rare and endangered species is inadequate and should be expanded. Some description of those species more likely to occur at site should at least be included. Some endangered species, such as the right whale, survive in such low numbers that injury to an individual could impact the entire population. Conceivably, the nature and volume of discharges at the 106-mile site could detrimentally affect individuals of severely stressed species.

OTHER ACTIVITIES IN THE SITE VICINITY

7-6 Page 3-8, para. 4: The work of Wigley et al. (1975)[1] indicates that red crabs found in deeper areas are young and migrate up-slope as they grow older. Therefore, any red crabs found in and adjacent to the 106-Mile Site would not be harvested in place, but would rather serve as recruits to commercial populations in shallower waters. Since red crabs in or adjacent to

---

[1] Wigley, Roland L., Roger B. Theroux, and Harriett E. Murray. 1975. Deep-sea red crab, Geryon quinquedens, survey off northeastern United States. Marine Fisheries Review 37(8):1-21.

the site would not normally comprise part of the harvest, the remarks regarding the inefficiency of a fishery at site are inappropriate.

ALTERNATIVE SITES IN THE NEW YORK BIGHT

Biological Conditions

Page 3-14, para. 3: The ocean quahog must be regarded as a real, not potential, fishery resource. The importance of this species has markedly increased following the mass mortality of surf clams in the New York Bight during the summer of 1976. The 1978 ocean quahog harvest was more than 23.5 million pounds of meat; or nearly 40% of the total sea clam harvest.

CHAPTER 4 ENVIRONMENTAL CONSEQUENCES

Commercial and Recreational Fish and Shellfish

106-Mile Site

Page 4-4, para. 2: We reiterate our former comment that red crabs found in and adjacent to the 106-Mile Site are not expected to be harvested in place, but are rather potential recruits to the fishery.

Furthermore, even if the red crab is not appreciably affected by the discharge in its benthic mode (as is surmised in the discussion), its planktonic larvae most certainly could be impacted.

Effects on the Ecosystem

7-7 Page 4-9, para. 2: We concur that the "scenario" relative to the long-term adverse effects resulting from chronic exposure to sub-lethal concentrations of toxic materials is overly simplified. It is impossible to determine whether or not such impacts are developing at the 106-Mile Site. The insidious nature of these impacts makes detection, especially in the short-term, extremely difficult. Once detected, associating a causative agent to a symptom and identifying the source of that causative agent is even more difficult. The current body of data for the dumpsite is not extensive. That which does exist only demonstrates the complexity of the system and our lack of understanding concerning its functioning. The implication made in this statement that industrial discharges at the 106-Mile Site will not affect human food resources is unfounded. Our present degree of knowledge prohibits any credible prediction in this respect.

106-Mile Site

Page 4-11, para. 4: Statements made in this paragraph echo our previous comments relative to the general lack of understanding regarding the ecological dynamics at the dumpsite. We believe greater emphasis should have been placed on this deficiency and less placed on convincing the reader that no significant impacts will occur from discharging industrial wastes at the 106-Mile Site.

CLEARANCE: SIGNATURE AND DATE:

F7: SEP 6 1979

8

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL OCEAN SURVEY
Rockville, Md. 20852

August 10, 1979 OA/C22:KP

TO: OA/C52x6 _ Judith Raines

FROM: OA/C22 - P. Kilho Park

SUBJECT: Reading of DEIS for 106-Mile Ocean Waste Disposal Site Designation

The central issue in this DEIS is "whether or not the 106 site being a good location for ocean dumping?" For this central issue, the two reasons out of five given on page xi on Environmental Consequences are appropriate. They are (1) high dilution and (3) low productivity. The remaining three are either irrelevant or do not require any extensive discussion. The reason (2) of "lack of fisheries" at 106 site is a simple fact, although Japanese are known to harvest squids from there. The reason (4) of "much is known about the site" being a good reason for choosing it over another deep-site is not relevant on the selection of 106 over the alternative shallow sites. We will discuss it comprehensively in our specific comment sections. The reason (5) of there being "no non-dumping uses of the sites" is a simple fact.

The present DEIS states heavily the general issues of whether the ocean should be used for waste disposal. However, it is not the specific issue here and its extensive discussion is inappropriate. However, if it
8-1 is the intent of EPA to deal with such a profound issue once in order to educate the general public, let it be stated only once, not repeating in the forthcoming 25 additional EIS' concerning ocean water disposal site designations by EPA and IEC (Interstate Electronic Corporation).

The two good reasons, high dilution and low productivity, will be discussed separately.

(1) High Dilution

The depth of the 106 site relative to all alternatives which are shallower is its greatest advantage. The objective of dumping waste into the sea is to achieve wide dispersion and, therefore, extensive dilution. As long as waste is in the water column, it is subject to horizontal dispersion. When it reaches the sea floor, it may persist in one location and accumulation of waste is possible.

Horizontal mixing is not uniquely effective at the 106 site. Our observation is that barge generated turbulence is very effective in

Rec'd PP/EC
AUG 16 1979

diluting waste by about a factor of 10^4. Subsequent dilution is due to oceanic processes which may be slow so that waste concentrations in the 5 to 50 ppm range may persist for a long time, often over 60 hours. Episodic events, i.e., storms, must be the mechanism for accelerated waste dispersion.

Vertical mixing seems to be limited by the pycnocline. Even in winter there is a pycnocline in the deep ocean. At shallower sites the ocean is homogeneous to the bottom in winter. Cross-pycnocline mixing is not impossible; it is just very slow. Waste is, therefore, diluted within the mixed layer at all sites. Waste concentrations are determined by the rate of dumping (volume per length of dumping track), barge generated turbulence, and oceanic processes. At shallow sites it can accumulate on the bottom, thus affecting non-mobile benthic organisms which may be of commercial value. The lack of a benthic effect at 106 is probable and is a great advantage to its use.

(2) Low Productivity

Since the standing crop of DWD-106 site often is less than that of the on-shelf, the total damage done to the biota is smaller than that of the on-shelf. However, on indigenous organisms we must consider the degree of sensitivity between the oceanic and the shelf organisms to assess their damage due to ocean dumping.

If there were no benthic effect at shallow sites, the choice between those sites and 106 would have to be on the basis of possible consequences to organisms in the mixed layer. In terms of commercial fisheries, their apparent absence from 106 is in its favor as a dumpsite. In terms of deep ocean waters being inherently less productive, less total damage is possible at 106. However, it has been shown that oceanic phytoplankton are more sensitive to wastes than similar organisms taken from heavily used coastal areas. Therefore, while it probably is so that waste dilutions are extensive enough to minimize effects in the mixed layer, effects are more likely at 106 than at alternative sites.

The fact that no effects have been demonstrated is due to earlier biological sampling not being done in recognition of the discrete nature of waste distributions. Unless a storm occurs, a plume from a single dump may contain waste at a maximum concentration of only 50 ppm but it is only about 1 km wide, even a day or two after a dump. Biological effects must be sought in these discrete plumes. Sampling at arbitrary locations within the dumpsite will probably be futile because waste will most likely not be encountered.

Our specific comments follow:

Page vii, line 30: In accordance with PL 92-532, Section 201, NOAA Ocean Dumping and Monitoring Division is conducting trend assessment survey at DWD-106 and other sites. NOAA has visited DWD-106 site 9 times. They are May 1974, July 1975, June 1976, August-September 1976, July 1977, January-February 1978, April 1978, June 1978, April 1979. The next survey is scheduled for September 1979. EPA works well with NOAA on dumpsite trend assessment.

Page viii, line 11: Please give the location of "adjacent off-shelf area" that has been evaluated.

Page ix, line 20-22: The sentence given here does not mean there is no impact. Biological sampling until now has not recognized well a discrete distribution of waste. Obviously, arbitrary sampling locations within the site are not useful. In addition, as it is made clear in the report (Page 4-26), there are a number of reasonable short-term ecological and physical impacts of dumping which occur.

Page ix, line 22-24: This sentence exemplifies a misuse of grammatical tone that appears many places in the report. The statement uses the indicative mood, and says that the site is not highly productive because it is oceanic. The statement would be of better scientific form if phrased in the subjunctive mood. Something to the effect of "The site is oceanic and, typical of surrounding waters, does not appear to be highly productive..." The site is probably never very productive, particularly in comparison to nearby shelf waters, but a conclusive data base demonstrating it is not given.

Page ix, paragraph 4, line 18-24: The paragraph given here should mention that both ammunition and radioactive wastes were dumped in this vicinity. For instance, during 1951-56 and 1959-62, 14,300 drums of radioactive wastes containing 41,400 curies of radioactivity were dumped at latitude 38°30'N and 72°06'W, 10 nautical miles south of the southern edge of the DWD-106. EPA and other concerned Federal agencies have been carrying out a comprehensive ocean dumping effect study of these radioactive wastes. Their work is still continuing.

Page ix, footnote: The footnote given here is incorrect. It is the size of plumes and the frequency of dumping relative to the residence time of water which minimizes the possibility of one waste plume mixing with another. The geographic size of the site is not critical.

Page xi, line 8, bullet 1: Depth is very important. Physical dispersion is due to barge and oceanic processes. Horizontal dispersion is not uniquely effective at DWD-106. The nature and magnitude of the vertical diffusion and dispersion data at the site are yet to be determined.

Page xi, line 19, bullet 3: According to Dr. Lynda Murphy of Woods Hole Oceanographic Institution, phytoplankton from clean areas are more susceptible to waste than from contaminated areas. The statement of "...less likely to afffect indigenous organisms" is not correct.

Page xi, line 21, bullet 4: The availability of data for predicting future impacts in the area may be overstated. Although a good bit of information exists about DWD-106, scientifically accurate long-term predictions of future impacts of dumping at the site appear premature.

Page vi, line 26, bullet 5: Good reason, though not critical. What would be the relationship between the proposed use and the past uses? For instance, would future dumpings facilitate the decay of the radioactive waste drums by providing foods for deep-sea bacteria? 8-2

Page xii, line 6-12: Organisms at DWD-106 may be more sensitive than those at alternative sites. Nevertheless, observed dilution should be adequate.

Page xii, line 22: Please elucidate "under certain restriction."

Page xiii, lines 3-5, bullets 1-2: Both these criteria would lessen settling. On bullet 1, lines 3-4, density and size of solid particles should be considered when settling is considered.

Page xiii, line 7: DWD-106 site is deep. The use of demersal, bottom-dwelling, organisms does not appear applicable here.

Page xiii, lines 9-12, bullet 4: We have detected waste up to 60 hours after dump and also at outside of the dumpsite. That does not imply detrimental effect, but it reflects on precision of measurement and on choice of appropriate waste indicators.

Page xiii, lines 26-27: NOAA is mandated to carry out, by PL 92-532, a comprehensive monitoring program. It is not mandated to receive EPA's approval. There is an interagency agreement, signed in 1975, between EPA and NOAA to coordinate their respective mandates. See page 1-6, lines 7-13.

8-3 Page xiii, line 27 - Page xiv, line 2: Monitoring by permittees may benefit from analyses of species composition but only if simultaneous measurements of oceanic waste concentrations are made. The present 4-hour dispersion study may be too short.

Page xiii, lines 2-5: We agree that these studies should be carried out.

Page xx, lines 6-7: C and D are reversed.

Page 1-7, Table 1-1, lines 15-16: Add "Comprehensive ocean dumping impact and short-term effect studies."

Page 1-8, between lines 10 and 11: Add "...short-term effects and potential long-term effects of ...." The short-term effect study is mandated by Section 201 of PL 92-532.

Page 1-8, lines 12-13: PL 92-532 gives the responsibility for conducting field investigations for comprehensive studies of ocean disposal effects to Department of Commerce, NOAA; it is not given to EPA. EPA is responsible for Title I of the PL 92-532 which provides a mechanisms for regulating ocean disposal of waste. This EIS work is concerned with Title 1, specifically Section 102(c). For the site designation work, EPA presently is carrying out field investigations.

Page 1-12, lines 31-33: Suggested change - "Once a site is selected and duly designated, permits for the use of the site can be issued by CE for dredged material dumping and by EPA for others."

Page 2-4, lines 12-15: How do the past uses of the site and its vicinity for munition and radioactive waste dumping affect the monitorability of the site. Is there any inherent complexity and danger involved? On line 14, 9 kilometers should be 18 km.

Page 2-4, lines 24-29: It is true that there is little, if any significant, U.S. fishery operations in and near the dumpsite, but there has been and possibly still is significant foreign, including Japan and Poland, fishing within the site itself. Specifically, Japanese fish for squids. It should be noted that squids migrate vertically in daily rhythms and might possibly feed at depths where wastes have been shown to accumulate.

Page 2-5, lines 1-2: Because we have not seen "long-term adverse effects..." in our studies does not mean this is so. It would be better stated, "Thus far, studies have shown no long-term effects...."

Page 2-5, line 21: Please quantify "... in deep water where currents are strong...." It may not be "strong."

Page 2-7, lines 6-7: Sludges seen acoustically at 60 m were below the seasonal pycnocline at 15 m. Therefore, it appears that sludges did penetrate the seasonal pycnocline at 15 m.

8-4 Page 2-7, line 20-21: Please give the calculation to obtain "2 percent additional nitrogen to the site." The conclusion given here appears correct, assuming the calculation is valid. However, in reality it is impossible to distribute waste throughout the site. The residence time of one waste plume within site is in the order of one week or less; the waste does not spread to 1600 km^2 in that time.

Page 2-8, line 23: The weight of the waste given as "612 metric tons" appears to be in error. Could it be "612,000 metric tons"?

Page 2-9, line 4: Change to "NOAA is responsible for comprehensive and continuing monitoring." It is mandated by PL 92-532, Section 201.

Page 2-20, line 18: Add a new sentence, "Starting September 1979, EPA and NOAA jointly monitor both the acid waste and sewage sludge disposal sites which are nearby to each other."

Page 2-22, lines 22-23: Change sentence to "EPA Region III and NOAA have a joint ongoing monitoring program...."

Page 2-23, lines 7-8: Although Pesch et al. (1977) indicate that the Delaware Bay site has been contaminated by acid dumping (vanadium being one indicator of this), there is a growing body of information being gathered indicating that a major contributor to pollution problems at this site is, in fact, sludge dumping at the nearby Philadelphia sludge dumping site.

Page 2-30, lines 10-20, paragraph 2: If in future any other off the continental shelf site is to be sought, it would be prudent for us to avoid the old munition and radioactive waste dumpsites whose impacts we have not studied thoroughly.

8-5 Page 2-31, lines 2-6: It appears that DWD-106 is the best choice for dumping of the areas considered. Yet, overall adequacy of the existing data base for predicting future impacts is questionable. In addition, the future DWD-106 site use should consider any probably interaction with the previous munition and radioactive waste dumpings.

Page 2-31, lines 20-21: The key word here is "demonstrated." We never can say that there are no effects. If effects occur, they must be within discrete plumes, not everywhere. Unless we look for the effects scientifically, with effective monitoring strategies, our chance of the effects "demonstrating" themselves and perceived by us is slim.

Page 2-31, line 23: Change "aqueous materials" to "wastes", for dispersion of solids is enhanced also.

Pages 2-33 to 2-36, Table 2-3: Well done summary evaluation of effects at the sites in consideration. On page 2-35, line 3, in 106 mile site column, delete "extremely slight" and substitute with "some difficulty in monitoring...."

Page 2-38, lines 23-26: Please consider the bottom, sea floor, surveillance and monitoring in light of the past munition and radioactive waste ocean dumping.

Page 2-39, line 12: Substitute "demonstrated" with "observed." If we do not look for properly, we would not observe the effects of current and previous discharges and dumping. Both munition and radioactive waste dumpings that occured in the past should be scrutinized before stating "no effects have been observed."

Page 2-41, lines 16-17, bullet 5: This is not the case now. Waste has been found outside of the site. However, finding waste is not the same as showing it to have environmental consequences.

Page 2-42, lines 1-15, paragraph 1: The statement given here is vague. Assimilative capacity here must mean room for dilution without mixing one waste with another. Here the mean transport of water through the site is important. Mixing over 4 hours is not dependent on transport time.

Page 2-43, line 9: The line should read, "...and for short-term impacts by NOAA and environmental...."

Page 2-43, lines 10-11: The sentence should read, "All permittees' monitoring studies are subject to EPA approval."

Page 3-1, lines 26-30: Eastward migration of the Shelf/Slope Front allows less dense Shelf Water to overspread Slope Water, forming a separate, relatively thin surface layer. Please note that "mixing" would tend to erase these water masses of differing density and hence the term should not be used. "Overspreading" would be a much better term.

Page 3-3, line 2: "other water" should be "shelf water."

Page 3-4, line 3: "forming layers of water...and density." should become "forming a seasonal thermocline," since the causative factor for the phenomenon is warming of the surface waters in late spring, (page 304, line 1).

Page 3-4, line 7: "200 meters" should be changed to "100 meters" since this is actually what is shown in Appendix A, pages A-18 to A-20.

Page 3-4, lines 11-16, paragraph 2: An approximate current speed of less than 0.2 knots should be used.

Page 3-4, lines 27 and 30: May we suggest "great diversity" (line 27) and "high concentrations" (line 30) when their modifiers for "greater than" and "higher than" are not stated. Regardless, semiquantification of these words will clarify their meanings.

Page 3-5, line 16: On the unit of dissolved oxygen, a preferred choice may be volume over volume, ml/liter, or weight over weight, mg/kg, not weight over volume, mg/liter, as used in DEIS.

Page 3-5, lines 19-22: There is continuous mixing in the ocean by either large scale turbulent mixing or small scale eddy diffusion. The permanent thermocline beginning around 200 m prevents large scale mixing. However, small scale vertical diffusion does occur. Large storms passing through the area will only temporarily disrupt this feature if at all.

Cross thermocline mixing is slow but not impossible. One of the NOAA study objectives is determining the mechanism and rate of each mixing.

Page 3-6, lines 11-15: Difference in metal levels between continental rise and shelf sediments is due partly to particle size difference.

Page 3-8, line 4: The sentence should start, "NOAA Ocean Dumping and Monitoring Division and Ocean Pulse Program plan to continue monitoring the 106-Mile site.

Page 3-10, line 22: Density is a function of temperature and salinity. Perhaps the words "and density" should be changed to "hence density."

Page 3-39, lines 8-10: This sentence may be read "The toxic effects of duPont's waste on .... were investigated by routine bioassays and special tests." Please clarify "special tests."

Page 4-5, lines 25-30, paragraph 4: The Delaware Bay site summary is well done, but the authors may want to expand the discussion a bit to include the somewhat contradictory findings of Pesch (1977) on one hand, and of Guarino and Almeida (1979, J. Water Pollution Control Fed. 51(4): 773-78) on the other hand.

Page 4-10, lines 23-27: General phytoplankton surveys will show natural variations. We must do a time series study within waste plume to understand the waste impact upon plankton.

Page 4-11, lines 4 and 5; Delete lines 4 and 5. These are not laboratory data.

Page 4-11, between lines 19 and 20, between paragraphs 2 and 3: A paragraph on phytoplankton may be placed here. Laboratory effect studies carried out by Murphy of Woods Hole Oceanographic Institution show the susceptibility of the effect a function of source of organism. Oceanic clones are more sensitive than those from polluted coastal areas.

Page 4-11, lines 32-33: What has not been recognized in earlier biota sampling is the discrete nature of waste distribution. Time series of phytoplankton effect studies now can be done at sea.

Page 4-11, lines 28 (last line): On Water and Sediment Quality organic toxicant study description, such as on DDT and PCB, is lacking. It should be added.

Page 4-12, lines 4 and 5: The statement "...that within four hours after dumping the values are within normal values..." is not so totally. Only those constituents which are at background levels after dilutions of 10^4 are undetectable as being waste derived. Other constituents have been identified and used as tracers of waste over much longer times.

Page 4-17, lines 9-25: The quoted NOAA statement concerning metals was correct in 1977. However since then duPont Edge Moor dumping has added a large amount of iron to the site in comparison to normal concentrations. This should be mentioned.

Page 4-17, line 27: Delete "not." NOAA investigations did detect elevated concentrations above ambient conditions after the initial mixing period.

Page 4-17, line 31: These "worst-case" models are misleading. However, if the waste-driven metals are allowed to accumulate throughout an eddy, we must use an area of an eddy, not the area of DWD-106, to calculate models.

Page 4-19, lines 1-8: Contamination is a problem and must be considered. It is not insurmountable. The fact that metals are in ppb (parts per billion) range does not mean they are not exerting a biological effect. Effects depend on concentration and speciation of metal. For copper, its concentration of 10^{-10} molar has been shown to affect phytoplankton growth.

Page 4-26, line 24, bullet 2: Suggest the following revision - Rise in the concentrations of waste constituents in the upper water strata.

Page 4-27, lines 3-4: Delete lines 3-4, for DWD-106 is deep, not shallow.

Page 4-27, line 21: The quoted "several years of studies" were not well designed to elucidate the long-term effect.

Page 4-28, line 7: Please name the valuable metals.

8-6 Page 4-28, lines 10-13, bullet 3: If ocean dumping is less expensive than land-based disposal, it is economical gain, not loss. Suggest deleting lines 10-13, bullet 3.

Page 5-1, line 20: May we suggest that the sentence be read as follows: "...alternatives are being developed and adequately field-tested." It is the intention of the Ocean Dumping Act, PL 92-532, to protect human health. Any unproven alternative method is too risky to take.

8-7 Page 5-6, Table 5-2: The chemical concentrations listed have come from the works of Professor Mueller and his coworkers. Since those data must be valid scientifically and legally at court of law, it is important to give their accuracy and precision. For instance, duPont Edge Moor waste is reported to have a pH range of 0.1-1.0 signifying the waste is highly acidic. However, in reality, the duPont waste often contains 2 to 4 molar hydrochloric acid which would give pH values of less than 0. Therefore, the pH range given in Table 5-2 is theoretically erroneous. These discrepancies will not withstand the scrutiny of the court of law should it become an issue. In fact, this DEIS does not give any consideration on the scientific data assurance. It should be dealt with to show to the public the state of art of the scientific measurement, however crude and ambiguous at present.

8-8 Page 5-7, lines 33-35: The first reason given here should consider that the added sludge will increase biological productivity. However sparce, phytoplankton can double its population once every several hours. The reduced supply of nutrients, the reason given here, is not totally valid. In addition, there is no assurance that off-shelf water is colder than shelf water. The reverse may be the case for DWD-106 site.

Page 5-8, lines 9-10, bullet 1: Since DWD-106 site is farther than other alternative sites considered, it may contaminate beaches less than other sites.

Page 5-8, lines 11, bullet 2: Oceanic, scientific, budget calculation is needed to understand whether or not deep-sea anaerobic environments can develop.

Page 5-9, line 10: Please insert "DWD-106 site" after "a Camden sludge dump."

Page 5-9, lines 17-18: It cannot be proven that secondary sludge would be more rapidly dispersed than that of primary. If it were buoyant, probably it would not be.

Page 5-10, lines 2-4: Please consider deleting "...could be viewed as...." Our reasoning is that three-dimensional oceanic dispersion is always highly anisotropic, and horizontal dispersion is always many orders of magnitude larger than vertical dispersion, particularly after initial mixing. Our suggested change is "This is an anisotropic....."

Page 5-10, lines 5-15: It may be beneficial to add a statement on the differences between speeds and residence time for wastes dumped in slope currents vs. Gulf Stream eddies.

Page 5-13, Table 5-4: Please consider the accuracy and precision of these metal concentrations.

Page 5-14, Table 5-5: Please consider the accuracy and precision of these nutrient concentrations. For instance, as they are given, the background nitrite plus nitrate concentration of 19.2 mg/liter implies its relative precision of about 0.5 percent with a range of 19.15 - 19.24 mg/liter. If so, it should be spelled out. The same applies to phosphate.

The nitrite plus nitrate/phosphate ratio given here is 19.2/124 = 0.17. This ratio contradicts with the nitrogen/phosphorous ratio in the sea of 15:1 given in Page A-34, line 14, by almost 90 times.

Page 5-15, line 11: May we suggest "desorb" in lieu of "deadsorb."

Page 5-16, lines 3-7: The second sentence on the page is too confusing to interpret, and the information in the sentence should be supported with a reference to its source. This matter of references to sources of information applies to many sections of the DEIS. Although the literature citations included in it are generally adequate, all statements referring to specific factual information should include a reference to the original source of the facts.

Page 5-17, line 11: Substitute "the water column" with "seawater." Sewage microorganisms die off quickly in seawater, not in the water column.

Page 5-20, line 3: Please explain "...carefully controlled conditions...."

Page 7-9, line 6: "μg/l" should read "micrograms per liter" not "milligrams per liter."

Page 7-12, lines 1-3: May we suggest the following pH definition, "A term used to describe the hydrogen ion activity in minus logarithum. Conventionally, pH 7 is considered neutral, less than 7 acidic, and greater than 7 alkaline."

Pages 7-17 to Pages 7-37: Extensive listing of pertinent scientific references is applauded. Please cite all of these references precisely, so that they can be used by others. For instance, Dr. M. Orr's works cited as "Orr, 1977ab" can be cited exactly by giving page numbers, sources, etc.

Page A-5, lines 8-18, paragraph 2: Please give a T-S diagram for the shelf- and slope-waters and their adjacent water masses. They will show to the readers how well these water masses are separated and are identifiable.

Page A-6, lines 25-36, paragraph 3: The first sentence of this paragraph should be clarified that there are high temperatures in the summer and low temperatures in the winter. A clearer statement leading into the "cool cell" is needed.

Page A-10, Figure A-2: Please give the description of horizontal and vertical coordinates.

Page A-27, line 12: Oxygen is needed by aerobic not by anaerobic organisms. And, there exists anoxic regions in the sea where these anaerobic organisms live.

Page A-27, lines 25-27: The saturation level of dissolved oxygen with respect to the atmospheric oxygen level in seawater is dependent on the temperature, salinity, and barometric pressure of the wet atmosphere at sea surface. At the great depth of the ocean, where no atmospheric phase exists, its oxygen level is determined by the temperature, salinity, and barometric pressure before that water left the sea surface. Subsequent mixing among different water masses and types and in-situ biochemical alteration, both phyto-synthesis and respiration, modify the oxygen content of the water under study.

Page A-28, line 3: Substitute line 3 with "oxygen below the saturation level suggests that biochemical oxidation, including respiration and bacterial activity, is removing...."

Page A-28, Figure A-13 and Page A-29, line 9: Two oxygen units are used in these two pages. They are "ml/liter" in Page A-28 and "mg/liter" in Page A-29. It would be better to use a single unit, either volume/volume (ml/liter as shown in Page A-28), or weight/weight (mg/kg).

Page A-29, lines 9-10: There appears some unit discrepancy between surface oxygen values of 4.9 and 7.5 mg/liter for August and April respectively, given in Page A-29, with that of 4.9 and 7.5 ml/liter for the corresponding months given in Page A-28. Does this imply that these two units (mg/liter and ml/liter) are interchangeable? We calculate 1.00 mg/liter oxygen is equivalent to 1.43 ml/liter oxygen.

Also, please show how you obtained the oxygen saturation values of 104 and 113 percent respectively for August and for April.

Page A-30, lines 3-20, paragraph 2. This paragraph contains several ambiguous and erroneous scientific statements. May we suggest the following paragraph to be substituted in lieu of the DEIS, Page A-30, lines 4-16 of paragraph 2.

"The expression pH is used conventionally to measure the acidity or alkalinity of an aqueous solution. The scientific definition is -log A^{H^+}, the minus logarithum of hydrogen ion activity. A neutral solution normally has a pH value of 7 at 25°C, while acidic solutions lower than 7, and alkaline solutions higher than 7. The advantage of the pH scale is that its range is only from 0 to 14 from 1-molar HCl to 1-molar NaOH, where hydrogen activity varies from 1 to 10^{-14}. The pH scale can be smaller than 0 as well as can be greater than 14 when HCl concentration exceeds over 1 molar (duPont Edge Moor wastes have 2 to 4 molar HCl), and NaOH over 1 molar concentration respectively.

Surface seawater pH is often 8.2 $\pm$ 0.4, thus slightly alkaline. This narrow range is maintained by the global and geochemical silicate and carbonate mineral equilibria. At sea surface the air-sea exchange of carbon dioxide tends to restore any perturbation of pH value back to about 8.2.

The alkalinity of seawater is defined as the sum of anions of weak acids present in seawater plus hydroxide ion, OH^-, minus hydrogen ion, H^+, concentrations. Alkalinity is important for fish and other aquatic life because it buffers pH changes that occur in nature, such as by photosynthesis and respiration and by ocean dumping of acid and alkaline solutions. Two main weak acids in seawater near the sea surface are carbonic and boric acids. Alkalinity is increased by the dissolution of carbonate minerals, such as limestones, and decreased by the precipitation of carbonate minerals, such as oolite deposition over the Bahama Bank. Most of the time alkalinity of seawater can be calculated by the empirical equation of alkalinity (milliequivalent/kg = 0.061 x salinity (g/kg)."

Page A-30, line 14: According to Webster's New World Dictionary of the American Language, Second Edition, 1976, the word "complex" is either "adjective" or "noun", not "verb." Until the majority of the American people use "complex" as verb, should we use it as adjective or as noun?

Page A-30, pH and alkalinity: The pH values for the 106 site are given on lines 21-23. Please give the site's alkalinity value since it is important for marine life.

Page A-31, line 16: Substitute "complexation" with "complex formation."

Page A-12, line 3: "complex" not "complexed"

Page A-34, line 14: The statement of the first sentence of paragraph 3 is not true. The nitrogen-phosphorus ration near sea surface varies greatly. For instance, the data given in Table 5-5, page 5-14, yield N/P ratio of 0.17 which is 90 times different from the ratio of 15:1. The changes in nitrogen compounds and phosphate compounds concentrations may be approximately 15:1 as shown in the classical work of Redfirled and his coworker at Woods Hole Oceanograph Institution (cited by Richards, F. A., 1965, Anoxic basins and fjords, p. 611-645. In J. P. Rile and G. Shirrow (eds.) Chemical Oceanography, v. 1. Academic, London).

Page A-35, Table A-9: Please give the basic seasonal variation pattern of the phosphate and nitrate distribution with illustrations. The Table A-9 does not permit to examine the criticality of nutrient distribution at DWD-106 site.

Page A-38, line 22, Trace Metals: Please give the state of analytical precision on the trace metal determination. The same applies to Organics ("organic" is adjective not noun) section on Page A-39. The issues of the precsion and accuracy on trace matter analyses has been debated heatedly in many areas of science. How good are we for DWD-106 site designation study?

Page B-1, lines 18 and 25; Page B-2, Figure B-1, line 2; Page B-3, Table B-1; Page B-4, line 3, line 10, line 15; Page B-5, Table B-2, line 23: "Metric ton" is a unit for weight, not for volume.

Page B-7, line 14: "196,820 liters (52,000 gallons)" waste release rate regulation may be simplified to "200,000 liters per nautical mile." In mathematics, one cannot attain five significant value conversion (196,820 liters) from two significant value entity (52,000). On Page B-8, last line, it is difficult to conceive that duPont-Grasselli has disposed of 225,572 kg (six significant numbers) of phenol at the 106-mile site.

Page B-12, Table B-8: The pH range for duPont Edge Moor, 0.1-1.0, does not appear correct. If the duPont waste contained 2 to 4 molar HCl, the lower value should be less than 0.

9

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE
CENTER FOR DISEASE CONTROL
ATLANTA, GEORGIA 30333

August 21, 1979

Mr. T. A. Wastler
Chief, Marine Protection Branch (WH-548)
Environmental Protection Agency
Washington, D.C. 20460

Dear Mr. Wastler:

We have reviewed the draft environmental impact statement (EIS) for the 106-Mile Ocean Waste Disposal Site Designation. We are responding on behalf of the Public Health Service.

We believe continuing the selected 106-mile chemical waste disposal site as proposed in this document will not pose any direct human health effects. However, to avoid the accumulation of chemical contaminants in the surrounding area, we feel a regular monitoring program should be implemented around the site, especially after sludge or acid waste disposals are made. In view of past monitoring data gathered by NOAA, further studies involving cytotoxic effects on fish eggs and histopathologic lesions on fish in the vicinity of the site should be investigated. 9-1

Thank you for the opportunity of reviewing this document. We would appreciate receiving a copy of the final statement when it is issued.

Sincerely yours,

Frank S. Lisella, Ph.D.
Chief, Environmental Affairs Group
Environmental Health Services Division
Bureau of State Services

10

United States Department of the Interior

OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20240

ER 79/676

SEP 14 1979

Mr. T. A. Wastler
Chief, Marine Protection
Branch (WH 548)
Environmental Protection Agency
Washington, D. C. 20460

Dear Mr. Wastler:

This Department has completed its review of the draft environmental statement for the 106-Mile Ocean Waste Disposal Site Designation in the Atlantic Ocean between Delaware Bay and Long Island, New York.

This environmental statement provides the rationale for and the environmental consequences of designating sites for continued ocean dumping in cases where waste disposal is in accordance with existing EPA requirements and for which land based disposal is infeasible. Individual permits for dumping at these deepwater sites will be considered by EPA on a case-by-case basis and the need for supplemental environmental statements will be determined at that time. We have reviewed the proposed action and its environmental consequences and find that these dump site designations and eventual use do not appear to significantly affect the programs and missions of this Department. However, we recommend that environmental documentation of these future permit applications fully assess the potential for impacting on existing or proposed units of the National Park System in the study area. 10-1

We wish to thank you for the opportunity to review this impact statement.

Sincerely,

Larry E. Meierotto
Assistant SECRETARY

11

DEPARTMENT OF TRANSPORTATION
UNITED STATES COAST GUARD

MAILING ADDRESS:
U.S. COAST GUARD (G-WEP-5/73)
WASHINGTON, D.C. 20590
PHONE: (202)755-7938

16471/9

AUG 13 1979

Mr. T. A. Wastler
Chief, Marine Protection Branch (WH-548)
Environmental Protection Agency
Washington, DC 20460

Dear Mr. Wastler:

The Draft Environmental Impact Statement for the 106-Mile Ocean Waste Disposal Site Designation dated June 1979 has been reviewed by my staff. The following comments are submitted.

1. The use of shipriders is not always a greater commitment of manpower compared to other surveillance methods. Vessel or aircraft patrols are more efficient at the close-in sites primarily because they can observe more than one dumping operation or more than one dumpsite due to their mobility. Shipriders are restricted only to the vessel upon which they are riding. Surveillance by shipriders at the 106 site, while being the only method presently available, is also the most efficient as well. Approximately one dump occurs per day at the 106 site. If vessels could be employed, they would be less efficient in terms of manpower because the number of personnel on board for the required number of hours to conduct surveillance would exceed shiprider hours.

2. The recommendation concerning a surveillance permit provision found on page xiii is not a good recommendation for several reasons. The Coast Guard has established a program goal of observing 75% of all dumping operations at EPA's industrial waste sites. One of the constraints of doing more is the lack of additional resources. A permit provision would commit the Coast Guard to conduct surveillance by shipriders. Coast Guard operations are multi-mission in nature. Personnel who conduct shiprider missions one day may be involved in pollution response or other high priority operation the next. It would be a burden on the USCG to require dumpers to have a shiprider for all dumping operations, or a burden on dumpers to delay the disposal mission until one was available. The use of Coast Guard Auxiliary personnel is also not warranted. Auxiliary operations normally augment search and rescue efforts. Auxiliarists have no law enforcement capability and could not be used for surveillance purposes. This recommendation would also restrict surveillance to shipriders, when other methods may become available in the near future. For example, the Ocean Dumping Surveillance System (ODSS) may be implemented within the next year. This device would permit nearly 100% surveillance of all dumping activities while at the same time relieve most of the need for shipriders and patrols by vessels or aircraft. I suggest this recommendation be dropped and a statement included that the USCG should continue to strive for 75% surveillance of dumps at the 106-mile site. These comments also apply for any future sewage sludge dumping at the 106 site, except that the level of surveillance would be 10%.

3. Page 1-5 discusses MPRSA regulation of transport via vessels for dumping purposes. MPRSA does not specifically address only vessels. I recommend the first sentence of the section entitled MARINE PROTECTION, RESEARCH & SANCTUARIES ACT be changed to, "The MPRSA regulates the transportation of material for dumping and ultimate dumping of materials in ocean waters."

4. Under Table 1-1 on p. 1-7 the DOT (USCG) responsibilities should include surveillance and other necessary enforcement acitivity, as well as authority to issue regulations and review of permit applications.

5. The last paragraph of page 1-7 should indicate that the Act assigns surveillance and other responsibilities to the Secretary of the Department in which the Coast Guard is operating and that these responsibilities have been delegated to the Commandant of the Coast Guard by the Secretary of Transportation (49 CFR 1.49(n)(5)).

6. The second sentence on p 1-8 should be changed to read "This system has been field-tested and evaluated by the USCG for future use in routine surveillance."

7. The last sentence of the paragraph on Surveillance, p. 2-8, should read "The USCG has stated that the program goal for surveillance at industrial waste sites is 75% coverage of all dumping missions."

8. The comments in paragraph 1 of this letter also apply for p. 2-9.

9. On pp. 2-22, 2-25, 2-26, 2-28, and 2-29, comments are made that the dumpsites are near or outside the limits of Coast Guard vessel or aircraft range. This should be clarified by

SPEED LIMIT 55
It's a law we can live with.

indicating they are outside the range of helicopters and 82- or 95- foot patrol boats normally used for ocean dumping surveillance. Many USCG aircraft and larger vessels do have the range necessary for surveillance further offshore; however, these resources are utilized primarily for fisheries enforcement and other activities which necessitate use of longer-range resources.

10. On pp. 2-25, 2-26, 2-28 and 2-29, comments on surveillance and associated costs are somewhat misleading. Shiprider surveillance would be easier because the distance, and therefore total transit time would be much less for the Northern or Southern sites. Shorter times means less shiprider hours per mission, which in turn could result in more missions covered with the same number of personnel as compared to 106-mile site operations.

11. The comments in paragraph 2 of this letter also apply for the recommendation found on page 2-43.

12. One point not discussed on page 4-7 concerning accidents at the 106 site is that if danger to life is involved, the further distance offshore would result in longer search and rescue response time than accidents closer to shore.

13. The fifth sentence on p. 4-25 should read "Twelve violations of permit provisions for alleged short dumping sufficient to cause ... etc." Many violations of permit provisions during these five years have required follow-up action; the twelve were specific to short dumping.

14. While surveillance of sewage sludge dumping operations at the 106-mile site is feasible as indicated on page 5-18, it is important to also indicate that it will place an additional burden on the Coast Guard which would require allocation of new personnel. This point was specifically made in CDR MULLEN's Toms River Testimony.

15. The Coast Guard has imposed no five hour rate of discharge for sewage sludge as described on p. 5-19. The Third Coast Guard District did strongly suggest the total amount of dumping time per day be restricted to five hours to avoid vessel congestion in the dumpsite. The five hour figure came from the fact that present sewage sludge dumping had been averaging that amount per day and the Coast Guard did not want to see it increase.

16. The comments in paragraph 2 of this letter also apply for the recommendation on p. 5-20 except that the Coast Guard has established a program goal of 10% surveillance over materials like sewage sludge.

I want to thank you for the opportunity to review the draft EIS. I hope these comments have been helpful.

Sincerely,

R. L. McFadden

R. L. McFADDEN
LCDR, USCG
Chief, Surveillance and
Monitoring Branch
By Direction of the Commandant

12

DEPARTMENT OF TRANSPORTATION
UNITED STATES COAST GUARD

MAILING ADDRESS:
COMMANDER (dp1)
THIRD COAST GUARD DISTRICT
GOVERNORS ISLAND
NEW YORK, N.Y. 10004
(212) 668-7001

16475.2/12-79
10 SEP 1979

Mr. T. A. Wastler
Chief, Marine Protection Branch (WH-548)
Environmental Protection Agency
Washington, D.C. 20460

Re: DEIS, 106-Mile Ocean Waste Disposal
Site Designation

Dear Mr. Wastler:

The Third Coast Guard District has reviewed the Draft Environmental Impact Statement (DEIS) for 106-Mile Ocean Waste Disposal Site Designation, and we offer the following comments for consideration in preparing the Final EIS:

Traffic Management

From a navigational safety standpoint, we consider the 106-Mile Site to be the preferable alternative. Based on our observations, most transits consists of ocean-going tugs towing chemical disposal barges in the 250-350 foot range. Most transits are conducted from facilities in the Arthur Kill to sea via the less heavily traveled southern route through Raritan Bay. Transits can thus be accomplished using the outbound Hudson Canyon Traffic Lane without having to cross through other traffic lanes for New York or Delaware, whereas the other alternative sites would involve dumping in or near the inshore portions of other traffic lanes (see Figure 3-10 in the EIS). Also, the other sites are smaller and closer inshore causing more congestion and interference with a wide variety of commercial and recreational activities. On a mathematical basis, the greater transit time poses a slight increase in the statistical probability of collision, but the impact of a collision involving a vessel laden with chemical waste would be greater closer inshore, as would the real possibility of collision.

Disposal Surveillance

You recommended on page xiii of the EIS that 100% of future waste disposal operations should be subject to shiprider surveillance by either the U.S. Coast Guard or the USCG Auxiliary (the latter at the permittee's expense). The Coast Guard's present Mission Performance Standards call for 75% and 10% surveillance of toxic chemical and sewage sludge disposal operations, respectively, using Petty Officers from the Regular Coast Guard, and on occasion, from the Coast Guard Reserve (limitations on the use of the Reserve are discussed in Commander MULLEN's testimony on page D-12 of the EIS). This represents a considerable expenditure of manpower, and, we feel, provides adequate surveillance. During calendar year 1978, 7,247 man-hours were expended in providing shiprider surveillance at the 106-Mile Site (this figure does not include considerable time shipriders were tied up awaiting departure due to frequent changes in departure time resulting from mechanical failures or weather and tidal conditions). To achieve 100% surveillance, it would be necessary to remove personnel from other mission areas, such as pollution prevention and response, where manpower shortages are already critical. A requirement of 100% surveillance leaves no discretion for performing other priority missions when conflicts arise. Moreover, your recommendation restricts surveillance to shipriders, when other methods may soon be available which could provide the USCG with significant manpower (i.e. shipriders) savings. One such method is the Ocean Dumping Surveillance System (ODSS), which you briefly mention in the EIS on page 1-8 and elsewhere. This automated device could provide almost 100% surveillance without the aid of shipriders or aircraft/vessel patrols. The ODSS has been successfully field-tested and may be used in actual surveillance operations beginning next year. In view of the above, we do not feel that this recommendation is justified and point out that nowhere in the EIS is any justification put forth.

The use of the Coast Guard Auxiliary to provide shiprider surveillance (at the permittee's expense) is not feasible. The Auxiliary is a voluntary organization of citizens who are owners of motorboats, yachts or aircraft, whose primary mission is to assist the Coast Guard in promoting safety at sea and efficiency in the operation of motorboats and yachts, as well as fostering compliance with laws and regulations governing the operation of motorboats and yachts. Members of the Auxiliary are not vested with any law enforcement authority.

Pages xii, xiv and Section 5 of the EIS consider disposal of sewage sludge at the 106-Mile Site if adverse health or other environmental effects are produced from disposal at the existing New York Bight Sewage Sludge Site. Use of the 106-Mile Site is recommended on pages xiv and 5-20 on a case-by-case basis, provided that certain conditions be met, one of which is that disposal surveillance be provided by the Coast Guard or Coast Guard Auxiliary. As stated above, the Coast Guard has a goal of 10% surveillance of sewage sludge disposal operations, and this standard would be maintained regardless of the disposal site location. However, a shift to the 106-Mile Site would probably necessitate the use of additional tugs to compensate for the extra transit time to this site, requiring additional Coast Guard shipriders with resulting strain on Coast Guard resources. These additional tugs would also cause further traffic congestion in the 106-Mile Site area, posing a greater risk of collision.

The current program of surveillance over near-shore dump sites benefits from the synergism of our "Multi-mission" concept. However, it is important to point out clearly that the extension of dump sites this far off shore must be accommodated by new fully-dedicated resources. Thus, the incremental costs of providing equivalent oversight of the dumping program will be much higher than may be apparent to you at this juncture.

Pages 2-16 and 2-18 mention that disposal surveillance at the Acid Site is normally conducted by patrol boats and aircraft, not shipriders. It is also stated that surveillance of possible additional waste discharges at this site "is not expected to create problems" (p.2-16), and that the cost would be "relatively low" (p.2-18). While surveillance would continue to be primarily by vessel or aircraft, we do not agree that additional surveillance would be relatively problem-free and low-cost. Any additional surveillance would require additional operating hours, fuel, and man hours. We are preparing cost estimates for this additional activity and will forward them to you upon completion.

Pages 2-25 and 2-28 refer to surveillance in the Southern and Northern areas, respectively, indicating there would be no significant changes in the allocation of USCG manpower over surveillance at the 106-Mile Site. Since the distance and resultant travel time to the 106-Mile Site is almost twice that to either the Southern or Northern area sites, we do not consider the statements made on these pages to be accurate.

Sincerely,

F. P. SCHUBERT
Captain, U. S. Coast Guard
Chief of Staff
Third Coast Guard District

13

STATE OF DELAWARE
EXECUTIVE DEPARTMENT
OFFICE OF MANAGEMENT, BUDGET, AND PLANNING
OFFICE OF THE DIRECTOR
DOVER, DELAWARE 19901
PHONE: (302) 678-4271

August 6, 1979

Mr. T.A. Wastler
Chief
Marine Protection Branch (WH-458)
Environmental Protection Agency
Washington, D.C. 20460

Dear Mr. Wastler:

RE: DRAFT ENVIRONMENTAL IMPACT STATEMENT FOR 106 MILE OCEAN WASTE DISPOSAL SITE DESIGNATION

The Office of Management, Budget and Planning, in its function as the State Clearinghouse, has reviewed the subject EIS.

Please be informed that the Delaware State Clearinghouse supports this EIS with the understanding that the exploration of alternatives to ocean disposal will continue.

Sincerely,

Nathan Hayward III
Director

fb

14

State of Maryland Department of Economic & Community Development

Division of Local and Regional Development
2525 Riva Road, Annapolis, Maryland 21401 • 301-269-2150

Harry Hughes
Governor
James O. Roberson
Secretary

July 19, 1979

Mr. T. A. Wastler, Project Officer'
U. S. Environmental Protection Agency
Oil and Special Materials Control Division
Marine Protection Branch
Washington, D. C. 20460

Dear Mr. Wastler:

I am in receipt of the Environmental Impact Draft Statement (EIS) for 106-Mile Ocean Waste Disposal Site Designation from the Department of State Planning of Maryland.

14-1 Ocean dumping is suicidal and EPA has never regulated effectively, therefore, it is not in the best interests of the State of Maryland to allow this to continue. It does conflict with present plans for economic development.

Sincerely,

Edward H. White III
Development Officer

EHW:rrs

cc: State Clearinghouse
Department of State Planning

An Equal Opportunity Employer

15

STEPHEN H. SACHS
ATTORNEY GENERAL

GEORGE A. NILSON
DEPUTY ATTORNEY GENERAL

ELEANOR M. CAREY
ASSOCIATE DEPUTY
ATTORNEY GENERAL

STATE OF MARYLAND
OFFICE OF
THE ATTORNEY GENERAL
DEPARTMENT OF NATURAL RESOURCES
TAWES STATE OFFICE BUILDING
ANNAPOLIS, MARYLAND 21401
(301) 269-2251

Thomas A. Deming, Acting
ASSISTANT ATTORNEY GENERAL
COUNSEL TO SECRETARY

JOHN B. GRIFFITH
RICHARD E. RICE

MICHAEL J. SCIBINICO, II
BEN BIALEK
PAMELA P. QUINN
ASSISTANT
ATTORNEYS GENERAL

August 21, 1979

Mr. T.A. Wastler
Chief, Marine Protection Branch
(WH-548)
Environmental Protection Agency
401 M Street, S.W.
Washington, D.C. 20460

Dear Mr. Wastler:

I am writing on behalf of the State of Maryland to comment on the draft Environmental Impact Statement concerning the 106-Mile Ocean Waste Disposal Site Designation. I regret that my schedule prevented me from attending today's hearing in Trenton. In lieu of the comments I would have made at the hearing, I request that this letter be made part of the administrative record concerning the 106-Mile Site designation.

Maryland is pleased that in the draft EIS EPA finally has addressed the potential impacts of sewage sludge disposal at the 106-Mile Site. Maryland was disturbed that so little information was forthcoming at the Tom's River hearing two years ago from NOAA's ongoing monitoring program concerning impacts of ocean disposal at the 106 Site. And that, subsequent to that hearing, EPA concluded that it could make no decision on shifting sludge disposal to the 106 Site due to concern for unknown, but possibly irreversible, impacts of ocean disposal. Maryland had suggested that the 106-Mile Site would be an acceptable, short-term, alternative location for the disposal of sewage sludge which is presently dumped in the ocean some 35 miles off Maryland's coast at the "Cape May" dump site. It had been clearly established already in numerous administrative proceedings before EPA, Region III, that the Cape May dump site had suffered environmental degradation as a result of sludge disposal. Specifically, statistically significant higher levels of heavy metals had been found in shellfish and in the sediment, visible evidence

of material attributable to sludge had been observed on the ocean bottom, shellfish in the area had been contaminated by pathogenic organisms attributable to the sludge, pathogenic organisms had been isolated from the water column, PCBs had been isolated at the site, and as a result of these various impacts a wide area around the Cape May dump site had been closed to shellfishing. Information available at the time indicated to Maryland that similar environmental impacts would not, over the short term, degrade to any appreciable degree the marine environment at the 106-Mile Site, which had received highly toxic chemical wastes for years.

The adverse environmental and economic impacts of ocean disposal at the Cape May site continue to this day. The continuing shellfish ban has prevented harvest of an abundant ocean quahog resource in the area of the dump site at a time when the ocean quahog has virtually replaced the surf clam as the economically important ocean shellfish of the mid-Atlantic region, under the "Fishery Management Plan for the Surf Clam and Ocean Quahog Fisheries" approved by the Secretary of Commerce in November, 1977. Also continuing to this day is a Congressional directive to EPA, in §102(a)(I) of the Marine Protection, Research and Sanctuaries Act of 1972, that: "In designating recommended sites, the Administrator shall utilize wherever feasible locations beyond the edge of the Continental Shelf". It is regretable that Maryland must petition a federal court to require EPA to now apply the statutory mandate in the mid-Atlantic area, when that action could and should have been taken by EPA years ago.

Even assuming that EPA continues to disagree with Maryland over whether Philadelphia's sludge dumping should be shifted to the 106-Mile Site immediately, Maryland would submit that there are strong reasons why it would be appropriate for EPA to now pursue whatever additional actions it feels are necessary to authorize use of the 106-Mile Site for sludge disposal by the City of Philadelphia. In his final decision of March 1, 1978, on proposals to relocate sewage sludge dumping by Philadelphia Assistant Administrator Jorling relied heavily on the fact that Philadelphia dumping would be phased out by December 31, 1980. Thus he indicated at page 20 of that decision: "Certainly, if there were any possibility that the City of Philadelphia would be dumping its sewage sludge at this site for a longer period of time, my conclusion might be very different". Maryland would suggest that such a possibility does exist. First of all, the U.S. v. Philadelphia Consent Decree does contemplate extensions of ocean dumping beyond the December 31, 1980, deadline, albeit with the likelihood of penalties attaching to such an action. More disturbing is the General Accounting

Office's recommendation that the 1981 statutory deadline on ocean disposal of sewage sludge be extended on a case-by-case basis. While aimed primarily at New York, we could expect pressures from the City of Philadelphia and its Congressional delegation if the approach recommended by the GAO were adopted by Congress. Therefore, Maryland is not at all sanguine about the firmness of the ocean disposal deadline for the City of Philadelphia, and we would strongly suggest that EPA cannot be over confident about meeting this deadline.

15-1 EPA should designate the 106 disposal site for future receipt of sewage sludge from any source, not just from New York City as is suggested by the discussion in the draft EIS. In this regard, it should be noted that the Tom's River Hearing Officer recommended at page 107 of his report preparation of an EIS "on the issue of relocating the sludge dumping sites to the 106 Mile Site" (emphasis supplied). And that, Assistant Administrator Jorling directed, at page 36, that the EIS on the 106-Mile Site should be prepared to "include the dumping of sewage sludge", with no qualification that this dumping would be limited to sewage sludge from New York City. Chapter V of the draft EIS contains a highly competent discussion of the NOAA monitoring information and addresses each of the concerns raised during the Tom's River proceeding. The draft EIS concludes that use of the 106-Mile Site for sewage sludge disposal would be environmentally acceptable. There is no reason to believe that this conclusion applies with any less force to sludge from Philadelphia.

In conclusion, Maryland would respectfully request that the final EIS and any subsequent regulatory action concerning designation of the 106-Mile Site clearly indicate that the site is suitable for disposal of municipal sewage sludge from the City of Philadelphia, as a short-term alternative to the Cape May dump site.

Yours very truly,

Thomas A. Deming

TAD/elb

cc: Senator Charles Mathias, Jr.
Senator Paul S. Sarbanes
Congressman Robert E. Bauman
Secretary James B. Coulter
George A. Nilson, Deputy Attorney General

16

State of New Jersey
DEPARTMENT OF ENVIRONMENTAL PROTECTION
JOHN FITCH PLAZA, P. O. BOX 1390, TRENTON, N. J. 08625

September 21, 1979

Mr. T. A. Wastler
Chief, Marine Protection Branch
EPA
Washington, D. C. 20460

Re: Draft EIS, 106-Mile Ocean Waste Disposal Site Designation

Dear Mr. Wastler:

The State's Department of Enviromental Protection has completed its review of the Draft Environmental Impact Statement prepared by the EPA with regard to the 106-Mile Ocean Waste Disposal Site. As a result of this review, the comments received from several of the Department's review agencies centered primarily on the issue of ocean dumping and land-based alternatives.

E-29

16-1 Although the Draft EIS assesses the impact of sludge dumping at the 106 mile site, the broader issue of the relative impacts of ocean dumping and land-based alternatives is unfortunately inadequate in this document. It is the New Jersey Department of Environmental Protection's position that this Draft EIS is essentially imcomplete without a comparison of the effects of ocean dumping and the development of land-based alternatives. We believe that this deficiency should be remedied in the Final EIS. Our own assessment of this issue for New Jersey follows:

The review of sludge management studies prepared by New Jersey's ocean dumpers has given us a reasonably accurate assessment of the impact of the cessation of ocean dumping on our State's environment. Estimates have been developed, for example, that the proposed Elizabeth Joint Meeting incinerator will effectively raise the lead content of the air above the City of Elizabeth, another 10% to 20% over levels expected from other sources, to a point where the ambient concentration will be in excess of two thirds of the maximum allowable lead concentration necessary for the protection of human health. The cadmium level will also be high enough to be of major conern. Furthermore the particulate load emitted to the atmosphere from the operation of this incinerator might preclude certain industrial development in the vicinity of the

plant. Some of the air pollution allocation allowed under the Federal Clean Air Act will be used to provide the dilutive capacity necessary to absorb the additional emissions from this incinerator. In the case of Passaic Valley Sewer Authority, the three quarters of a million tons of sludge, which will be stored for a period of 4-6 years, will contain sufficient mercury to effectively preclude their incineration under today's standards. The amount of mercury emitted by incinerating the sludge from PVSA would be approximately three times the maximum allowable under law. The final environmental assessment of incinerating this particular sludge has not been completed yet. However, the foregoing statement on mercury is based on the Authority's Heavey Metals Source Determination Study, and therefore our assessment with respect to that specific contaminant is accurate. The only way we can expect to legally burn this material would be to dilute the stored sludge with new, clean, pretreated sludges anticipated in the 1980's.

These examples make it clear that the implementation of the Industrial Pretreatment Program is vital to environmentally sound sludge disposal. It is equally clear that if industrial pretreatment is not implemented, New Jersey could find itself in a completely intolerable enivornmental predicament. Should these interim solutions to the 1981 ocean dumping ban, such as landfilling or storage, become final, permanent solutions because sludge contaminant levels continue to prevent the use of selected long-term solutions, a severe impact on the quality of life in New Jersey would result. Even composting of sewage sludge, an alternative that has been chosen by a number of sewerage authorities in New Jersey, is dependent on a commitment to remove the heavy metal at the source.

With the implementation of the Industrial Pretreatment Program, one would expect a dramatic improvement in the water quality of the Bight, which receives the effluent from the largest New Jersey and New York Sewage treatment plants. Heavy metals surveys in New Jersey have been partially completed by the Passaic Valley Sewerage Commissioners, Rahway Valley Sewerage Authority, Elizabeth Joint Meeting, and the Bergen County Utilities Authority. These surveys indicate that, in general, a four-fold reduction in heavy metals is achievable, for both effluent and sludge. We beleive that such contaminant reductions may possibly eliminate the necessity for a categorical ban on the dumping of sewage sludge in the ocean.

We would recommend that in order for us in New Jersey to properly plan for the implementation of long-term sludge management solutions:

16-2 1. That the USEPA immediately promulgate the industrial pretreatment standards and undertake the full implementation of the program as mandated by Section 307 of the Clean Water Act for the reasons presented above; and

2. that because of difficulties involved and the inadequacy and insensitivity of the tests used, monitoring at the site is unlikely to turn up long-term sublethel effects or to detect possible bioaccumulation of organic compounds. This does not mean that such sublethal effects or bioaccumulation would not occur. It is imperative therefore that "environmental impact criteria", with regard to organics and more particularly with regard to organo halogens, be stricter than stated (see page 1-13 of draft EIS). Any organic material with potential to bioaccumulate should be prohibited. (The phase "must be less than is known to be toxic to organisms" is not an adequate criteria in this situation.)

16-3

16-4 3. That any permittee should provide an exhaustive and complete organic analysis of its wastes.

We wish to express our appreciation to EPA for the opportunity to reveiw the Drafts EIS. It is anticipated that these comments will assist the EPA in their endeavor to make the Final EIS as environmentally sound as possible.

Sincerely,

Lawrence Schmidt
Chief Office of
Environmental Review

LS/sje

17 COMMENTS TO THE

U.S. ENVIRONMENTAL PROTECTION AGENCY

CONCERNING THE DRAFT ENVIRONMENTAL IMPACT STATEMENT

FOR THE 106-MILE OCEAN WASTE DISPOSAL SITE DESIGNATION

Presented in Trenton, New Jersey

on

August 21, 1979

Prepared By:

Dr. Marwan M. Sadat, Program Director
Theresa Van Rixoort, Program Development Specialist
Office of Sludge Management and Industrial Pretreatment
Division of Water Resources
New Jersey Department of Environmental Protection

Mr. Birmingham, members of the panel:

Thank you for providing us with this opportunity to comment on the Draft Environmental Impact Statement (EIS) concerning the suitability of the 106 mile site for the disposal of sewage sludge.

The New Jersey Department of Environmental Protection (DEP) congratulates and commends the staff of the Agency on the detailed and comprehensive analysis of the environmental and economic considerations for sludge dumping at the 106 mile site.

The Draft EIS clearly indicates that dumping of sewage sludge at the 106 mile site will not significantly impact the area and that any environmental degradation will be immediate and temporary. The use of the 106 mile site has been advocated by DEP since 1976. Clearly, the limited area and the shallow depth of the existing 12 mile site make it unsuitable for the continuing disposal of municipal sewage sludge. Even the most crude engineering computations will leave little doubt that any increase in the sludge quantity being dumped at the 12 mile site must inevitably result in anaerobic conditions in the benthic/ocean boundary layer. The Department is very much concerned that any additional sludge dumping in New York Bight will cause a violation of Water Quality Standards on the New Jersey beaches. The proximity of the 12 mile site to the New Jersey shore increases the likelihood of pathogen survival in quantities sufficient to exceed the New Jersey Water Quality Standards for this area.

17-1 Although the Draft EIS thoroughly assesses the impact of sludge dumping at the 106 mile site, the broader issue of the impact of ocean dumping and land-based alternatives is unfortunately absent from this document. It is the New Jersey Department of Environmental Protection's position that this Draft EIS is essentially incomplete without a comparison of the effects of ocean dumping and the development of land-based alternatives. We believe that this deficiency should be remedied in the final EIS. Our own assessment of this issue for New Jersey follows:

The review of sludge management studies prepared by New Jersey's ocean dumpers has given us a reasonably accurate assessment of the impact of the cessation of ocean dumping on our State's environment. Estimates have been developed, for example, that the proposed Elizabeth Joint Meeting incinerator will effectively raise the lead content of the air above the City of Elizabeth, another 10% to 20% over levels expected from other sources, to a point where the ambient concentration will be in excess of two thirds of the maximum allowable lead concentration necessary for the protection of human health. The cadmium level will also be high enough to be of major concern. Furthermore the particulate load emitted to the atmosphere from the operation of this incinerator might preclude certain industrial development in the vicinity of the plant. Some of the air pollution allocation allowed under the Federal Clean Air Act will be used to provide the dilutive capacity necessary to absorb the additional emissions from this incinerator. In the case of PVSC, the three quarters of a million tons of sludge, which will be stored for a period of 4-6 years, will contain sufficient mercury to effectively preclude their incineration under today's standards. The amount of mercury emitted

by incinerating the sludge from PVSC would be approximately three times the maximum allowable under law. The final environmental assessment of incinerating this particular sludge has not been completed yet. However, the foregoing statement on mercury is based on the Authority's Heavy Metals Source Determination Study, and therefore our assessment with respect to that specific contaminant is accurate. The only way we can expect to legally burn this material would be to dilute the stored sludge with new, clean, pretreated sludges anticipated in the 1980's.

These examples make it clear that the implementation of the Industrial Pretreatment Program is vital to environmentally sound sludge disposal. It is equally clear that if industrial pretreatment is not implemented, New Jersey could find itself in a completely intolerable environmental predicament. Should these interim solutions to the 1981 ocean dumping ban, such as landfilling or storage, become final, permanent solutions because sludge contaminant levels continue to prevent the use of selected long-term solutions, a severe impact on the quality of life in New Jersey would result. Even composting of sewage sludge, an alternative that has been chosen by a number of sewerage authorities in New Jersey, is dependent on a commitment to remove the heavy metals at the source. An absolute ban on the ocean dumping of these highly contaminated sludges as of 1981 may, therefore, of dangerous.

With the implementation of the Industrial Pretreatment Program, one would expect a dramatic improvement in the water quality of the Bight, which receives the effluent from the largest New Jersey and New York sewage treatment plants. Heavy metals surveys in New Jersey have been partially completed by the Passaic Valley Sewerage Commissioners, Rahway Valley Sewerage Authority, Elizabeth Joint Meeting, and the Bergen County Utilities Authority. These surveys indicate that, in general, a four-fold reduction in heavy metals is achievable, for both effluent and sludge. We believe that such contaminant reductions may even eliminate the necessity for a categorical ban on the dumping of sewage sludge in the ocean.

We would recommend to this panel that, in order for us in New Jersey to properly plan for the implementation of long-term sludge management solutions:

17-2 1. That the USEPA immediately promulgate the industrial pretreatment standards and undertake the full implementation of the program as mandated by Section 307 of the Clean Water Act for the reasons presented above; and

17-3 2. That the USEPA recommend to Congress the consideration of continued ocean dumping beyond 1981 in limited cases, under the following conditions:

a) that the present dump site be banned from use,

b) that all future sludge dumping be allowed only at the Chemical Waste Dump site, (Movement of the disposal area to the 106 mile site would remove the economic incentive to ocean dump since the cost for dumping at the 106 mile site is approximately the same as for the implementation of long-term land-based alternatives such as composting or incineration. Environmental improvement would also result in the Inner New York Bight.) and

c) that the ocean dumping of sludge at the 106 mile site be carefully studied by NOAA, the USEPA, and other federal agencies in order to develop the necessary criteria to properly manage this practice in terms of application methods and rates. (In our opinion, an analogy can be drawn between the carefully managed land application of sludge and the prudent management of sludge disposal in the ocean to prevent over-fertilization and to insure that pollutants are kept below toxic levels.)

We believe that it is imperative that ocean dumping of sludge at the present ocean dumping site cease as soon as possible. It certainly should not continue past 1981. The amount of sludge that the site would then receive would be approximately 11 million tons per year, which is a five-fold increase over the amount it received in 1972. The assimilative capacity of the 12 mile site is effectively exhausted. In our estimation, continued dumping at the site could lead to violation of water quality standards on the New Jersey and Long Island shores. At the same time, land-based disposal or storage of those sludges which are highly contaminated at present may also pose a severe environmental threat, particularly if the implementation of pretreatment is delayed. We are further convinced that, as stated in the draft EIS and with the proper management and controls, the ocean dumping of sludge, at the 106 mile site or another appropriate site, may be a viable and environmentally acceptable alternative for sludge disposal. It is our opinion that the development of long-term environmentally sound sludge management alternatives for those states which border the Atlantic and Pacific Oceans is incomplete without the proper assessment of managed and controlled deep-waters ocean disposal. We should not fear remaining objective and open-minded about the possibility of some proper role being established for the ocean waters in our management of society's waste.

New York State Department of Environmental Conservation
50 Wolf Road, Albany, New York 12233

Commissioner
Robert F. Flacke

September 6, 1979

Mr. T. A. Wastler
Marine Protection Branch (WH-548)
Oil & Special Materials Control Div.
U. S. Environmental Protection Agency
Washington, D.C. 20460

RE: Environmental Impact Statement (EIS) for 106-Mile Ocean Waste Disposal Site Designation. DEC #012-006

Dear Mr. Wastler:

The Department of Environmental Conservation has completed its review of the above noted project and has found the document to be accurate in its treatment of the problems and solutions to proper waste disposal.

The primary concern of this Department has always been to ensure that hazardous wastes are disposed of properly. When considering the various disposal alternatives currently available, we feel that secure landburial sites represent a better solution than ocean disposal. However, we do agree that the ocean disposal should still be considered in special cases provided that the operation is carefully scrutinized. Fortunately, beyond 1981 there will be only one company permitted to use the 106-Mile site as a disposal area until they find a land based alternative. This should simplify our waste management strategy in one sense.

Ocean disposal of sewage sludge is another area of particular concern for New York State. Again we prefer to place our confidence on land based treatment technology since we are experiencing marked progress in this area. The quality of the Long Island beaches is especially in need of proper safeguarding; therefore, any emergency ocean disposal operation must be accomplished in a prudent manner.

We must stress that it is the Department's goal to see that all wastes are treated, stored or disposed of in New York State using proper and practical methods; and it is our aim to cooperate with other State and Federal agencies to accomplish this goal.

Thank you for the opportunity for review. We request review of the final document when available.

Very truly yours,

Terence P. Curran, Director
Division of Regulatory Affairs

TPC:ERM/scs

cc: G. Colvin
N. Nosenchuck
File
R. Persico

Pennsylvania State Clearinghouse

PSC

Commonwealth of Pennsylvania

GOVERNOR'S OFFICE
OFFICE OF THE BUDGET

P.O. BOX 1323 – HARRISBURG, PA. 17120 – (717) 787-8046
783-3133

August 24, 1979

Marine Protection Branch
Oil and Special Materials Control Division
U. S. Environmental Protection Agency
Washington, D.C. 20460

Dear Sir:

The Pennsylvania State Clearinghouse has received from your office a copy of the Draft Environmental Impact Statement on the 106-Mile Ocean Waste Disposal Site Designation and have no comments to make at this time.

Thank you for your cooperation.

Sincerely,

Richard A. Heiss
Supervisor

21

COMMONWEALTH of VIRGINIA

Council on the Environment

J. B. JACKSON, JR.
ADMINISTRATOR

903 NINTH STREET OFFICE BUILDING
RICHMOND 23219
804-786-4500

August 8, 1979

Mr. T. A. Wastler
Marine Protection Branch (WH-548)
Oil and Special Materials Control Division
U. S. Environmental Protection Agency
Washington, D. C. 20460

SUBJECT: 106-Mile Ocean Waste Disposal Site Designation

Dear Mr. Wastler:

Thank you for the opportunity to review the subject Draft Environmental Impact Statement. On behalf of the Commonwealth of Virginia, the Council on the Environment coordinated a review among pertinent agencies of the State. The State Water Control Board and the Virginia Institute of Marine Sciences commented on the proposal.

The Commonwealth supports the designation of the Disposal Site for continued ocean waste disposal. With the safeguards that EPA has built into the proposal, the environmental impacts should be minimal.

Please find enclosed the comments and recommendations of the State Water Control Board, which we hope will be useful in your further considerations of the action.

Do not hesitate to contact me if I can be of further assistance.

Sincerely,

J. B. Jackson, Jr.

JBJr:RFW/gcj
Enclosures

cc: The Honorable Maurice B. Rowe, Secretary of Commerce and Resources
Mr. Dale Wright, State Water Control Board
Mr. Thomas Barnard, Jr., Virginia Institute of Marine Science

22

COMMONWEALTH of VIRGINIA

STATE WATER CONTROL BOARD
2111 Hamilton Street

R. V. Davis
Executive Secretary

Post Office Box 11143
Richmond, Virginia 23230
(804) 257-0056

August 2, 1979

AUG 1979
Council on the Environment

Mr. Reginald F. Wallace
Environmental Impact Statement Coordinator
Governor's Council on the Environment
Ninth Street Office Building
Richmond, Virginia 23219

Dear Reggie:

RE: DEIS/106 Mile Ocean Waste Disposal Site

Our staff has reviewed the above-referenced DEIS and we have the following comments:

A review of this draft indicates that the dumping of Aqueous Chemical Wastes at the 106 mile disposal site would primarily have short term effects. The following recommendations seem appropriate to protect water quality and closely monitor long range effects of the dumpings.

22-1 1. Routine monitoring should be established to evaluate water column dispersion and persistance of toxics and heavy metals.

22-2 2. Benthic accumulations and biota should also be routinely monitored to closely define long range impacts.

22-3 3. Another site beyond the shelf should also be established so that a rotation pattern could be developed. This would allow recovery of the dump sites.

4. Sewage sludge disposal at the site would facilitate a more thorough scientific evaluation of the impact at sites beyond the continental shelf and though more expensive could be beneficial in the recovery of the New York Bight and other continental shelf disposal locations.

22-4 5. It has been emphasized that the cost of maintaining a routine surveillance program would be expensive, surcharges should be levied against those industries using the site to cover the expense of these programs.

Continued. . .

Thank you for the opportunity to comment on this DEIS. If you have any questions, please feel free to contact me.

Sincerely,

Dale E. Wright
Pollution Control Specialist
Bureau of Surveillance
and Field Studies

/scc

cc: D. H. Treacy-SWCB, Division of Ecological Studies
R. F. Jackson-SWCB, Tidewater Regional Office
EIS File

23

Monmouth County Planning Board

COURT STREET AND LAFAYETTE PLACE
FREEHOLD, NEW JERSEY 07728

CHAIRMAN
THOMAS G. O'HARA, ESQ.
Holmdel
VICE CHAIRMAN
ELWOOD L. BAXTER
SECRETARY
JOSEPH R. VUZZO
Middletown
LESTER S. GOLDSTEIN
Neptune Township
ALBERT A. KERR, JR.
Rumson
TAYLOR PALMER, JR.
Manalapan

BOARD OF
CHOSEN FREEHOLDERS MEMBERS
RAY KRAMER
Asbury Park
THOMAS J. LYNCH, JR.
Middletown
CHARLES B. VAN BENSCHOTEN
County Engineer
ROBERT D. HALSEY
Director of County Planning
ALTERNATES
Robert A. Conforti, Esq.
Paul Kiernan, Jr.
Allan J. MacDonald
William V. W. Cokelet

201 · 431-7460

October 17, 1979

Mr. T. A. Wastler
Chief, Marine Protection Branch (WH-548)
Environmental Protection Agency
Washington, DC 20460

RE: Draft Environmental Impact Statement for 106-mile Ocean Waste Disposal Site Designation

Dear Mr. Wastler:

This is to advise you that the Monmouth County Planning Board has reaffirmed its support for a strict enforcement of the December 31, 1981, deadline for the termination of sludge dumping in the ocean. The Board took the action after a report by the staff on the EPA's proposal to use the so-called 106-mile site off Southern New Jersey for the continued disposal of chemical waste by DuPont and for an expanded sludge dumping program at that site if continued disposal off Sandy Hook is found unacceptable. While the Board does not desire to comment on administrative decisions concerning chemical disposal or case-by-case extensions to the deadline for sludge dumping, it does wish to underscore its opposition to any sludge disposal in the New York Bight after 1981.

While the sources of pollution in the New York Bight are many, the continued dumping of sludge 12 miles off Sandy Hook can only contribute to the further alteration of the marine ecosystem and periodic contamination of bathing areas. The Board trusts that the EPA will continue to enforce existing compliance schedules for the development of land-based alternatives before 1982. 23-1

Very truly yours,

Robert D. Halsey
Director of County Planning

RDH/DM/ea
cc: Thomas O'Hara, Chairman MCPB
Elwood Jarmer, Chairman, Coastal Counties Committee
Sandra T. Ayres, NJ Division of Public Interest Advocacy
Dr. Marwan Sadat, Director, Office of Sludge Management & Ind. Pretreatment
Kathleen Rippere, Chairman, Environmental Council

24

TOWN OF OCEAN CITY

TELEPHONE 289-8221
P. O. BOX 158

MAYOR & CITY COUNCIL
OF OCEAN CITY
MARYLAND
21842

HARRY W. KELLEY
Mayor

COUNCILMEN
J. WARREN FRAME
President

WILLIAM H. PURNELL, JR.
Secretary

GUY R. AYRES, III
THELMA G. CONNER
BERNARD F. DEUTSCH
HALE HARRISON
GRANVILLE D. TRIMPER

SHELDON E. DIETERT
Clerk - Treasurer

MILES C. ALLGOOD, JR.
City Engineer

August 3, 1979

Mr. T. A. Wastler
Chief, Marine Protection Branch
U. S. Environmental Protection Agency
Washington, D. C. 20460

RE: Draft EIS - Final Designation of 106 Mile Chemical Water Ocean Disposal Site

Dear Mr. Wastler:

The Town of Ocean City and myself, as Mayor, has repeatedly expressed its complete opposition to the continued pollution of our oceans - whether by chemical or sewage sludge disposal. We reaffirm our feelings on this subject and again urge you to force the development of alternate non-ocean means of waste disposal. 24-1

Sincerely,

Harry W. Kelley,
Mayor

HWK/js

CC: Mr. James T. McConnaughhay
Chief, State Clearing House
Maryland Department of State Planning
301 West Preston St.
Baltimore, Maryland 21201

25

TOWN OF OCEAN CITY

TELEPHONE 289-8221
P. O. BOX 158

MAYOR & CITY COUNCIL
OF OCEAN CITY
MARYLAND
21842

HARRY W. KELLEY
Mayor

COUNCILMEN
J. WARREN FRAME
President

WILLIAM H. PURNELL, JR.
Secretary

GUY R. AYRES, III
THELMA G. CONNER
BERNARD F. DEUTSCH
HALE HARRISON
GRANVILLE D. TRIMPER

SHELDON E. DIETERT
Clerk - Treasurer

MILES C. ALLGOOD, JR.
City Engineer

July 24, 1979

Mr. T. A. Wastler
Marine Protection Branch
Oil & Special Materials Control Division
U. S. Environmental Protection Agency
Washington, D. C. 20460

RE: Draft E.I.S. - Final Designation of 106 Mile Chemical Water Ocean Disposal Site

Dear Mr. Wastler:

I have reviewed the referenced summary which was received from our State Clearinghouse. Because of the impact which such a use might have upon a resort such as Ocean City, we are very interested in this matter. Therefore, I am requesting that we be provided a complete copy of the document. 25-1

I might add that the time allowed us to review and comment on the Proposal is very limited.

If you have any questions or comments, please contact me at 289-8221.

Sincerely,

Martin Neat,
Grantsman

MN/js

26

DELAWARE RIVER BASIN COMMISSION
P. O. BOX 7360
WEST TRENTON, NEW JERSEY 08628
(609) 883-9500

GERALD M. HANSLER
EXECUTIVE DIRECTOR

HEADQUARTERS LOCATION
25 STATE POLICE DRIVE
WEST TRENTON, N. J

August 14, 1979.

Dear Mr. Wastler:

The Delaware River Basin Commission staff has reviewed the Draft EIS for the 106-Mile Ocean Waste Disposal Site Designation and is in general agreement with EPA's recommendation that this site receive final designation for continued industrial waste disposal, subject to EPA Ocean Dumping Regulations and Criteria.

There are three options available for waste disposal remaining after reuse, recycling and/or treatment to reduce waste volumes or to render waste less active. They are land, air or water disposal. All of these options must be considered in waste management. Each, with appropriate criteria, regulations and monitoring, can provide environmentally acceptable means of waste disposal.

DRBC's position on the issue of ocean disposal is a matter of record. In cases where no land-based disposal alternative is available and when the only other alternative involves discharge of contaminants into a stream with adverse impact on the river and/or its estuary, DRBC has recommended ocean disposal as the most acceptable option -- provided it meets EPA's ocean disposal criteria.

We believe this position is especially valid in a situation where the wastes discharged to the ocean have no demonstrable adverse impact on the marine environment and in which the treatment of the effluent would produce a residue for which no satisfactory land disposal facility is available. An example would be a waste which when treated would produce large volumes of sludge. Land disposal of some sludge could cause measurable environmental degradation. With proper controls, disposal at the 106-mile site would be the most acceptable alternative.

We recognize that numerous studies on the effects of various types of wastes on the marine environment are incomplete and that much of the data they have generated are inconclusive. Such studies should be continual. The adverse impact on ground and surface water of inadequately handled land disposal, however, has been clearly established, as is that of the direct discharge of waste materials to fresh or brackish surface water sources. Therefore, when confronted with

options - one set of which poses a threat of contaminated land, ground water or surface water with its immediate impact on society; the other involving an impact of insignificant consequences, short-term or long-term, on a distant tract of ocean - the Commission supports the ocean disposal option.

We believe that this position has increased validity when applied to ocean disposal as an option for a discharge until such time as alternatives can be researched and practical permanent solutions can be found.

Sincerely,

Jerry Hansler

Gerald M. Hansler

Mr. T. A. Wastler, Chief
Marine Protection Branch
U.S. Environmental Protection Agency
Washington, D. C. 20460

27

E. I. DU PONT DE NEMOURS & COMPANY
INCORPORATED
WILMINGTON, DELAWARE 19898

ENGINEERING DEPARTMENT
LOUVIERS BUILDING

CC: Dr. P. W. Anderson - EPA - Region II
Dr. W. M. Dunstan - Interstate Electronics Corp.
Ms. Kathleen King - Interstate Electronics Corp.

September 26, 1979

Mr. T. A. Wastler
Chief, Marine Protection Branch (WH-548)
Environmental Protection Agency
Washington, DC 20460

Dear Mr. Wastler:

This is in response to a request for comments on "Environmental Impact Draft Statement (EIS) for 106-Mile Ocean Waste Disposal Site Designation." We are encouraged to note the conclusion, that no significant adverse effects have been demonstrated at the site because of waste disposal.

Our detailed comments are attached herewith. Of particular concern to us are:

- Incorrect data on bioassays and other characteristics of Du Pont wastewaters given in Table 5-2 (page 5-6) and on pages B-12 and B-13.
- The implication on page 2-23 that the Delaware Bay Acid Waste Disposal Site was closed to shellfishing because of previous use of that site by Du Pont.
- Certain recommendations (pages xiii and 2-41) on industrial wastewater characteristics which, if adopted, would exclude the use of ocean disposal for Du Pont wastewaters. These recommendations need modification so that the site can continue to be used for disposal of wastes which have no significant environmental impact.

We appreciate the opportunity to comment on the draft EIS.

Very truly yours,

ENGINEERING SERVICE DIVISION

L. L. Falk

L. L. Falk

LLF:rbw
Atch

E-38

COMMENTS OF E. I. DU PONT DE NEMOURS & CO.
ON ENVIRONMENTAL IMPACT DRAFT
STATEMENT (EIS) FOR 106-MILE
OCEAN WASTE DISPOSAL SITE DESIGNATION

Page	Comments
viii-ix	The statement is made that "the disposal of chemical wastes, in combination with other types of material, is generally an undesirable practice." Since, in general, chemical wastes have not been disposed of with other types of material, there has been no experience on which to base such a statement. The reasons for this statement should be presented.
xiii, 2-41	The EIS recommends several characteristics which industrial wastes should have for disposal at the 106-mile site. The first recommendation is that concentrations of solids should generally be less than 1 percent. The text does not specify what kind of solids are referred to, nor the basis for the recommendation. The 106-mile site is deep (1500-2700 meters) and has excellent dispersing characteristics for wastes which contain even several percent suspended solids (eg, sewage sludge per pages 5-8 through 5-11). In addition, dispersal of wastewater containing several percent of dissolved solids, such as Du Pont-Grasselli's, is also quite rapid as the EIS points out on pages B-14 through B-16. We suggest that the first recommendation be modified to state that suspended or dissolved solids concentrations should not be high enough to interfere significantly with the dispersion of wastewater constituents.

Page	Comments
	The second recommendation is that the wastewaters be neutrally or slightly negatively buoyant in seawater. As we interpret this recommendation, it means the wastewaters should have a specific gravity equal to or greater than that of seawater. Might that not be a better way to state this recommendation?
	The third recommendation is that the wastewater characteristics "demonstrate low toxicity to representative planktonic and demersal marine organisms." The toxic effect of a wastewater is a function of its concentration. Therefore, the toxic effect of wastewater disposed of in the ocean depends on the dilution achieved, a function of the rate of release and barge speed (ie, tons released per unit of distance traveled.) Falk and Gibson (1977) and Falk and Phillips (1977) demonstrated, for both Du Pont-Grasselli and Du Pont-Edge Moor wastes, that a time-concentration curve can be developed by proper release rate such that concentrations at any time after release can be kept below the corresponding toxic effects concentration for the same time. (See EIS reference list, p. 7-21, EIS page 2-6, 2nd paragraph, and EIS pages B-13 and B-17).
	The same concept can be applied to any wastewater of almost any toxicity by use of an appropriate release rate. The higher the toxicity, the lower the release rate. Therefore, the logistics and economics of ocean disposal become the determinants. The recommendation that the wastes have low toxicity is not relevant. What is relevant is that the toxicity be mitigated by proper dispersion practices. Therefore, we suggest that the third recommendation be modified to provide for demonstrating low toxicity to representative

Page	Comments
	planktonic and demersal marine organisms at wastewater concentrations achieved after dispersion (see EPA regulations, 40 CFR Part 227, Subpart B).
	The fifth recommendation deals with certain constituents which should not be detectable above ambient levels outside the site within 4 hours after discharge. We suggest this recommendation be clarified. For example, does it literally mean outside the entire 106-mile site 4 hours after release? What kinds of constituents are being referred to?
xiii-xiv, 2-43	Five numbered additional recommendations are made:
	The second of these indicates that monitoring (at permittees' expense) for short-term impacts should be by "environmental contractors." If a permittee is qualified to do the monitoring, the permittee should be allowed to do it.
	Correct the last word in the second recommendation from "waste" to "waste-sea-water mixture."
1-5	The first lines indicate the CWA of 1977 (PL 95-217) replaced earlier legislation and established a regulatory program for controlling discharges to navigable waters from outfalls. Actually, such a program was established at the Federal level by PL 92-500 when the Federal Water Pollution Control Act was amended in 1972. Further, most States had such regulatory programs for many years prior to 1972.
2-4	The text indicates the 106-mile site is located 167 km (90 n. mi) east of Cape Henlopen, Delaware. Scaling the <u>western</u> boundary of the site on Figure 2-1 shows it is 232 km (126 n. mi) east of Cape Henlopen. The site is farther from Cape Henlopen than it is from Ambrose Light.

Page	Comments
2-14	Re lines 18 through 23, Mueller, et al. did not report on sodium sulfate and calcium chloride entering the New York Bight Apex. Those probably do come from land runoff (eg, street salting) and other sources in the metropolitan area.
2-20	In the second paragraph, change "sulfide" to "sulfate."
2-23	In the first paragraph is the statement: "Preliminary work by Pesch et al. (1977) indicates that previous acid waste disposal has contaminated scallops near the Site. At this time, the Site is still closed to shellfishing by FDA." We strongly object to the first sentence in the quote as well as the implication of the second. The second sentence implies that FDA closed the area because of contamination of shellfish from the previous acid waste disposal. Actually, closure was because of bacterial contamination at a nearby sewage disposal site. Further, Pesch et al. did not state that scallops were "contaminated" by acid wastes. They indicated that certain waste constituents, eg, vanadium, provided a tag for the acid waste. They found locations of statistically higher vanadium concentrations in sea scallops south of both the Delaware Bay Acid Waste Site and the nearby Philadelphia Sewage Sludge Site as well as in the latter site (see their Figure 6). Those authors, however, made no statement that the scallops were "contaminated" such that closing to shellfish harvesting was needed. We urge that the EIS specify the basis upon which FDA closed the Site to shellfishing, both here and on page 4-5.

Page	Comments
2-37	The last line of the second paragraph indicates the point of land nearest to the northwest corner of the 106-mile site is 200 km (110 n. mi) away. If the nearest point is scaled off from Figure 2-1 (p. 2-5), the correct distance is 167 km (90 n. mi).
2-38	The 200 km (110 n. mi) distance should be corrected as shown above.
3-13	What evidence exists to show that organic carbon acts as a trap and transport agent for toxic substances (2nd paragraph)? This may be true of suspended particles, but they do not have to be "organic carbon."
3-17	The longitude boundaries given for the New York Bight Acid Wastes Site should be 73°36' W to 73°40'W.
3-21, 3-22	Table 3-4 should show the loads as "metric tons/year." The first line on page 3-21 should begin: "The total mass loads of several trace metals released annually into ...." The EIS says Mueller et al. (1976) did not report iron. They did (see their Table 38), at 230 metric tons/day of which 79 percent is from barging (see their Table 39).
3-35	The last paragraph indicates that there is a large flow of fresh water out of Delaware Bay in springtime. It would be more accurate to speak of "lower salinity water" because the Bay supports marine organisms which could not survive "fresh water."
3-38	In line 6, change "sulfide" to "sulfate." In line 8, the waste is described as 30 percent hydrochloric acid. This is incorrect. The waste's total acidity during 1976 was generally between 100,000 and

Page	Comments
	220,000 mg $CaCO_3$/kg. This is equivalent to a range of 7.3 to 16 percent acid (expressed as hydrochloric).
3-39	Table 3-8 shows abnormally high loads of nickel and zinc in 1976. This is believed caused by including anomalously high analyses for those metals in certain barge samples. To be specific, the nickel concentrations in barge 6-48 (and the composite from barges 6-39 to 6-48) are more than two orders of magnitude greater than any other samples during 1976. The zinc concentration in the composite from barges 6-59 to 6-68 is about 10 times that from the next highest 10-barge composite. The 1976 nickel and zinc loads should be calculated without those high anomalous values. If so done, the 1976 nickel load will be 5.8 and the zinc load 41 metric tons.
4-5	The text should state that Pesch et al. (1977) considered vanadium as a tag for Du Pont wastes. However, they did not prove that "past waste disposal at the Site caused elevated vanadium levels in scallops from the area." They had no data on vanadium levels in scallops prior to the start of disposal. Furthermore, examination of their Figure 6 (vanadium distribution) does not rule out that the higher vanadium values were from causes other than ocean disposal of titanium dioxide wastewater. EPA should be contacted to learn if vanadium levels have decreased since Du Pont ceased use of the Delaware Bay Acid Waste Site. If levels have not declined, then causes other than industrial waste disposal should be sought.

Page	Comments
4-16	Examination of Figures 2-6 of Pesch et al. (1977) indicates elevated concentrations of several metals in sea scallops well away from both the Delaware Bay Acid Waste Site and the Philadelphia Sewage Sludge Site. Further, comparison of the figures shows significantly different patterns. Compare Figure 5 for cadmium with the others. This indicates industrial waste disposal is not the sole cause of elevated metal levels. We should point out that the presence of both acid and sewage sludge (two entirely different wastes) in the area studied by Pesch et al. does obscure the effects of waste disposal, contrary to item (3) listed in the paragraph on p. 4-16.
5-6	Table 5-2 contains several misleading values: 1. The range for copper concentrations of Du Pont-Grasselli wastewater is given as 25 - 154,700 ug/l. The maximum value is in error because of a faulty analysis. EPA-Region II had been provided a correct value. Therefore, the maximum value observed since 1974 should be shown as 1470 ug/l. Consequently, the mean value should be changed from 3000 to 330 ug/l (1974-1978 analyses). 2. The range of 96-hour LC50 values for Grasselli wastewater to the Atlantic silversides (M. menidia) is given as 1.8 - 6950 mg/kg. The asterisk indicates the source of the data is Mueller et al. (1976). Data submitted to EPA-Region II beginning with monthly wastewater samples taken in January, 1976 show that the range for aerated M. menidia 96-hour LC50 was 750 - 6950 ul/l. We believe the 1.8 mg/kg reported as the lowest value in Table 5-2

Page	Comments
	may have come about because bioassay data for a standard toxicant was taken as wastewater toxicity. The toxicity of sodium lauryl sulfate is determined each time a test is run. Its toxicity to M. menidia is in the range of 0.87 - 3.50 mg/l, averaging 1.6.
	We have examined Mueller et al. (1976) and find no reference to bioassays of Grasselli wastewater to M. menidia.
	3. The range of 96-hour LC50 values to S. costatum for Grasselli wastewater is given as 29 - 8600 "mg/kg." Reports submitted to EPA beginning in 1976 show a range of EC50 values as 160 - 8600 "ul/l."
	4. For the Edge Moor wastewater, the average vanadium value is given in ug/l but the range is given in mg/l. The two should be shown in the same units.
	5. Mueller et al. (1976) give no data for LC50 values to M. menidia for Edge Moor wastewater.
	6. Does ND mean "not detected" or "not determined"?
7-2	BOD is incompletely defined. It is the amount of oxygen consumed by microbiological organisms while assimilating and oxidizing organic (and some nitrogenous) materials in water or wastewater under specified environmental conditions and time periods.
	A "chronic effect" does not necessarily reduce survivorship. It is conceivable that a substance could have a chronic effect which does not affect survivorship or might even increase it. The whole process of evolution could be considered to result from series of "chronic effects."

Page	Comments
7-11	The abbreviation for "parts per thousand" should be "0/00," not "0/000."
7-21	Falk, et al., 1974 can be referenced as EPA-600/2-77-112 (NTIS PB 268157).
A-33	In Table A-8, should the concentrations be shown as ug/l rather than mg/l?
A-40, A-72	In Tables A-10 and A-16, is the data accuracy sufficient to show averages to 4 and 5 significant figures?
B-1, B-4	Page B-1 states there were 66 permittees in 1973. Page B-4 states there were 61 permittees + 3 previously mentioned = 64 total. Are these statements inconsistent?
B-7	In the last paragraph, the EIS discusses the composition of the "organic phase" of Grasselli wastewater. The words "organic portion" would be more accurate since there is only one phase.
B-12	Bioassay data given for M. menidia is incorrect, as noted above in comments for Table 5-2 on page 5-6. The correct range should be 1250 to 6950 ppm for aerated tests and 660 to 6170 ppm for nonaerated 96-hour LC50 (ie, TL50) tests during 1977 and 1978. Similarly, bioassays on S. costatum for the same period showed 96-hour EC50's ranged from 160 to 8600 ppm.
	The low values of 1.8 and 1.65 ppm shown for 96-hour LC50 values for M. menidia are possibly the misquotation of the toxicity of the standard toxicant used for quality control during the bioassays.

28

E. I. DU PONT DE NEMOURS & COMPANY
INCORPORATED
GRASSELLI PLANT
LINDEN, NEW JERSEY 07036

August 24, 1979

Dr. Peter W. Anderson
Marine Protection Program
U.S. Environmental Protection Agency
Region II
Edison, New Jersey 08817

Dear Dr. Anderson:

Re: Draft Environmental Impact Statement (EIS) for 106 - Mile Ocean Waste Disposal Site Designation - Public Hearing, August 21, 1979

E-43

As we discussed via telephone, we wish to comment on the 96-hour TL_{50} values from the bioassays with Atlantic silversides (Menida menida). These values are reported on pages B-12 and B-13 of the draft EIS and were alluded to by Ken Kamlet in his comments at the public hearing on August 21st.

28-1 We believe that the preparer of the draft EIS (Interstate Electronics Corporation) either made a typographical error or reported the TL_{50} values for the standard toxicant in reporting the range of 96-hour TL_{50} values. The lower range values 1.8 ppm for aerated tests and 1.65 ppm for non-aerated tests are not correct. Our data indicate the lowest TL_{50} value to be three orders of magnitude or about 1000 times higher than the values above.

We plan to submit these and other comments to Interstate Electronics Corporation relative to the draft EIS.

Very truly yours,

H W McDowell

H. W. McDowell
Environmental Coordinator

HWM/jhw

29

GREENSTONE AND SOKOL
COUNSELLORS AT LAW
39 HUDSON STREET
HACKENSACK, NEW JERSEY 07601
(201) 488-3930

JAY W. GREENSTONE (N.J. AND FLA. BAR)
LEON J. SOKOL (N.J. AND FLA. BAR)
KENNETH H. MACK

JOSEPH F. BEHOT, JR.
CAROL W. MC CRACKEN

8581 W. McNAB ROAD
TAMARAC, FLORIDA 33321
(305) 722-0430

ALAN PRIGAL (N. Y. N. J. AND FLA. BAR) OF COUNSEL

August 21, 1979

United States Environmental Protection Agency
Marine Protection Branch
Washington, D.C. 20460

Att: Mr. T.A. Wastler, Chief, Marine Protection Branch (WH-548)

Re: DRAFT ENVIRONMENTAL IMPACT STATEMENT for 106-Mile Ocean Waste Disposal Site Designation

Dear Mr. Wastler:

On behalf of the Bergen County Utilities Authority, the following comments are offered on the aforementioned draft proposal regarding the 106-mile Ocean Waste Disposal Site.

29-1 1. We suggest that your study include the environmental impact of a pipeline to the site which would carry sludge from secondary treatment plants. This study should include the economics of such a pipeline, and if the economics can be made more favorable by having a large number of sewer treatment plants utilize the pipeline.

A preliminary calculation by our staff of a pipeline which would be utilized by the major sewer authorities in Northern New Jersey indicates that disposal costs could be as low as $62.00 per dry ton including the amortization of the cost of the pipeline which is estimated to be well in excess of one billion dollars. This estimate assumes a substantial Federal subsidy, and a summary of the estimate is attached hereto as Appendix "A".

We recognize that the notion of a pipeline is farfetched to some at this time, but we believe that all possibilities should be explored in such a comprehensive study.

29-2 2. The draft notes that the economics of transporting

sewerage sludge to the 106-mile site are almost prohibitive because of the substantial increase in costs compounded by the limited number of ships which can travel to that location. We would, therefore, ask that an additional study be made of potential means of transportation which are less expensive.

For example, can ocean-going vessels be somehow utilized to transport sludge beyond the 106-mile site? Can the sludge be towed in disposal containers, or can it be taken on board as either ballast or in empty storage compartments? If any of these ideas are feasible, is there sufficient ocean-going traffic to handle the volume of sewerage sludge generated in this area?

29-3 3. Can industrial pretreatment requirements be relaxed if an economically feasible method of disposal at the 106-mile site can be developed? This could have serious economic consequences for for this region since in some cases, the requirement of industrial pretreatment places an onerous burden on small and medium sized businesses. This makes it additionally difficult for this area to compete for new business investment, and we would note that this area has continued to experience a net outflow of industrial jobs over the past 20 years.

If we can maintain an environmentally sound method of disposal which is ultimately less costly in the aggregate, including cost to the Authority as well as well as cost to industrial users, then the plan could be very attractive. In any event, we would like to have more data available for evaluation.

Very truly yours,

GREENSTONE & SOKOL

Leon J. Sokol

LJS:cy
cc: Dr. Peter Anderson
Enclosure
cc: John G. Costello
James J. Craffey

APPENDIX "A"

TABLE 1
BERGEN COUNTY UTILITIES AUTHORITY
106-MILE DUMP SITE

Sludge Pumping
Cost Estimate

In Million $

Present Worth	Case 1 BCUA & PVSC	Case 2 Regional
Capital Cost	$ 1,050.0	$ 1,050.0
Operation & Maintenance	3.1	15.9
Present Worth - Operation & Maintenance (20 years, 6-5/8%)	33.5	173.9
Total Present Worth	$ 1,083.5	$ 1,223.9
Annualized Cost	99.3	112.2
Cost Per Dry Ton (in $)	625	154
Local Costs		
Capital Costs	$ 1,050.00	$ 1,050.00
Less Grants	690.00	690.00
Local Share	360.00	360.00
Debt Service (30 years, 7%)	29.0	29.0
Operation & Maintenance	3.1	15.9
Total Annual Costs	32.1	44.9
Cos Per Dry Ton (in $)	202	62

TABLE 2
BERGEN COUNTY UTILITIES AUTHORITY
COMPARISON OF SLUDGE DISPOSAL ALTERNATIVES

Alternative	Present Worth Annualized Cost in million $	Present Worth $ Costs Per Dry Ton	Local Costs Annual Cost in million $	Local Costs $Cost Per Dry Ton
106-Mile Pumping:				
Case 1 BCUA & PVSC	99.3	625	32.1	202
Case 2 Regional	112.2	154	44.9	62
106-Mile Barging - BCUA Only:				
Fuel @$0.60/gal ($8.00 wet ton)	3.7	230	3.7	230
Fuel @$.090/gal ($10.76 wet ton)	4.9	310	4.9	310
Thickening & 106-Mile Barging - BCUA Only:				
Fuel @$0.60/gal	2.5	155	1.3	123
Fuel @$0.90/gal	3.1	194	1.6	146
Land Based - BCUA Facility Plan BCUA Only:	3.2	201	1.95	123

LEAGUE OF WOMEN VOTERS
OF MONMOUTH COUNTY, N.J.

August 10, 1979

Mr. T. A. Wastler
Chief, Marine Protection Branch (WH-548)
Environmental Protection Agency
Washington, D. C. 20460

Re: Draft EIS for 106-Mile Ocean Waste Disposal Site Designation

The League of Women Voters of Monmouth County has been actively concerned with the problems relating to ocean dumping since 1970 when sludge dumping was first called to the attention of the citizens of the county. It affected us deeply since Monmouth is the northernmost county in New Jersey with an ocean shore. It is in closest proximity to the New York Bight and our extensive northern shore faces the bays and harbors behind Sandy Hook.

The Monmouth League's last participation in the discussion of ocean dumping was for the hearing in 1977, which we did not attend, but to which we sent written testimony (apparently, not recorded by EPA). Our statement strongly opposed moving the sludge dump site to the edge of the Continental Shelf. Our grounds included the "out of sight, out of mind" factor, the cost for monitoring and adequate shipping which we felt would prevent expenditures for alternate disposal methods, the difficulty of monitoring the deepwater site, and the fact that sewage sludge appears to play a relatively small part in pollution of the Bight. We stressed the need to cease use of the ocean for wastes completely. This testimony was in response to the proposal of an alternate northern or southern site, but was also in answer to locally generated arguments favoring moving municipal sludge to the 106-mile site.

Basically, we continue to hold this same position. However, we appreciate the fact that a good deal of advance has been made toward eliminating the two types of ocean dumping covered in the EIS and that some concrete knowledge has been gained about the 106-mile site through monitoring the effects of actual dumping there. We also appreciate the fact that some alternative to land application or to continued disposal in the Bight is necessary for emergency use.

Based on research which has shown relatively little commercially valuable benthic life in the area and because it is believed that fish in passing through are sufficiently mobile to avoid a polluted environment, we feel it necessary to approve the 106-mile site in preference to either the northern or southern alternatives on the more sensitive and productive Continental Shelf.

However, it is obvious that continuing problems exist with this alternative. Most readily understood is the cost of providing adequate shipping and surveillance. It was some time ago in a session called by Assemblyman Villane at Sandy Hook that the Coast Guard testified to its need for electronic surveillance of ships traveling any distance to sea. It is disappointing that this condition still exists although the proposal to authorize ships to use the 106-mile site is again under

consideration.

It seems obvious under existing conditions of an inadequate fleet and inadequate monitoring facilities that to transport all sewage sludge to the 106-mile site would be not only costly, but extremely wasteful if the operation is to be carried out only on an interim basis. Consequently, we must return to the position frequently expressed at the 1977 hearings that transfer of dumping to the 106-mile site must be considered only if conditions in the Bight become extremely hazardous and only if the sewage sludge can be pinpointed as a major contributor to the condition. Interim use alone should not call for the kind of expense involved in long-term dumping. It seems essential that some sort of cooperative arrangement should be planned in advance so that such expenditures would in no way be encouraged. Otherwise, the difficulties of enforcing the 1981 deadline will become virtually insurmountable.

The need to consider the energy requirements to transport sludge to the 106-mile site reinforces the view that it must be used only on an interim basis.

On the other hand, it must be recognized that use of the 106-mile site only on an interim basis and as an alternate to use of other areas (land or New York Bight) will mean that upgrading of Coast Guard monitoring abilities will, presumably, not take place. This obviously leaves the question of how to prevent habitual short dumps and, even more difficult, how to monitor compliance with the regulations governing separation of wastes and methods of disposal. Here, again, the answer remains to hold as closely as possible to the 1981 schedule for total cessation of ocean dumping of sludge.

As far as the cost of monitoring by NOAA is concerned, we feel that this expense is necessary regardless of what occurs in the future. There remain enough unanswered questions and enough potential threats at the 106-mile site regarding the ultimate fate of wastes dumped there and their combination with other components to require careful and continual monitoring. It is too easy to recall that dumping in the New York Bight went on for years without monitoring and until the resulting unhealthy condition became too obvious to ignore, no open acknowledgement of the probable causes of the problem was made, let alone any efforts to determine exactly how serious the contamination had become or from what source it originated. We were well involved in a virtually irreversible disaster before most of us knew we were there. This must not be allowed to happen as a result of use of the 106-mile site and it is impossible to feel that the potential for a repetition is not there.

As far as the acid dumps are concerned, we are extremely gratified to note the progress EPA is making toward land treatment of industrial wastes. With the ultimate removal of large dischargers such as Dupont-Edge Moor, American Cyanamid and Kerr-McGee some improvement should begin to become noticeable and it should make conformity by smaller companies easier to enforce. Correcting the large companies first is an advisable approach.

Aside from attention to the removal of hazardous pollutants, we

are extremely pleased to see emphasis on the need to reuse wastes as far as possible. This will obviously become increasingly necessary as basic elements are depleted and, as with most environmental problems, that we are just beginning to attack, the time to start reclamation is already well past. The immediacy of the need to alter past procedures is apparent.

With the progress apparently being made, we feel that pressure should continue on Dupont-Grasselli at whatever cost to them to seek means of waste treatment other than ocean dumping. We have long believed that there will be an adverse economic reaction to alteration of the habits that industry has been allowed to follow in this country (and following our lead, now, in many others). Ultimately this will have to be considered unavoidable. However, it must not be allowed under any circumstances to influence us to return to the habits we are just beginning to abandon, or, at some point, the whole process of environmental cleanup will have to begin over from a far worse position than we are presently in. We do not believe the economic effects will be permanent. Other methods and technologies will mean different, but not fewer jobs, as they are already providing. We need to get on with facing the facts and doing something about them. We trust that EPA will not permit itself to weaken stands already taken. Your guidelines for moving sludge to the 106-mile site and for handling industrial wastes are excellent IF they can be enforced. This we feel they must be, again, at whatever cost.

We would appreciate having this testimony read into the record of the hearing to be held on August 21 so that in the future we can receive pertinent material for comment.

Sincerely,

Kathleen H. Rippere

Kathleen H. Rippere
Natural Resources Chairman

934 Navesink River Road
Locust, N. J. 07760

31

MID-ATLANTIC FISHERY MANAGEMENT COUNCIL

ROOM 2115 FEDERAL BUILDING
NORTH & NEW STREETS
DOVER, DELAWARE 19901

TELEPHONE: 302-674-2331

DAVID H. HART
Chairman
ELIOTT GOLDMAN
Vice Chairman

JOHN C. BRYSON, P.E.
Executive Director

October 4, 1979

Mr. John Rhett
Deputy Assistant Administrator for
Water Program Operations (WH-546)
U.S. Environmental Protection Agency
Washington, DC 20460

Dear Mr. Rhett:

The Mid-Atlantic Fishery Management Council is very concerned about the chemical dumping in area 106. We finally were able to obtain a copy of the EIS on September 5, 1979. We note a hearing was held on August 21, 1979 in Trenton, New Jersey.

Although we have previously expressed concern over the potential impact on fisheries by ocean dumping and have requested to be informed of proposed changes we still do not seem to be on the mailing list. I trust you can notify the proper personnel so this may be corrected.

According to the EIS, routine bioassay will be performed using appropriate sensitive marine organisms. May we receive information and/or copies of these bioassays.

31-1 The report also states the probablility of fish accumulating toxic levels of contaminants from the 106 area is extremely remote due to the high migratory nature of the fish. This would seem to depend on concentrations in the area and the extent of the migrations.

I gather from the report that since we do not know the extent of fisheries in the 106 area due to the lack of surveys that you assume a problem will not exist, yet we are advised that species such as bluefish move to deep water during the winter as well as
31-2 migrate to the south. Are we sure area 106 is outside important fishery areas or merely taking a lack of knowledge as a means to appease the chemical and other toxic waste disposers who want a cheap disposal technique.

Shark are becoming a more important species for the US. We surely don't expect the shark not to be in area 106. We can reasonably expect tuna and swordfish to be in the area. Since swordfish are already contaminanted this should be a signal for greater caution.

In order that we may evaluate the EIS more properly we request a list of all contaminants being dumped in area 106 and a copy of the bioassays that have been completed to date.

We are enclosing a table from the NOAA evaluation of area 106 that show the species that we can expect to be in the area.

31-3 We will take particular interest in the bioassays on those species highlighted as they are very important to the fishery of the Mid-Atlantic Area.

Sincerely,

John C. Bryson

JCB/nbw

enclosure

Table 2. List of Fish Species Caught on Longline in and around DWD 106* 38°-40°N, 71°-73W

Family	Common name	Scientific name
Lamnidae	White shark	Carcharodon carcharias
	Shortfin mako	Isurus oxyrinchus
	Porbeagle	Lamna nasus
Carcharhinidae	Silky shark	Carcharhinus falciformis
	Blacktip shark	C. limbatus
	Oceanic whitetip shark	C. longimanus
	Sandbar shark	C. milberti
	Dusky shark	C. obscurus
	Tiger shark	Galeocerdo cuvieri
	Blue shark	Prionace glauca
Sphyrnidae	Scalloped hammerhead	Sphyrna lewini
	Unidentified hammerheads	Sphyrna ssp.
Squalidae	Spiny dogfish	Squalus acanthias
	Unidentified sharks	
Dasyatidae	"Stingrays"	
Alepisauridae	Shortnose lancetfish	Alepisaurus brevirostris
	Longnose lancetfish	A. ferox
	Unidentified lancetfish	Alepisaurus ssp.
Lampridae	Opah	Lampris regius
Branchiostegidae	Tilefish	Lopholatilus chamaeleonticeps
Pomatomidae	Bluefish	Pomatomus saltatrix
Coryphaenidae	Dolphin	Coryphaena hippurus
Sparidae	Sea Bream	Archosargus rhomboidalis
Gempylidae	Escolar	Lepidocybium flavobrunneum
	Oilfish	Ruvettus pretiosus
Scombridae	Wahoo	Acanthocybium solanderi
	Little tunny	Euthynnus alletteratus
	Albacore	Thunnus alalunga
	Yellowfin tuna	T. albacares
	Bigeye tuna	T. obesus
	Bluefin tuna	T. thynnus
	Unidentified tuna	
Xiphiidae	Swordfish	Xiphias gladius
Istiophoridae	Blue marlin	Makaira nigricans
	White marlin	Tetrapturus albidus
	Unidentified marlin	
Molidae	Ocean sunfish	Mola mola

Miscellaneous catch: Atlantic loggerhead turtle, unidentified turtles, "haka"

*Data from all sources.

32

National Wildlife Federation

1412 16TH ST., N.W., WASHINGTON, D.C. 20036 202—797-6800

August 31, 1979

Mr. T.A. Wastler
Chief, Marine Protection Branch (WH-548)
Environmental Protection Agency
401 M Street, S.W.
Washington, D.C. 20460

Re: NWF Comments on DEIS for 106-Mile Ocean Waste Site Designation

Dear Mr. Wastler:

Attached are the National Wildlife Federation's ("NWF") formal comments in response to the subject Draft Environmental Impact Statement. The substance of these comments coincides closely with that of NWF's statement at the August 21, 1979, public hearing in Trenton, N.J. The present comments provide additional details and make several new points not raised in Trenton, however.

The thrust of our reaction to the DEIS is that it does a very poor job of conveying useful information. We do not, however, oppose formal designation of the 106-Site for continued use (provided adequate justification for such designation is presented in the Final EIS). Since the EIS for the 106-Site will inevitably be used as a model by IEC and others in preparing Site Designation EIS's for the dozens of remaining dumpsites still to be studied, we are particularly anxious to ensure that the present EIS is worthy of emulation.

I trust that the Final EIS will address (and resolve) all of the various concerns raised in the attached comments and in the appended Exhibits.

Sincerely,

Kenneth S. Kamlet

Kenneth S. Kamlet
Counsel, and Assistant
Director for Pollution
and Toxic Substances

Attachments

cc: Dr. Peter Anderson
Dr. Thomas O'Connor

Mr. T.A. Wastler
August 31, 1979
Page Two

cc: Dr. P. Kilho Park
Paul Birmingham, Esq.
Mr. Bill Mansfield
Dr. William Dunstan
Dr. Joel O'Connor

National Wildlife Federation

1412 16TH ST., N.W., WASHINGTON, D.C. 20036 202—797-6800

COMMENTS OF THE NATIONAL WILDLIFE FEDERATION ON
THE DRAFT ENVIRONMENTAL IMPACT STATEMENT FOR
106-MILE OCEAN WASTE DISPOSAL SITE DESIGNATION
JUNE 1979

The Draft Environmental Impact Statement ("DEIS") proposes the designation for continuing use of the 106-Mile Chemical Waste Disposal Site located approximately 90 n.mi. east of Cape Henlopen, Delaware. The Site has been used for ocean disposal since 1961 (p. B-1), primarily for the disposal of industrial chemical wastes. Although not mentioned in the DEIS, low-level radioactive wastes and high explosives have also historically been dumped at the Site. See, Interstate Electronics Corporation. 1973. Ocean Waste Disposal in Selected Geographic Areas. Rept. 4460CI54I. Currently, only four chemical waste dumpers continue to use the 106 Site: American Cyanamid (Linden, N.J.), E. I. duPont de Nemours & Co. (Edge Moor, Del. and Linden, N.J.), and Merck & Co. (Rahway, N.J.). Three of the four current permittees (all but duPont-Grasselli) will cease ocean disposal within the next two years (p. 1-2). The other one may be allowed to continue dumping at the 106 Site beyond 1981, if it can continue to demonstrate compliance with the Ocean Dumping Criteria--including an adequate need to dump and non-availability of land-based alternatives.

The Site covers portions of the Continental Slope and Continental Rise and is very large. Water depths within the Site range from 1,500 meters in the northwest corner to approximately 2,725 meters in the southeast corner. The Site is "immense" in surface area (p. ix, fn.) and, in fact, is larger than the whole New York Bight Apex. The DEIS, however, provides no quantitative
32-1 information on the Site's surface area.

The purpose of the DEIS is to evaluate the suitability of the Site for continued use as an ocean dumpsite. The Site was approved for dumping on an interim basis in January 1977 "pending completion of baseline or trend assessment surveys and designation for continuing use or termination of use." 40 C.F.R. § 228.12(a). By the terms of the current Ocean Dumping Criteria, this interim approved status "will remain in force for a period not to exceed three years [expiring in January 1980]..., except for those sites approved for continuing use or disapproved for use by promulgation in this Part during that period of time." Id. By the terms of the Criteria, site designation "will be made based

on environmental studies of each site, regions adjacent to the site, and on historical knowledge of the impact of waste disposal on areas similar to such sites ...," with "[a]ll studies for the evaluation and potential selection of dumping sites [to] be conducted in accordance with the requirements of §§ 228.5 and 228.6." 40 C.F.R. § 228.4(b). Among the general site selection criteria, specified in § 228.5, is the requirement that "[t]he sizes of ocean disposal sites will be limited in order to localize for identification and control any immediate adverse impacts and permit the implementation of effective monitoring and surveillance programs to prevent adverse long-range impacts." 40 C.F.R. § 228.5(d). "The size, configuration, and location of any disposal site [is to] be determined as a part of the disposal site evaluation or designation study." Id. Among the specific site selection criteria prescribed by § 228.6 are: consideration of the "[f]easibility of surveillance and monitoring"; and "[e]xistence and effects of current and previous discharges and dumping in the area (including cumulative effects)." 40 C.F.R. §§ 228.6(a)(5), (a)(7).

32-2 The DEIS, unfortunately, does not adequately discuss the legal framework of the proposed action.

Our specific criticisms of the DEIS follow:

1. THE DEIS DOES NOT ADEQUATELY SYNTHESIZE, ANALYZE, AND EVALUATE THE INFORMATION PRESENTED

The National Wildlife Federation regards the DEIS as a very poor document of only the most limited value to decisionmakers and to public and interagency reviewers. In our view, it falls
32-3 far short of fulfilling the informational requirements of an EIS in general and of a site designation EIS in particular. Specifi-
32-4 cally, although the DEIS contains much descriptive information, it reflects little effort to synthesize and digest this information in a manner capable of aiding the decisionmaker or enlighten-
32-5 ing the public. For example, while the DEIS makes repeated reference to the notion that deep dumpsites make good dumpsites (see, e.g., pp. xi, 2-6, 3-1, 5-15), there is absolutely no mention or discussion of the premise that waste dispersal is preferable to waste containment as a waste management technique.
32-6 This is an issue which is the subject of wide debate in the scientific community and should have at least been touched upon in the DEIS. Similarly, although Appendix B is a compilation of information on contaminant inputs to the 106-Mile Chemical Waste Site, little of this information is integrated into the text of
32-7 the EIS, and virtually no effort is made to discuss such pertinent questions as: possible interactions of wastes dumped at the site; cumulative effects of interacting wastes; frequency of dumping in relation to persistence of particular waste constituents; total quantities dumped on a cumulative basis since the inception of dumping; how much of particular wastes the Site is capable of assimilating or accommodating under worst-case conditions, etc.

32-8 In short, given the choice between conclusory assertions and documented statements, between undigested information and careful analysis and evaluation, and between blanket generalizations and precise discussion, the DEIS seemed to always choose the less informative alternative.

2. THE DEIS'S DISCUSSION OF THE POTENTIAL ADVERSE IMPACTS OF WASTE DISPOSAL AT THE SITE IS INCOMPLETE AND INCONSISTENT

The DEIS is deficient, for example, in failing to adequately address--especially in its discussion of industrial waste dumping--
32-9 the factors which led EPA Assistant Administrator Tom Jorling at the Toms River hearing in 1978 to reject the designation of the 106 Site for sewage sludge disposal. Many of these factors are equally applicable to many of the industrial wastes presently and potentially dumped at the 106 Site, and should have been discussed in the DEIS.

32-10 Specifically, while the EIS emphasizes the waste dispersal mechanisms said to be in operation at the 106 Site, it gives exceedingly short shrift to waste concentrating mechanisms which also operate at the Site and which could result in toxic constituents entering biological systems, potentially including human seafood, in dangerous amounts. Examples of such concentrating mechanisms--some of which are briefly alluded to in passing in scattered sections of the EIS--are:

a) Concentration of lipophilic organic waste constituents, including toxic constituents, in monomolecular surface films of oil and grease present at the 106 Site (see, EIS, pp. 2-15, 4-11, A-36, A-37).

b) Concentration of toxic metals and organic constituents by adsorption to and complexation with the massive ferric hydroxide floc formed as a result of the huge quantities of DuPont Edge Moor titanium dioxide wastes dumped at the site. This floc, dumped on the average every four days (DEIS, at B-4), is known to persist for periods of 3-4 days, making the presence of an almost continuous floc a very real possibility.

c) Concentration of toxic waste constituents and prolonged persistence of these constituents and of pathogenic microorganisms through their association with floating organic particles--especially if sewage sludge additions to the site are increased.

d) Potential bioconcentration of toxic waste constituents as a result of the known attraction of many species of fish to ocean dumping activities--a fact that the EIS itself acknowledges in other contexts (see, DEIS, at 3-23, 2-19, 4-4, 4-13, 4-26).

e) Concentration by build-up of toxic waste constituents at the seasonal or permanent thermocline--a factor implicitly discussed only in the context of sewage sludge (DEIS, at S-13).

Not only is this concern not discussed in connection with industrial wastes, but the assumption is made that trapping of constituents at the thermocline will avoid concentration of toxic wastes by preventing significant deposition on the ocean bottom. (See, DEIS, at 5-9, 5-11; xi, 2-6, 4-15, C-3).

f) Bioconcentration as a result of the vertical migration of fish (DEIS, at 2-30, A-63-A-66) and zooplankton through the thermocline--potentially bioconcentrating contaminants accumulated there.

g) Concentration as a result of current-mediated transport of contaminants in dissolved, particulate, and precipitate form to onshelf and offshelf fishery areas where bioaccumulation may occur (DEIS, at 2-10, 2-30, 3-6, 2-4, xi, 3-14, 3-16, 2-21, 2-33, 2-39, 2-3, 4-3 - 4-4, 4-27, 3-10, 2-31, 3-25, A-75).

h) Concentration and enhancement of persistence and toxicity of toxic organic constituents as a result of diminished biodegradation in the deep ocean. Could be a problem, for example, for the organophosphate pesticides dumped by American Cyanamid (DEIS, at 2-7, A-29; cf., Ch. 5).

i) Concentration as a result of the horizontal migration of fish in and out of the dumping areas (DEIS, at 2-30, A-75).

j) Concentration as a result of the gradual settling of particulates to the ocean bottom, coupled with the enhanced food-gathering capabilities of deep-sea organisms (DEIS, at B-15).

k) Possible concentration through the operation of "loop currents" similar to those in the Gulf of Mexico which may entrain hydrophobic and particle-bound contaminants and partially counteract otherwise operative dispersive tendencies. The possible role of Gulf stream eddies in such a phenomenon needs to be discussed (DEIS, at 3-3, A-5, A-7).

l) Concentration in the vicinity of important fisheries as a result of short-dumping (the frequency of which increases with increasing distance to the dumpsite) in the New York Bight and at other on-Shelf locations (DEIS, pp. 4-25, 2-10, 2-30, 3-14, 3-16, 2-21, 2-33, 2-39).

It should be noted that Assistant Administrator Jorling, in his Toms River decision, specifically concluded (p. 12) that "the feasibility of using an off-the-Shelf site for the disposal
32-11 of sewage sludge should be based on a consideration of at least six major factors: known environmental acceptability; ability to monitor impact; surveillance of dumping activities; economic burden; logistics; and the effect of utilizing such a site on the ability of dumpers to meet the December 31, 1981, deadline for

the termination of harmful sewage sludge dumping." It is incomprehensible to us that the present DEIS could undertake to consider the feasibility and suitability of the 106-Site, for either sludge or industrial chemicals, without at least attempting to address the six major factors that were central to EPA's 1978 decision--especially, since that decision appears to conflict with the present proposed action.

Similarly, the Report of the Hearing Officer at the
32-12 Toms River hearing (September 22, 1977) discusses at great length the general apprehensiveness of the scientific community knowledgeable concerning processes in deep ocean environments about the environmental impacts of "dumping wastes containing solid materials into deep ocean waters." Among the reasons cited for being wary of ocean disposal in the deep sea were: its relatively very low biological decomposition rates; its great constancy with respect to the physical-chemical environment, and the resultant sensitivity of fauna living there to small environmental changes; and the minimal opportunities to alter the course of events if deleterious effects occur in the deep sea. I append as EXHIBIT 1, pp. 75-87 of the Hearing Officer's Report as an illustration of the kinds of issues the present DEIS should have addressed, but largely failed to deal with. I append as EXHIBIT 2, a copy of the National Wildlife Federation's testimony at the Toms River Hearing, pages 3-25 of which discuss the arguments both for and against use of the 106 Site.

The Final EIS must address these concerns.

3. THE DEIS FAILS TO EVALUATE THE 106-SITE IN LIGHT OF THE PROPERTIES OF THE SPECIFIC WASTE CONSTITUENTS PRESENTLY DUMPED THERE AND IN RELATION TO THE SITE'S OVERALL CAPACITY TO ASSIMILATE OR ACCOMMODATE WASTES PRESENTLY AND POTENTIALLY DUMPED THERE

A third basic shortcoming of the DEIS is its failure to
32-13 evaluate contaminant inputs to the Site in light of the Site's capacity to receive and accommodate them. For example, although Appendix B purports to describe contaminant inputs to the Site, it contains little in the way of critical analysis and no attempt is made to integrate the contaminants data found in the Appendix into the body of the EIS. It seems to have been tacked on as a reluctant afterthought. In fact, it is impossible to properly evaluate the suitability of a site for ocean dumping without providing an in-depth evaluation of the fate and effects of dumping particular wastes at that site. (DEIS, at 2-38.) This the DEIS woefully fails to do. Although the Impact Statement tacitly assumes that the 106 Site is large enough, and individual dumping operations conducted there are segregated enough, to avoid or minimize significant interactions among different wastes dumped at the Site, this is far from self-evident

and needs to be documented in detail. Such documentation is especially necessary in light of the large volume and high frequency of ocean dumping (nearly a dump a day) taking place at the Site (DEIS, at B-4). Among other things, the Final EIS needs to discuss how far apart different wastes must be dumped in relation to how far the wastes can reasonably travel, in order to avoid undesirable waste interactions (DEIS, at 2-42, 4-7, 5-20).

32-14 The Final EIS needs to discuss the properties of all significant waste constituents expected to be dumped at the 106 Site. How toxic are they? How persistent will they be under worst-case dumpsite conditions? How susceptible are they to bioaccumulation? And so forth.

32-15 The Final EIS also needs to assess the overall assimilative capacity of the 106 Site and how close present and planned dumping practices will approach this limit--based upon worst-case assumptions. The DEIS's flat assertion that the "total assimilative capacity of the Site is unknown" (at 2-42) is an unacceptable cop-out--particularly since scientists convened by NOAA earlier this month in Crystal Mountain, Washington, were able to readily estimate what they regarded as the Site's minimum assimilative capacity.

32-16 The potential for and consequences of waste interactions at the Site and cumulative impacts must also be considered (DEIS, at 2-41, B-4; cf., at 5-15)--including possible interactions with an incineration area planned to be designated to the south of the Site (p. 3-8).

32-17 One of the most serious shortcomings of the Draft Statement's discussion of contaminant inputs to the 106 Site is its failure to discuss the toxicity of these inputs on anything approaching a worst-case basis. For example, although the DEIS itself contains data indicating that DuPont-Grasselli waste can kill half of a population of Atlantic silversides in 4 days at concentrations as low as 1 to 2 parts per million, which translates into a "limiting permissible concentration" in the range of 10 to 20 ppb (DEIS, at B-12-B-13, 5-6), the DEIS blithely accepts for discussion purposes Company bioassay results on opposum shrimp and sheepsead minnows which yielded limiting concentrations forty thousand times higher (DEIS, at B-13, B-16). The DEIS also fails to point out, in discussing these toxicity tests, that deep-sea organisms are likely to be much more sensitive to ocean-dumped toxicants than are the estuarine or nearshore organisms typically used for bioassay testing purposes. This means that the bioassays relied on in the DEIS are likely to greatly understate the potential impacts on resident organisms.

Toxicity test results are also mis-used in the discussion of the potential use of the 106 Site for sludge dumping. The

32-18 toxicity of sewage sludge, a multi-phase waste with solid and particulate components, is inappropriately compared to that of liquid industrial wastes strictly on the basis of 96-hour particulate-phase bioassays. An accurate assessment of the toxicity of ocean-dumped sewage sludge can only be obtained based on the results of 10-day solid-phase bioassays, as specified in the ocean dumping criteria--but lacking in the DEIS (at 5-16).

4. MISCELLANEOUS COMMENTS

32-19 The DEIS is inconsistent in a number of places. For example, it provides three different figures, ranging from 100 meters to 250 meters (DEIS, pp. A-9, 3-4, 5-9, 2-7), as the depth of the permanent thermocline. It also gives three different distances of the Site from shore (at least two of which are stated to be the distance to nearest land), ranging from 90 to 110 miles (DEIS, Summary Sheet, p. 1, pp. 2-4, 2-37). The Final EIS should use the closest-to-shore distance uniformly and consistently.

32-20 Another inconsistency, already alluded to, is the quite different mode of analysis of potential sludge dumping impacts at the 106 Site than of industrial waste dumping impacts at the Site. One can only assume that EPA is more interested in avoiding the appearance of inconsistency between its 1978 Toms River decision and subsequent EIS and the present EIS which reached opposite conclusions regarding the suitability of the 106 Site for sludge than it is in avoiding the inconsistent evaluation of sludge and industrial waste dumping within the same document in the present EIS.

32-21 The Draft EIS also fails to adequately consider the alternative of not redesignating the 106 Site for continued use--in light of the fact that come 1981 only one industrial dumper will still be using the 106 Site, the DuPont-Grasselli plant (DEIS, at 1-2, 2-3, 2-19). Nor does the EIS adequately explain its assertion that DuPont-Grasselli cannot develop land-based alternatives and so must be allowed to continue its ocean dumping. (DEIS, at 2-2, 1-2, B-5.) And, although we do not take the position that site designation EIS's generally need to address in detail the circumstances of individual ocean-dumpers, it does seem essential in this case, in considering the need for permanent designation of the 106 Site, for the EIS to address (in a non-conclusory way) the need for continued ocean dumping on the part of the solitary dumper known to probably want to continue using the Site beyond 1981.

32-22 Finally, the DEIS fails to adequately evaluate the suitability of the 106 Site as an ocean dumpsite in light of the requirement of the ocean dumping criteria that an important factor in evaluating a dumpsite is the feasibility of conducting

surveillance and monitoring at the Site. (DEIS, at 1-10, 2-7, 2-8, 2-9, 2-27, 2-16, 4-10). The difficulty of carrying out adequate surveillance, and particularly monitoring, at the Site (DEIS, at xii), is one of the strongest arguments against perpetuating use of that Site for ocean dumping. As was noted above, monitoring difficulties were one of the principal concerns of EPA at the Toms River hearing. The Final EIS should give greater attention to this criterion factor.

Additional comments and concerns:

(a) The Final EIS must justify the designation of an enormous dumpsite like the 106 Site--its actual surface area in square miles should be given, along with an indication of how this area compares with that of whole New York Bight--in
32-23 light of the explicit requirement of the Ocean Dumping Criteria (§ 228.5(d))--noted briefly without discussion on pp. 1-9 and 2-32 of the DEIS--that disposal site sizes "will be limited in order to localize for identification and control any immediate adverse impacts and permit the implementation of effective monitoring and surveillance programs to prevent adverse long-range impacts."

(b) The DEIS refers in several places to the "continuing need to have available for use a site of known environmental characteristics for the disposal of some wastes under emergency conditions ...." Rhett transmittal letter, p. 2 (see also, DEIS, pp. iii, 1-2). The Final EIS should discuss the intent of this statement in light of the statutory prohibition against "emergency" ocean dumping except "in an emergency to safeguard life at sea." Section 105(h); 33 U.S.C. § 1415(h).

(c) The DEIS erroneously refers to a March 1977 amendment of the MPRSA as bringing U.S. legislation into full compliance with the international Convention (p. vii). In fact, as correctly noted elsewhere in the DEIS (p. 1-9), the amendment designed to achieve conformity with the Convention was adopted in March 1974.

(d) The DEIS erroneously refers to the Corps of Engineers as holders of special ocean dumping permits (p. 1-14). The distinction between "special" and "interim" ocean dumping permits applies only to dumping under EPA as opposed to Corps of Engineer jurisdiction. (Only for international law purposes, would dumping approval for the Corps be considered "special" permits--as opposed to "general" permits.)

(e) The Final EIS should, in keeping with §§ 228.7 and 228.8, specify conditions on the future use of the 106 Site, including constraints on the dumping there of significant quantities of persistent, toxic wastes. It should indicate, in other words, what waste types the 106 Site may be suited for

and what waste types it is clearly unsuited for. For example, should the 106 Site be considered for the dumping of barge-loads of organo-arsenical wastes?

(f) The Final EIS should attempt to explain why it was deemed necessary to again consider the possibility of using the 106 Site for the dumping of sewage sludge, after EPA repeatedly rejected the idea (i) at Toms River, (ii) in a 1978 EIS on sludge dumping alternatives, and (iii) in a 1979 redesignation of the present sludge dumping site (and an alternative 60-mile area) for future sewage sludge ocean dumping.

(g) Among the DEIS's numerous undocumented assertions which require elaboration and explanation in the Final EIS are statements on the following pages: 3-6, 3-13, 3-32, 4-5, 4-18, 4-21, 4-23, 4-24, 4-25, 5-15.

(h) The DEIS fails to discuss the heavy metal content of NL Industries' ocean-dumped waste. Numerous heavy metals are present in small, but significant, concentrations. The data should be provided.

(i) The reference on p. 3-23 to "NOAA-NMFS (1972)" is not reflected in the bibliography.

(j) The index to the DEIS, on p. xx, mislabels Appendices C and D.

(k) The DEIS states (p. 3-28) that the "sport catch [of fish in the New York Bight] often equals or surpasses the commercial landings of certain species ...." In fact, a recent NOAA Workshop in New York City indicated that the recreational catch may exceed the commercial catch by a factor of 5 (check this with the NOAA New York Bight Project office). The implications of this in terms of at least short dumping impacts should be addressed. (I.e., the fact that certain areas in the Bight may be closed by the FDA to commercial shellfishing does not afford much protection to recreational fishermen.)

(l) The DEIS unjustifiably minimizes the problem of PCB contamination of sewage sludge (p. 5-4), especially where sludge particulates are concerned. A NOAA-funded study by West and Hatcher indicates that the heaviest PCB contamination of bottom sediments in the New York Bight is associated with sewage sludge dumping.

(m) Of all aspects of NWF's testimony at the Toms River hearing, the DEIS chose to cite the least pertinent (p. 5-19).

(n) The DEIS does not explain the significance of its reference (p. A-37) to dissolved and particulate aliphatic hydrocarbon levels.

5. CONCLUSION

The National Wildlife Federation does not necessarily oppose continued use of the 106 Site for certain industrial chemicals--provided such use is adequately justified. We are, however, irrevocably committed to ensuring the integrity and adequacy of the Site Designation process. The present DEIS is the first of a long series to be prepared by the Interstate
32-24 Electronics Corporation on literally dozens of ocean dumpsites all around the country. At least some of these other sites make very poor ocean dumpsites and should not be redesignated. We are concerned that the site designation EIS for the 106 Site, since it will inevitably be looked upon as a model for future site designations, be a model worthy of being imitated. The present DEIS is a poor model indeed.

In rewriting this EIS, the purposes of such documents, as articulated by a succession of Federal courts, should be kept in mind:

> "The 'detailed statement' required by §4332(2)(C) serves at least three purposes. First, it permits the court to ascertain whether the agency has made a good faith effort to take into account the values NEPA seeks to safeguard. To that end it must 'explicate fully its course of inquiry, its analysis and its reasoning.' Ely v. Velde, 451 F.2d 1130, 1139 (4th Cir. 1971); Appalachian Power Co. v. EPA, 477 F2d 495, 507 (4th Cir. 1973). See also Natural Resources Defense Council v. E.P.A., 478 F.2d 873 (1st Cir. 1973); Environmental Defense Fund v. Ruckelshaus, 142 U.S. App. D.C. 74, 439 F.2d 584 [2 ERC 1114] (1971). Second, it serves as an environmental full disclosure law, providing information which Congress thought the public should have concerning the particular environmental costs involved in a project. To that end, it 'must be written in language that is understandable to nontechnical minds and yet contain enough scientific reasoning to alert specialists to particular problems within the field of their expertise.' Environmental Defense Fund v. Corps of Engineers, 348 F.Supp. 916, 933 (W.D. Miss. 1972). It cannot be composed of statements 'too vague, too general and too conclusory.' Environmental Defense Fund v. Froehlke, 473 F.2d 346, 348 (8th Cir. 1972). Finally, and perhaps most substantively, the requirement of a detailed statement helps insure the integrity of the

> process of decision by precluding stubborn problems or serious criticism from being swept under the rug. A conclusory statement 'unsupported by empirical or experimental data, scientific authorities, or explanatory information of any kind' not only fails to crystallize issues, Natural Resources Defense Council v. Grant, 355 F.Supp. 280, 287 (E.D.N.C. 1973), but 'affords no basis for a comparison of the problems involved with the proposed project and the difficulties involved in the alternatives.' Monroe County Conservation Council v. Volpe, 472 F.2d 693, 697 (2d Cir. 1972). Moreover, where comments from responsible experts or sister agencies disclose new or conflicting data or opinions that cause concern that the agency may not have fully evaluated the project and its alternatives, these comments may not simply be ignored. There must be good faith, reasoned analysis in response."

Massachusetts v. Andrus, 12 ERC 1801, 1810-11 (1st Cir. Feb. 20, 1979).

The present Draft EIS, unfortunately, is a collection of statements which are "too vague, too general and too conclusory" and it fails to contain "enough scientific reasoning to alert specialists to particular problems within the field of their expertise."

We trust the Final EIS will do better.

EXHIBIT 1

MAR 8 1978

Public Hearing on Relocating Sewage Sludge Ocean Dumping Sites

Toms River, N.J.
May 31-June 1, 1977

Report of the Hearing Officer
(Excerpt)

September 22, 1977

points out that ocean quahogs are abundant in the area, but that their resource potential in comparison to surf clams has not been defined (E-5-6-r, p. 128).

The major economic impact associated with the use of this site is the increased cost of transportation of sewage sludge for dumping at this site. The EIS presents an extensive examination of the cost factors, including capital costs for potential fleet expansion as well as operation, maintenance and repair costs (E-5-6-r, p. 137-138). It is estimated that the total cost through 1981 would be 220-298 percent more than it is at present (E-5-6-r; p. 4), from a total cost of $78 million to $249-310 million for the period 1977 to 1981. These estimates were based on current unit costs from haulers and on projected sludge volumes.

c. Public Health and Social

Use of this site would have no significant effect on the public health and welfare of beach communities or on the quality of Long Island or New Jersey coastal waters. Floatables from this site are not expected to reach these beaches under any weather conditons, including winter storms. Potential contamination of commercial shellfish would be limited to the immediate vicinity of the dumpsite (E-5-6-r; p. 126).

106-mile site

a. Environmental

The scientific community knowledgeable concerning processes in deep ocean environments is generally apprehensive about the

environmental impacts of dumping wastes containing solid materials into deep ocean waters. At a 1971 ocean disposal conference, co-sponsored by the Woods Hole Oceanographic Institute (WHOI) and the COE, the panel on biological effects stated:

"Disposal should not occur in the deep sea, i.e., beyond the continental shelf. A fundamental reason for this suggestion is the following. The deep sea is an area where biological decomposition rates are apparently very low in comparison with other ocean regions. It is an area of great constancy with respect to the physical-chemical environment and it is thought that the fauna living there is finely tuned to small environmental changes. Thus, the fauna may be quite susceptible to large environmental perturbations such as might be expected with the introduction of dredge spoils. If deleterious effects occur in the deep sea, the opportunities to alter the course of events are minimal. We, therefore, suggest that deep sea should be off limits for disposal activities at least until other information is brought to bear which would render the possible dangers non-existent.

"A similar view was expressed at a 1974 workshop at Woods Hole, sponsored by the National Academy of sciences (NAS): Data for the evaluation of the deep sea as a disposal site are inadequate. This is due to: difficulties in conducting bioassays; slow rates of mixing and diffusion potentially resulting in anaerobic conditions; slow organic degradation; and narrow tolerance ranges for sensitive assemblages of organisms. Although the area is relatively stable

in comparison to the shelf and nearshore, the much greater scientific uncertainty, and consequently increased risk associated with off-shelf disposal, dictate that any but the most innocuous use of the area should be approached with extreme caution" (E-5-6-r, p. 65-66).

The National Oceanic and Atmospheric Administration (NOAA) has also expressed opposition to moving dumpers to the 106-mile site without knowledge of the impacts at the 106-mile site (HR, 125). NOAA points out that, in comparison to shelf waters:

"...the environmental effects of disposal in deeper waters are correspondingly more difficult to measure, and hence, to predict. This is due to factors such as the greater depths of water and distances from shore, involving cumbersome sampling techniques in many instances and problems in geographic positions, and also to the general paucity of environmental and biological information in the off-the-shore areas.

"In the case of DWD-106 this situation is further complicated by the interaction of major water masses, Shelf Water, Slope Water and Gulf Stream Eddies.

"The DWD-106 is, therefore, an exceedingly complex oceanographic area in which to assess environmental conditions and external impact upon those conditions." (HR, 132-133)

Dr. Carol Lichfield, a marine microbiologist, expressed concern about the survival in the deep ocean of micro-organisms contained in sewage sludge:

"Unfortunately, there is very little information on the survival of coliforms in deeper waters.

"It has been shown, however, that decreased temperatures aid the survival of coliform bacteria in the increased salinities and slightly increased pressures that they would encounter at the deeper dump site, therefore, automatically assuming that deeper waters will "take care of" potential pathogens more efficiently than that which occurs at the present location, could lead to a very false sense of security." (HR. 355)

The statement of the National Wildlife Federation (NWF) includes as exhibits statements and published articles of a number of highly respected marine scientists who have made significant scientific contributions to our understanding of deep ocean environments (E-11-16, p. 829-687). The NWF statement summarizes its concerns about the environmental impact of deep ocean dumping in this fashion.

"As little as we know about the marine environment for nearshore continental shelf areas, and the fate and effects of pollutants in it, we know even less for deep ocean areas off the edge of the continental shelf.

"For example:

(a) Sewage sludge organic matter may have a totally different behavior off than on the continental shelf--to the extent such organic matter finds its way into water below a few hundred feet from the surface, there is good reason to expect its rate of biodegradation to be greatly diminished.

The possible consequences of such a reduction in microbial decompostion rates are unknown. Extensive studies by Dr. Holger Jannasch and his associates at Woods Hole (see, Exhibits A-1 - A-4) have consistently demonstrated that the in situ microbial response to enrichment of deep sea water and sediments with various organic substrates was between one to three orders of magnitude lower than in the controls, (Exhibits A-3, p. 675) that the use of the deep sea as a dumping site for organic wastes is "very

inefficient" as a means of either disposing of or recycling these wastes, as well as being an approach resulting in the "rather uncontrollable" accumulation of waste materials or decomposition products on the ocean bottom.

Jannasch has also expressed the view (Exhibit A-2) - that "in the deep sea, organic wastes... could accumulate for years and years and then float up undecayed" to contaminate seas and beaches. Conversely, as expressed by Dr. Bumps of Woods Hole (see Exhibits B-4 and C-5), "There is the possibility of creating anaerobic deep sea environments from the dumping of organic materials, "depending "on the rate of introduction of organic materials and the strength of the advective processes," as well as on the rates of biodegradation.

(b) Deep sea marine organisms may be far more sensitive to ocean dumping impacts than their nearer shore counterparts--As noted by Dr. Howard Sanders of the Woods Hole Oceanographic Institution, (See, Exhibit C-1, p. 3), the ocean floor below the thermocline is "a region of remarkable stability" in which '(t)emperature, salinity, oxygen conditions, and other factors in contrast to shallower waters are essentially unvarying and have changed little over many thousand and even millions of years.'

"Under these "conditions of constancy and predictability over geological long periods of time there have evolved in the deep sea a delicately attunned, highly sensitive assemblage of organisms with a very narrow range of tolerances," which "can be expected to be most fragile". "As a consequence, a perturbation or stress

that might have little significance in the variable and less predictable shallow waters could have severe and perhaps catastropic implications in the deep sea."

This concern is shared by Dr. P.H. Wiebe of Woods Hole (Exhibit B-1, p. 1-5), although he acknowledges that "we don't (really) know that deep sea populations are fragile."

(c) The artificial transport of heavy metals and other undesirable sludge constituents into the open ocean off the edge of the shelf through ocean dumping constitutes a new major source of such constituents in these wastes, the consequences of which are unknown.

As pointed out by Dr. Ralph Vaccaro (Exhibit, B-2), "the heavy metal load transported into marine coastal areas by rivers and streams is quickly precipitated out of the column, becomes bound to the sediments and is effectively excluded from the ocean realm," making atmospheric "fall-out" the only major natural pathway for the deposition of many heavy metals in the open ocean.

The direct introduction of such metals and other chemicals, as well as of microorganisms, into this environment as a result of ocean dumping could have severe and perhaps catastrophic consequences.

(d) Sludge particles and associated contaminants could become entrained in the Gulf Stream (which impinges on the 106-mile site) and be transported to fishing grounds as far away as Newfoundland.

"(e) The nature and effects of possible interactions between sewage sludge and the various toxic chemicals presently dumped at the 106-mile site are essentially unknown." (HR, 290-294)

It should be noted, however, that in the proceedings leading to the moving of Camden to the 106-mile site, ten affidavits by EPA and FDA staff members recommended moving Camden from the Philadelphia site to the 106-mile site. These affidavits were based on the presence of fecal micro-organisms in the Camden sludge which might possibly affect shellfisheries and beaches and on the presumed greater opportunities for dilution and dispersion at the 106-mile site (E-6-7-a). None of these affidavits addressed the questions of survival of pathogens in the deep ocean, the lower rates of decomposition of materials in deep ocean environments, and the possibility of severe damage to biota accustomed to a very stable environment, which are the major concerns expressed by the marine scientists familiar with deep ocean environments.

It can be concluded from these statements that there is agreement among experienced marine scientists that deep ocean disposal of wastes, particularly wastes containing solid materials, has the potential for causing severe environmental impacts. The types of impacts that could occur could result in subtle, long-range adverse effects which might not be detectable until trends leading to severe irreversible damage had already begun. The dumping of sewage sludge at the 106-mile site would, therefore, be regarded as having high potential for causing severe, if unknown, adverse environmental impacts.

b. Economic

There are no known shellfisheries in the area of this site. However, certain wind conditions in the area could cause waste materials to drift onto the upper slope, where the developing red crab fishery would be active or even to the outer shelf where there are several seasonally active fisheries (flounder, porgy, butterfish, lobster by U.S. fishermen) (E-19-11, p. 63). There is, therefore, a potential adverse economic impact associated with the use of this site, although it is not quantifiable at the present time. The National Fisheries Institute has expressed opposition to moving dumpsites from their present locations because of increased contaminantion of other areas (S-49).

The greatest economic impact of moving sludge dumping to the 106-mile site would be in the added cost of transporting the sludge to the 106-mile site for dumping. To do this would require the addition of carrying capacity in the New York Metropolitan Area, primarily by the City of New York (HR, 243-246). There is some disagreement as to what would be the most economical way to accomplish this (HR, 247-249; 256-257) and the basis on which the estimates made by the City of New York were made. Supplementary information supplied for the record indicated an annual cost of $19,200,000 per year if no constraints were placed on the rate of discharge (E-15-15). These figures are based on amortizing the new carrying capacity over a four-year period; without this, the

total annual cost is estimated at $17,200,000. The basis on which the operating costs are estimated is consistent with the figures used by EPA Region II in estimating overall costs for barging to the 106-mile site (E-5-6-r; p. 68-69).

The cost of moving all New York Metropolitan area sludge dumping to the 106-mile site is estimated by EPA Region II at between $35.0 million and 43.8 million dollars annually, as opposed to the present $5.4 million, assuming a constant sludge volume between now and 1981 (E-5-6-r, p. 70). This estimate does not include the cost of monitoring the site or the cost of Coast Guard surveillance of dumping.

The City of Philadelphia has estimated its costs for moving to the 106-mile site at $5,210,650 over a 3.5-year period. This is an annual average cost of $1,490,000 (E-16-26). These are based on estimates provided by their present hauling contractor.

Moving sludge dumping to the 106-mile site would also have an economic impact on the cost of surveillance of dumping operations. The Coast Guard has stated that surveillance would have to be done by shiprider until their automated surveillance system becomes operational, and that this will require the use of additional personnel, with added costs for salaries and training. No estimate is available as to what these costs might be (HR, 180-193).

To develop and implement an effective monitoring program at the 106-mile site would have a significant economic impact. No information is available as to what this would be, but typical baseline cruises cost $200,000-$300,000 each, based on EPA and NOAA costs. If four seasonal cruises were regarded as an adequate monitoring program, the total cost would be about $1,000,000 per year. It should be noted, however, that baseline cruises of this nature would not be capable of detecting the types of environmental effects which have been indicated to be of importance by responsible marine scientists, as indicated in the previous section (HR, 297-198).

In summary, the available information indicates that the total additional economic burden of moving sludge dumping to the 106-mile site would be well in excess of $30 million per year. The bulk of this cost would be borne by the communities now dumping sludge. Several municipalities pointed out the difficulties they might have in obtaining the additional funds necessary to barge to the 106-mile site as well as implement alternatives by 1981 (HR, 245-246, 254-255, 448-449, 493). The NWE comments that any significant increment between now and the end of 1981 in the cost of sewage sludge disposal could as easily discourage as encourage the expedited phase-out of sludge dumping if it had the effect of diverting into continued ocean dumping limited funds which would otherwise be available to implement a dumping phase-out (HR, 278).

c. Public Health

It is unlikely that sludge dumping at the 106-mile site would have any conceivable impact on shorelines and beaches. Concern was expressed, however, concerning the increased frequency of short dumping expected to be attendant upon a move of sludge dumping to the 106-mile site, as a result of adverse weather conditions and possibly willful misconduct by haulers (HR, 304-306, 492; E-5-6-r, p. 70). The probability of such occurrences has not been estimated. Since, however, the barge paths would cross highly productive shellfish areas on the continental shelf, any short dumping could result in contamination of shellfish by pathogens. Unless these corridors were closed to shellfishing by the FDA, there could be contamination of some shellfish from time to time, and the concomitant risk of harvesting them. The results of the EPA Region III studies at the Philadelphia dumpsite suggest that fecal micro-organisms can persist in the marine environment for long enough periods of time to move great distances (E-18-7, p. 161-165). If this is the case, then there could be a hazard to public health of unknown proportions from short dumping en route to the 106-mile site.

d. Social

Concern has been expressed in several statements about the general public reaction of moving sludge dumping from the present sites to the 106-mile site. These concerns are based on the belief

that there may be an "out of sight - out of mind" reaction (HR 16, 37; S-49). It is also felt that moving sludge dumping to the 106-mile site — uld increase pressure to permit an indefinite continuation of ocean dumping (HR, 37, 287-289). The difficulty of detecting adverse impacts at this site as well as reduced public concern are cited as reasons that this may occur.

Summary

60-mile site

Some environmental damage to the site would be expected, but it is unlikely that there would be significant adverse effects on commercial fisheries, shorelines or beaches. There would be a significant adverse economic impact in that the cost of barging to this site would be about $8 million per year more than costs for barging to the present site.

106-mile site

There is agreement among knowledgeable marine scientists that the dumping of wastes containing solid materials, such as sewage sludge, into the deep ocean could cause severe damage to the marine environment. The primary concern is for long-range, undetectable until irreversible, adverse effects on marine biota. There is no likelihood of significant adverse effects on shorelines and beaches from dumping at this site; there is, however, some possibility of adverse impact on Continental Slope and Shelf fisheries, and

National Wildlife Federation

1412 16TH ST., N.W., WASHINGTON, D.C. 20036 Phone 202—797-6800

EXHIBIT 2

STATEMENT OF KENNETH S. KAMLET
ON BEHALF OF THE NATIONAL WILDLIFE FEDERATION
AT PUBLIC HEARING BEFORE THE U.S. ENVIRONMENTAL PROTECTION AGENCY
ON THE DESIRABILITY OF RELOCATING OCEAN DUMPSITES
FOR THE DISPOSAL OF MUNICIPAL SEWAGE SLUDGE,
TOMS RIVER, NEW JERSEY,
MAY 31 - JUNE 1, 1977

INDEX

Text of Statement	Pages
I. Introduction	1-2
II. Basic Assumptions	2
III. Arguments in Support of Relocation to the 106 Site	
1. MPRSA requires off-Shelf dumping, wherever feasible	3
2. Greater productivity and density of marine life on the Shelf	4
3. Will permit restoration of commercial shellfishing at sites closed by FDA	5
4. Will increase cost of ocean dumping and provide dumpers with incentive to expedite land-based alternatives	7
5. Will help avoid future fishkills and beach closings	9
6. Will, in the Philadelphia case, reduce human health impacts associated with shellfish contamination	12
7. Ocean dumping criteria require relocation because of "Category I" impacts at present sites	13
IV. Arguments Against Relocation of the 106 Site	
1. Will appreciably increase the risk that current phaseout deadlines will not be met	14
2. Will result in unknown and possibly serious environmental consequences	15
3. Will preclude monitoring and corrective measures	20
4. Will increase the likelihood of undesirable short dumping	24
V. Considerations Relevant to the 60-Mile Site	26
VI. Conclusions and Recommendations	27
Footnotes	
List of Exhibits	
Exhibits	

STATEMENT

Introduction

My name is Kenneth S. Kamlet. I am counsel to (and also a biologist with) the National Wildlife Federation ("NWF"), which is by far the nation's largest private conservation organization. The Federation's longstanding efforts to strengthen federal regulation of ocean dumping practices, and to promote the phase-out of harmful or potentially harmful ocean dumping in favor of suitable land-based alternatives, are well-known. We are here today to comment on the desirability of relocating two sewage sludge ocean dumpsites, which together contribute some 4.1 million wet tons per year of sludge and associated contaminants to coastal waters located off the shores of Maryland and Delaware in the case of the Philadelphia site, and of New Jersey and New York in the case of the New York Bight Site. The two present sites are located 40 miles and 11 miles offshore, respectively. The primary candidates for use as alternative sites are the so-called "60 mile site," located about 33 miles south of Long Island, and the so-called "106-mile site," located about 90 miles due east of Cape Henlopen, Delaware.

In a nutshell, for the reasons discussed below, NWF recommends against any change in sludge dumping locations under present conditions.

The May 6, 1977 Federal Register notice (42 Fed.Reg. 23164-65) which announced the holding of these hearings, listed five questions as to which EPA was interested in receiving comment and quantitative information. The notice also solicited comments on the relative advantages and disadvantages of sewage sludge dumping at each of the

existing and candidate sites, in light of the eleven evaluation factors listed in § 228.6(a) of the revised ocean dumping criteria. We will touch on and discuss several of these questions and factors on the comments which follow, but will approach the matter from a somewhat different conceptual framework, since we don't believe that selection of an alternative site in which to relocate existing dumping activities should be treated the same as initial site selection for a brand-new ocean dumping activity or that the choice of a site for interim use for 3 or 4 years pending a dumping phase-out should be treated the same as selection of a site for use over much longer periods.

Basic Assumptions

The analysis which follows, and our conclusion that neither sludge dumpsite should be relocated at the present time, are based upon the following basic assumptions:

1) That the sewage sludge under consideration does not and cannot (in the foreseeable future) meet the ocean dumping criteria and is, in fact, harmful to the marine environment, and that, therefore, its continued ocean dumping is undesirable;

2) That the deadlines currently in force for the termination of sewage sludge ocean dumping are reasonable (if not generous) and should not be relaxed for anything short of the most dire emergency;

3) That any change in the location or conditions of sewage sludge ocean dumping which would lead or contribute to a real (or imagined) inability to meet current phase-out deadlines is undesirable;

4) That the current sewage sludge dumpsites should not be relocated unless there is a reasonable basis for believing that the potential for adverse impacts is appreciably less with use of new as opposed to old dumpsites;

5) That the ocean dumping of sewage sludge at a previously undegraded location should not be initiated absent clear and convincing evidence that abandonment of previously utilized sites will yield at least equivalent benefits; and

6) That the ocean dumping of sewage sludge should not be initiated at sites as to which the consequences of such dumping cannot be reasonably predicted and monitored.

Arguments in Support of Relocation to the 106 Site

1. The statute requires the Administrator, "wherever feasible," to designate ocean dumpsites located beyond the edge of the Continental Shelf; the two existing sludge dumpsites are on the Shelf, the 106 Site is off the edge of the Shelf.

This statutory directive appears in section 102(a)(I) of the Marine Protection, Research, and Sanctuaries Act (MPRSA"). It is reiterated in § 228.5(e) of the revised ocean dumping criteria. Whatever its basis or justification, it must be heeded as the law of the land.

Comment: The statute does not make use of off-Shelf dumpsites an absolute requirement; such sites must be used only where "feasible." It is necessary and appropriate in considering use of the 106 site (or other off-Shelf site) for sewage sludge to evaluate its "feasibility" in terms of each of the following: (a) incremental cost relative to existing practices, (b) ability to properly evaluate, monitor, and control dumping occurring at this site, and (c) effect of such a move on the ultimate phase-out of sewage sludge ocean dumping. Section 228.5(e) of the criteria, moreover, recognizes that the appropriateness of using off-Shelf dumpsites may be greater for brand-new than for existing dumping sources, in specifying that EPA "will, wherever feasible, designate ocean dumping sites beyond the edge of the continental shelf and other such sites that have been historically used." (Emphasis added).

2. The productivity and density of important marine species is far greater on the Shelf than off, with a correspondingly greater likelihood on the Shelf than off that ocean dumping will produce undesirable consequences.

A public Affairs Office brochure on the MPRSA, published by EPA in December 1972, describes the statutory encouragement of off-Shelf dumping as "a vital provision since about 90 percent of known marine life is concentrated above the Continental Shelf." Drs. Vaccaro, Grice, Rowe, and Wiebe of the Woods Hole Oceanographic Institution (Exhibit C-3) have questioned the accuracy of this statistic "as given," although they acknowledge that "it probably holds [true] for the productivity (a rate function) of economically useful marine species or for the relative concentration of biomass (biomass per unit volume) present at these diverse locations." Rachel Carson, in The Sea Around Us, described the continental shelves, "Of all the parts of the sea...[as] perhaps most directly important to man as a source of material things," pointing out for example that most of the "great fisheries of the world... are confined to the relatively shallow waters over the continental shelves." In short, it seems apparent that on-Shelf ocean dumping, all things being equal, would be more likely to encounter (and potentially adversely impact) economically important marine species on the Shelf than off it.

Comment: As has been pointed out by Vaccaro, et al. (Exhibit C-3), "Were one to integrate the entire water column [at off-Shelf locations], along with the attendant bottom, our expectation is that the quantities of biomass would not differ as markedly [relative to on-Shelf locations]" as productivity and density considerations would suggest. In terms of potential impacts on the organisms, one cannot

assume that the extent of these impacts will be determined solely on the basis of relative organism densities. As Vaccaro, et al. also point out (id.), "Even if damage is substantiated [for nearshore ocean dumping] there is no a priori certainty that transporting a particular waste further out to sea would entail a less damaging effect." Nor can one assume that all things are otherwise equal on and off the Shelf. For example, differences in organism sensitivities to sludge contaminants, differences in sludge persistence, differences in current patterns, differences in "short dumping" frequencies, and differences in the ability to track the fate and effects of ocean-dumped sludge, may all operate to offset any apparent advantage in favor of off-Shelf dumping based upon relative organism densities alone. It is important to consider organism densities, but this factor alone should not be determinative. (The problem of seafood contamination is addressed in section 6 of this part).

3. The relocation of sludge dumping from the present sites, both of which have been closed by the Food and Drug Administration to commercial shellfishing, to either the 60-mile site or the 106-site, will permit recovery of those sites and restoration of active commercial fishing.

As documented at the EPA adjudicatory hearing on ocean dumping of sewage sludge by the City of Philadelphia, the "main band" of the U.S. sea clam (also known as the "Surf Clam") "ranges from Long Island to approximately Cape Hatteras [in] a band about 20 miles wide from the coast out to approximately the 100 foot depth level." The sea clam industry, moreover, "accounts for approximately 43 percent of... all clams and cysters and mussels... harvested in the United States today," the entire industry being "virtually limited" to the area from Long Island to Cape Hatteras. 1/

Because of ocean dumping in the New York Bight, the Food and Drug Administration in 1970, closed to shellfishing a circular area of over 113 square miles in size, encompassing the sewage sludge dumpsite. Another nearly 100 square miles were added to this closure area in 1974 to encompass sources of Long Island and New Jersey sewage effluent. In December 1976, the FDA closed to shellfishing a 71-square mile area encompassing the Philadelphia dumpsite, along with another area of equal size surrounding the DuPont acid waste dumpsite. 2/

The fact that the "Delaware Bay Dump Site" formerly used for Philadelphia sewage sludge had recovered sufficiently from the effects of dumping to be reopened to shellfishing on January 1, 1975, less than 2 years after the cessation of dumping at that site (in May 1973), after having been declared off-limits to shellfishing in May 1970, 3/ gives rise to some hope that relocating the present dumpsites may allow resumption of some currently suspended shellfishing activities.

Comment: In point of fact relocation of the sludge dumpsites would yield little or no benefit to commercial shellfishermen. In the first place, the closure of the New York Bight site would remain in effect even with relocation of sludge dumping activities, due to continued discharges of shore-based sewage. In the second place, relocation of sludge dumping to the 106-site, would probably result in closure by the FDA of a new 20-mile long, 4-mile wide (i.e., 80 square mile) corridor representing the overlap between the route of barge travel from Ambrose Light to the 106-site and the distribution of commercially significant populations of the ocean quahog. 4/

Such a corridor would be establihhed to guard against seafood contamination due to short dumping enroute to the assigned dumpsite. (Relocation to the 60-mile site would be even worse, since commercially important quahog populations exist in the immediate vicinity of that site.) And, in the third place, even if sludge dumping at the Philadelphia site were halted almost immediately (i.e., it was relocated to another area), and even if recovery and reopening of the site to shellfishing could all be completed within a year to a year-and-a-half (i.e., by July to December, 1978), at best, 2 to 2-1/2 years of shellfishing use would be gained before the dumping is scheduled to be phased-out entirely anyway (i.e., by the end of 1980). So, it might be possible to reopen a 70-square mile area for 2-1/2 years; but it might be necessary in exchange to close down for up to 4-1/2 years (i.e., the period from the changeover to the end of 1981)a brand-new 80-square mile area.

4. The relocation of sludge dumping to more distant offshore dumpsites would significantly increase the cost of continued ocean dumping and would, therefore, provide an incentive to sludge dumping municipalities to accelerate and intensify their efforts to develop and implement land-based alternatives.

Table 30 and Figure 41 of the Draft Environmental Impact Statement on the Ocean Dumping of Sewage Sludge in the New York Bight (February 1976) ("DEIS"), pp. 244-45, indicate that relocating New York and New Jersey sludge dumpers from the present 11-mile site to the proposed 60-mile site would increase sludge hauling costs between 1976 and 1981 by nearly $33 million or some 69 percent. If the shift were made to the 106-mile site, sludge hauling costs by commercial barges or tankers would not significantly increase

(according to the DEIS) beyond the incremental cost of moving out to the 60-mile site. The cost for New York City tankers to move out to the 106-site would be about double that of moving to the 60-mile site. Westchester County barges would not be cost-effective at any distance beyond the existing dump site. Since ocean dumping as currently practiced is significantly less costly than land-based alternatives (see,e.g., DEIS Table 31, p. 252), economic incentives now exist for sludge dumping municipalities to prolong the continuation of ocean dumping to the extent possible. If the costs of ocean dumping could be increased by relocating the dumpsites and increasing haul distances, the additional cost increment necessary to accomplish land treatment or disposal would be reduced or eliminated, along with the disincentive to expedite implementation of land-based alternatives.

Comment: In the first place, any significant increment between now and the end of 1981 (the deadline for completing the phase-out of sewage sludge ocean dumping) in the cost of sewage sludge disposal could as easily discourage as encourage the expedited phase-out of sludge dumping, if it had the effect of diverting into continued ocean dumping limited funds which would otherwise be available to implement a dumping phase-out. In the second place, if the cost increment for relocating the dumpsite were not substantial enough to jeopardize the implementation of land-based alternatives, chances are they would also not be substantial enough to provide much if any incentive to accelerate a dumping phase-out. In fact, a total (maximum) cost increment of $5 or $6 million a year--$33 million

divided by six years, see DEIS Table 30--for 4 million (present) or even 8 million (projected for 1981) wet tons of sewage sludge (which would correspond, based on a solids content of 5%, to 200,000 to 400,000 dry tons per year), would give rise to a maximum annual cost increment of $30 per dry ton. While this might make land-based disposal attractive for at least some bargers relative to incineration, pyrolysis, or drying and sale, it would not add significantly to the economic attractiveness of land application, and for some bargers would still leave ocean dumping as the most cost-effective alternative. See, DEIS Table 31, p. 252. Indeed, if the "mother-ship" or large tanker approach advocated by some proves feasible, the incremental cost of sludge hauling to a more distant ocean dumpsite could be substantially less than $30 per dry ton. This would further reduce any spur to accelerate the implementation of land-based alternatives.

5. The relocation of sludge dumping to more distant offshore dumpsites would reduce the risk of repetition of the conditions which led to beach closings in New York and fish kills off New Jersey last summer.

It is a commonly held popular view in New York and New Jersey that the beach closing and fish kill incidents of last summer were attributable to the ocean dumping of sewage sludge at the 11-mile New York Bight site. To the extent that this belief has a factual foundation, the further offshore one can move the dumping, the better, and the less likely will be a repetition of last summer's unfortunate occurrences. Even if sludge dumping did not cause last summer's fish kills and beach foulings, it could do so in the future,

particularly as the quantity of sewage sludge ocean-dumped doubles between now and 1981. So, whether it is regarded as a remedial or merely a precautionary measure, it makes sense to move sludge dumping activities as far from the coastline as possible.

Comment: The various investigative bodies which have looked into the causes of last summer's incidents, uniformly regard factors other than sludge dumping as the primary if not sole factors responsible for these incidents. For example, a National Science Foundation workshop held in October 1976, 5/ concluded that "the anoxic (low oxygen) condition that existed during the summer and fall of 1976 [and which was responsible for the reported fish kills] was the combined result of meteorological conditions, shelf water circulation, and the degradation of organic matter, including an extensive algal bloom." (p. ix). In terms of organic matter degradation, the evidence presented to the workshop indicated (pp. 68-69) that ocean-dumped sewage sludge could account for less than 6 percent of the organic carbon inputs and less than 11 percent of the nutrient inputs with phytoplankton production contributing far more than both sludge dumping and estuarine input. The oxygen demand associated with these sludge inputs makes up a far smaller proportion of the total. While "a prudent person would assume that urban waste and runoff had some significant effect" (p. 81), the contribution of ocean-dumped sewage sludge seems quite small.

An October 1976 report by the New Jersey Department of Environmental Protection 6/ concluded that "the overwhelming proportion of the shore pollution [associated with dead fish washing ashore in

connection with the fish kill incident] was associated with the algal bloom and decay process," and that the "black tide" alleged by some to be sewage sludge was, in fact, decaying algae. A rough estimation of annual nitrogen loadings in New Jersey coastal waters (Table 1, p. 13) attributed only 8 percent of the total to sewage sludge.

Finally, a February 1977 report on the Long Island beach closing incidents 7/ by NOAA's MESA ("Marine Ecosystems Analysis") program, concluded that the floating litter that inundated Long Island's south shore beaches in June 1976 could have come from a variety of sources (pp. 54-55), but that the sewage sludge dump site must be considered a "relatively minor" source of floatables (p. 55). In terms of oil and grease contributed to the New York Bight, for example, sewage sludge contributes only 2.6 percent of the total (p. 38).

Whether or not the 50-year practice of dumping sewage sludge has produced a stable distribution pattern of sludge-associated bottom muds, it is no longer being contended that ocean-dumped sewage sludge is steadily creeping toward New York's beaches. 8/

Thus, there would appear to be no compelling short-term need, based upon prevention of future beach fouling and fishkill incidents, to require a sudden relocation of sludge dumping activities to sites located further offshore--particularly, if such a step would in any way compromise efforts to totally eliminate the practice of sewage sludge ocean dumping within the next 4-1/2 years. If, as the quantities of sludge increase over the next several years, the complicity of sludge dumping becomes more significant, it may be appropriate to re-evaluate the relocation of such dumping activities. But, that time has not yet arrived.

6. The relocation of sludge dumping by the City of Philadelphia to more distant offshore dumpsites would reduce the risks to human health of shellfish contamination by sludge-associated micro-organisms in fisheries in the vicinity of the present dumpsite.

EPA Region III has amassed data demonstrating incipient bacterial contamination of shellfish and the beginnings of detectable bottom accumulations of sludge (within which the viability of harmful micro-organisms might be increased) in the vicinity of the Philadelphia sludge dumpsite. Although fecal contamination of shellfish has apparently not yet progressed to the point that a serious public health threat presently exists, continued ocean dumping at the 40-mile site could well give rise to such a threat between now and the scheduled cessation of Philadelphia's dumping 3-1/2 years from now. Inasmuch as it could take a year or more to implement a decision to relocate the dumpsite, and in view of the potential public health threat, procedures to relocate the Philadelphia dumpsite should be initiated immediately.

Comment: The possibility of human food chain contamination as a result of continued sludge dumping at the Philadelphia site is the most compelling argument in favor of relocation, at least for this one site. (In the case of the New York Bight site, the New York Bight apex is already so badly contaminated, not only as result of sludge dumping, but because of other dumping and discharge activities, that edible shellfish populations are few and far between in this part of the Bight, and even those that are present would likely be unfit for human consumption even if sludge dumping were moved off the Shelf). However, there is a better way to minimize the food chain risk than simply to transfer the dumping from one place to another; namely, to take steps to reduce the microorganism content of the sludge, with resort being made to a dumpsite shift only if these steps fail to bring the contamination problem under control. We understand that efforts

are currently underway to reduce the microorganism levels of Philadelphia sludge through modifications in the digestion process, as well as through aging of the sludge. While we would support and encourage immediate efforts to lay the groundwork for a possible later dumpsite relocation (if that were to prove necessary) we are not persuaded that a final decision to relocate should be made at this time.

7. The ocean dumping criteria require relocation of the current sewage sludge ocean dumpsites by virtue of "Category I" impacts observed at these dumpsites.

Section 228.11(c) of the revised ocean dumping criteria requires the EPA Administrator to place necessary limitations on the use of dumpsites which display Category I impacts, so as to reduce the impacts to acceptable levels. Both the 11-mile site and the 40-mile site appear to show Category I impacts, based upon conditions (i), (ii), and (v) of § 228.10(c) of the criteria. Short of a total dumping phase-out (not possible immediately), the only practicable measure capable of reducing impacts at these sites to acceptable levels is dumpsite relocation.

Comment: In the case of the 11-mile site, relocation of sludge dumping cannot reasonably be expected to restore the environment to an acceptable condition, as long as dredge spoil and other dumping continue nearby, and as long as inadequately treated sewage wastewater continues to pour into the New York Bight from land-based outfalls. Substantial upgrading of sewage treatment in New York and New Jersey at about the time of the scheduled sludge dumping phase-out, will hopefully make cessation of sludge dumping in the Bight meaningful

(in terms of yielding visible improvement in the condition of the Bight) by the end of 1981. Mere relocation now won't do much good in the Bight, and may merely relocate some of the harm from one site to another. As far as the Philadelphia dumpsite is concerned, relocation of sludge dumping to another area might improve conditions in the present dumpsite area for an extra couple of years, but at the expense of the alternative dumpsite. If microbial contamination of edible shellfish is the primary documentable concern, efforts to reduce such impacts by reducing the microbial contamination would seem the more reasonable approach. If these efforts were unsuccessful, relocation might then be appropriate.

Arguments Against Relocation to the 106 Site

1. A shift from the present dumpsites, at which harm to the environment can be documented, to sites further offshore at which such harm may be more difficult to detect and demonstrate, may appreciably increase the risk that current phaseout deadlines will not be met.

Although the present sludge dumpers are subject to phase-out deadlines and implementation schedules as part of their ocean dumping permits, and although the revised ocean dumping regulations (§ 220.3(d)) specify an essentially rigid end-of-1981 phase-out deadline for sludge which fails to meet the criteria, a relocation of sludge dumping to the 106-site may well increase the pressure to modify these requirements, and/or undercut EPA's ability (and perhaps desire) to strictly enforce them. This is so for two reasons, one practical, one legal: first, if the sludge is moved out of the "backyard" of the coastal states from New York to Maryland, much of the political and

public pressure and support for a rapid phase-out of ocean dumping may evaporate; second, and even more critically, a shift to the 106-site may greatly increase the difficulty of detecting and demonstrating harm to the marine environment as a result of continued ocean dumping. This in turn could increase a federal judge's reluctance to order a recalcitrant sludge dumper to adhere to the terms of its phase-out schedule. It certainly could increase the inclination of such dumpers to be recalcitrant and to gamble on the unwillingness of a court to enforce an EPA phase-out order under conditions of uncertain environmental consequences. (A shift to more costly alternative sites might also deplete the funds otherwise available to expedite the implementation of land-based alternatives). A significant risk of slippage in existing phase-out deadlines is more than ample justification for rejecting a dumpsite relocation of uncertain need and of unknown consequences.

Comment: EPA would contend that it intends to adhere firmly to existing deadlines, regardless of the location of dumping, and that a federal judge could and would enforce existing administrative requirements, without regard to the ability to demonstrate specific ocean dumping impacts. Perhaps, but perhaps not.

2. The consequences of relocating current sludge dumping practices to the 106-site are largely, if not totally, unknown.

As little as we know about the marine environment for near-shore continental shelf areas, and the fate and effects of pollutants

in it, we know even less for deep ocean areas off the edge of the continental shelf. For example;

(a) Sewage sludge organic matter may have a totally different behavior off than on the continental shelf--to the extent such organic matter finds its way into water below a few hundred feet from the surface, there is good reason to expect its rate of biodegradation to be greatly diminished. The possible consequences of such a reduction in microbial decomposition rates are unknown. Extensive studies by Dr. Holger Jannasch and his associates at Woods Hole (see, Exhibits A-1 - A-4) have consistently demonstrated that "the in situ microbial response to enrichment of deep-sea water and sediments with various organic substrates was between one to three orders of magnitude lower than in the controls." (Exhibit A-3, p. 642). This led Jannasch, et al. to conclude (Exhibit A-1, p. 675) that the use of the deep sea as a dumping site for organic wastes is "very inefficient" as a means of either disposing of or recycling these wastes, as well as being an approach resulting in the "rather uncontrollable" accumulation of waste materials or decomposition products on the ocean bottom. Jannasch has also expressed the view (Exhibit A-2) that "in the deep sea, organic waste... could accumulate for years and years and then float up undecayed" to contaminate seas and beaches. Conversely, as expressed by Dr. Bumpus of Woods Hole (see, Exhibits B-4 and C-5), "There is the possibility of creating anaerobic deep sea environments from the dumping of organic materials," depending "on the rate of introduction of organic materials and the strength of the advective processes," as well as on the rates of biodegradation.

(b) Deep sea marine organisms may be far more sensitive to ocean dumping impacts than their nearer shore counterparts--As noted by Dr. Howard Sanders of the Woods Hole Oceanographic Institution. (see, Exhibit C-1, p. 3), the ocean floor below the thermocline is "a region of remarkable stability" in which "[t]emperature, salinity, oxygen conditions, and other factors in contrast to shallower waters are essentially unvarying and have changed little over many thousands and even millions of years." Under these "conditions of constancy and predictability over geologically long periods of time there have evolved in the deep sea a delicately attuned, highly sensitive assemblage of organisms with a very narrow range of tolerances," which "can be expected to be most fragile." "As a consequence, a perturbation or stress that might have little significance in the variable and less predictable shallow waters could have severe and perhaps catastrophic implications in the deep sea." This concern is shared by Dr. P.H. Wiebe of Woods Hole (Exhibit B-1, pp.1, 5), although he acknowledges that "we don't [really] know that the deep sea populations are fragile."

(c) The artificial transport of heavy metals and other undesirable sludge constituents into the open ocean off the edge of the shelf through ocean dumping constitutes a new major source of such constituents in these waters, the consequences of which are unknown. As pointed out by Dr. Ralph Vaccaro (Exhibit, B-2), "the heavy metal load transported into marine coastal areas by rivers and streams is quickly precipitated out of the water column, becomes bound to the sediments and is effectively excluded from the

oceanic realm," making atmospheric "fall-out" the only major natural pathway for the deposition of many heavy metals in the open ocean. The direct introduction of such metals and other chemicals, as well as of microorganisms, into this environment as a result of ocean dumping could have severe and perhaps catastrophic consequences.

(d) Sludge particles and associated contaminants could become entrained in the Gulf Stream (which impinges on the 106-Site) and be transported to fishing grounds as far away as Newfoundland.

(e) The nature and effects of possible interactions between sewage sludge and the various toxic chemicals presently dumped at the 106-Site are essentially unknown.

Comment: (a) As far as inhibition of biodegradation is concerned, whether or not it is relevant to ocean-dumped sewage sludge will depend on how long it takes sludge organic matter to settle to the ocean bottom. Based on a sedimentation rate for particulate organic matter of "from several weeks to more than a year per 1000 m of depth" (Exhibit A-3, p. 643), it could take quite some time for sludge to make it to the bottom of the 2,000-meter (i.e., 6,000 feet) deep 106-Site. By that time, it could have already been biodegraded. It is really impossible to say for certain whether enough sludge will penetrate sufficiently deep to make inhibition of biodegradation likely. Moreover, we can't be sure that inhibition of biodegradation, even if it occurred, really is a problem.

(b) With regard to the greater sensitivity of deep sea organisms, Drs. Vaccaro, Grice, Rowe, and Wiebe of Woods Hole (Exhibit C-3) have cautioned against "an over commitment to the Sanders' hypothesis," because "[t]he book is not yet closed on this subject." They do recognize, however, that the Sanders' hypothesis "is consistent with [the] rather static [physical] regimes... [present] at great oceanic depths."

(c) In relation to atmospheric fall-out and existing toxic chemical dumping taking place at the 106-Site, the additional heavy metals which would be introduced into the deep-ocean environment by the commencement of substantial sludge dumping may not be very significant (although the metals coming in with the toxic chemicals and the fall-out are probably largely present in soluble dilutable form, whereas the metals coming in with sludge would come in as non-soluble particulates--this could make for different fates and impacts). Of perhaps greater concern is the introduction of alien microorganisms into an environment unaccustomed to them. (The ocean dumping criteria, in § 227.7(c), reflect this concern by prohibiting the ocean dumping of "wastes containing living organisms" which would endanger human health or other organisms by extending the range of pathogens, degrading uninfected areas, or introducing viable species not indigenous to an area). The potential impacts of introducing these microorganisms are unknown. (The fact that relatively small amounts of Camden sludge will have been dumped at the 106-Site for a relatively short period prior to the initiation of intensive and extensive sludge dumping by Philadelphia and New York by no means suggests that adding these new sludge dumpers wouldn't do substantial incremental damage).

(d) and (e) Such effects are conjectural. The large size of the 106-Site and its great depth should tend to minimize the occurrence of extensive waste interactions.

3. Relocation of sludge dumping to the 106-Site would essentially deny the opportunity to monitor the situation and render it virtually impossible to alter the course of events should corrective action be necessary.

This concern has several components:

(a) Denial of the opportunity to monitor-- This is a frequently cited concern. For example, at the EPA workshop on "Evaluation of Ocean Dumping Criteria," convened at Airlie House, August 31-September 1, 1973, a group chaired by Dr. Edward D. Goldberg, and including among others, Drs. Dean F. Bumpus, Gilbert T. Rowe, and David Menzel, concluded that, although off-Shelf dumpsite locations "would be amenable to mixing of liquids, it is not possible to predict the effect and fate of solids at great depths and it would be difficult to monitor their effects" (Exhibit B-5, p. 2). Dr. Holger Jannasch (Exhibit C-2) has pointed out that "the feasibility of short-term studies [on deep-sea biodegradation] is very limited," and that, for this and other reasons, "it will probably be difficult or impossible 'to show harm'--not because there will be no harm..., [but because] [s]cientific evidence for or against such an effect will be very difficult to obtain." These limitations of relatively quick scientific evidence in offshore marine pollution bear the danger, if scientific proof is over-emphasized, that ocean dumping becomes a cheap and unrestricted practice leading to a continued waste of national resources by short-term economic considerations and taking the pressure off from

developing procedures for controlled waste recycling." (Id.) Drs. Vaccaro, Grice, Rowe, and Wiebe (Exhibit C-3) have suggested, in addition, that "an increased number of dump sites especially in the deep ocean is not necessarily a responsible alternative at this time," because "[a]s additional sites are created surveillance problems also increase proportionately." [Note: in our case, since the 106-Site is an existing site, any increased "surveillance" problems would have to do with the possibly greater difficulty of conducting surveillance at sites increasingly distant from shore]. See, also Exhibits B-2, B-3, and C-2, for the views of Drs. Vaccaro, Bumpus, and Jannasch. The greater expense and difficulty of deep-sea than of nearer-shore monitoring surveys is another factor to consider, although less insurmountable (see, Exhibit D) than the inherent difficulty of detecting pollutant fates and effects under deep-sea conditions. For example, it is obviously a lot easier to coordinate survey efforts with dumping activities and weather conditions at near-shore sites than at sites further from shore. Moreover, previous use of the 106-Site for the dumping of undetonated explosives, may make bottom-sampling at that location not only difficult but potentially dangerous.

(b) Inability to take corrective action-- Vaccaro, et al. (Exhibit C-3) make the argument that "highly toxic wastes, not readily attenuated, should be restricted to point sources favoring deposition within a restricted area of the sea bottom..., because [f]or a shallow water column such a procedure facilitates corrective action should it become necessary to contend with an unforeseen emergency..., [whereas] [c]onversely, less toxic substances, such as

rich organic concentrates, which ultimately respond to biological degradation, are more logical candidates for dispersal whereby the environmental consequences are effectively diminished by maximum dilution." The heavily contaminated urban sludges being considered for relocation to the 106-Site must be regarded as toxic substances, as to which ocean dumping practices should be "containment" rather than "dispersal" oriented. [Even if they were deemed "rich organic concentrates," however, and as such appropriate candidates for dispersal, it makes no sense to disperse them off the Shelf where biodegradation may be inhibited than to do so in shallower, nearer-shore waters]. The EPA adjudicatory hearing on Philadelphia sewage sludge likewise concluded that containment rather than dispersal should be the objective for ocean dumping of dirty sludges like Philadelphia's. See, also Exhibits B-1 and B-2 for the similar views of Drs. Wiebe, et al., and Dr. Vaccaro. Dr. Bumpus (Exhibit B-4) makes the further salient point that "Lack of data prevents adequate control." We simply have far less data regarding deep-sea phenomena than we do concerning events taking place closer to shore.

(c) Limited relevance of the ocean dumping criteria to deep-sea dumping-- Dr. Bumpus (Exhibit B-4) has pointed out that "There is tremendous difficulty in completing bioassays with deep sea material." Although the ocean dumping criteria have rejected the suggestion of Vaccaro, et al. (Exhibit C-3),and others,that "insofar as possible, the bioassay organisms should be chosen from organisms typical of the proposed dump sites," they do rely heavily

for waste screening on the use of bioassay tests, and they do mandate the use of "appropriate sensitive" marine organisms for testing purposes (see, e.g., § 227.27). Thus, given the differing sensitivities and physiologies (see, Exhibit C-6) of deep-sea than of near shore organisms, given the dependence of the criteria on bioassays, and given the inability to perform such bioassays on deep-sea organisms, the current ocean dumping criteria must be regarded as far less useful for characterizing wastes proposed for off-Shelf than for on-Shelf ocean-dumping. This only heightens the concern that we lack the ability to adequately predict and evaluate the consequences of off-Shelf ocean dumping of sewage sludge.

(d) Interferences from other wastes already at the 106-Site--Vaccaro, et al. (Exhibit C-3) have endorsed the notion that classes of wastes should be assigned to the most logical ocean disposal sites, and that different waste types should be kept separate "to minimize interference effects associated with complex waste mixtures." Combination of sewage sludge with the many diverse toxic chemicals already being dumped at the 106-Site can only serve to complicate monitoring problems.

Comments: (a) If we were sure that dumping off-the-Shelf would not delay complete phase-out and we were sure that off-Shelf dumping caused less harm than present dumping practices, it probably wouldn't matter much if a move off the Shelf impeded monitoring--provided, however, that sufficient surveillance were conducted to minimize the occurrence of short-dumping. In fact, such a move might actually increase surveillance by Coast Guard shipriders, since the Coast Guard assigns greater priority to surveillance of dumping at the 106-Site than to dumping at either of the current sludge dumpsites.

(b) It is a lot more difficult to take corrective measures for wastes in the ocean--even when contained in nearshore waters--than for wastes on land. The incremental difficulty of taking such measures at the 106-Site than at the 11-mile site, or particularly at the 40-mile site, may have little practical significance.

(c) True, but relevant only if we're not sure that a move to the 106-Site won't delay phase-out and won't cause any more harm than present practices.

(d) The potential for interaction and interference is no greater at the 106-Site than at the present 11-mile site, given the density and diversity of dumping and other polluting activities in the New York Bight. The concern may be more valid at the Philadelphia dumpsite, particularly now that DuPont is no longer dumping acid wastes nearby.

4. Relocation of sludge dumping to the 106-Site would substantially increase the likelihood of short-dumping and attendant undesirable consequences.

The practice of waste dumping short of assigned ocean disposal sites is well-known if not widespread. One or two such incidents are detected each year in connection with the Philadelphia dumpsite, and short-dumping probably occurs in connection with the 11-mile dumpsite as well. Some short-dumping is willful and represents an effort by waste haulers to save time and money. In other instances it is regarded as necessary to preserve ship and crew, where unexpected adverse weather conditions arise at sea.

If sludge dumping is relocated to the 106-mile site, the frequency of short dumping will inevitably increase substantially. Even with adequate surveillance by ship-riders and absent willful misconduct, it is clear that unexpected bad weather and the need for "emergency" short dumping will be a bigger problem the more the haul distance increases. The consequences of this, in addition to the probable need for closure of additional shellfish grounds, will be the periodic introduction of a variety of contaminants into a number of hitherto relatively uncontaminated areas.

Comment: The incremental haul distance for Philadelphia is not nearly as great as for New York, and intervening shellfish resources are far less substantial. Also, the frequency of "emergency" short-dumps and the impacts of such dumping are uncertain, where areas other than shellfish grounds are impacted. EPA should develop estimates of the number and frequency of new barge trips to the 106-site which would result from relocated sludge dumping. These estimates should be compared with similar estimates for existing barging activities in the 106-site, to provide a better feel for the expected degree of increase in existing barge traffic levels. Assuming that reliable estimates can be made for the frequency of short dumping by existing barge traffic (given its recent origins, barge traffic associated with dumping by DuPont-Edgemoor should probably be factored out of these considerations), it should be possible (at least for sludge dumping originating in New York Harbor) to project the likely frequency of new short dumping due to sludge dump relocation.

Considerations Relevant to the 60-Mile Site

The major consideration relevant to possible relocation to the 60-mile site relates to the fact that no ocean dumping has ever taken place at this site, so that new dumping there would cause the degradation of a previously undegraded area. In the absence of a compelling reason to abandon use of current sludge dumpsites, the factors which led NOAA and EPA (based on the DEIS on sludge dumping) to decide last year against moving sludge dumping from its present location in the New York Bight to the 60-mile site, would appear to remain valid. Indeed, even if compelling reasons were to arise to justify relocation of present sludge dumping practices, it is far from clear that the 60-mile alternate should be given preference, even for New York and New Jersey sludge dumping, over use of the 106-site (it would be a matter of whether it was worse to risk unknown consequences at the 106-site than to degrade a previously undegraded 60-mile site). Obviously, use of the 60-mile site would make little sense for Philadelphia sewage sludge under any circumstances since that site is probably not much closer to Philadelphia than is the 60-mile site, and the route a barge would have to take to get there would probably mean crossing (and potentially impacting through short dumping) more square miles of important shellfish grounds than any other alternative. Use of the 60-mile site for both New York and Philadelphia might also result in more intentional short dumping than any other alternative, since it is unlikely that the Coast Guard would increase its use of ship-riders for barge transport of sludge to sites other than the 106-site.

Conclusions and Recommendations

On the basis of the factors analyzed in the foregoing discussion, we conclude that neither of the existing sludge dumps should be relocated at the present time. This conclusion is based principally on the lack of demonstrable need for and desirability of such a move, the uncertain but potentially serious adverse consequences of relocation to either the 106-site or the 60-mile site, and the potential negative impact of relocation on the enforceability of existing phase-out deadlines. Should the need for a move arise, relocation of Philadelphia sludge to the 106-site, and of New York and New Jersey sludge to either the 60-mile or the 106-mile site, may then become appropriate. The likelihood of such a need arising in the foreseeable future seems greater in the Philadelphia situation than in the New York Bight area.

Accordingly, the National Wildlife Federation respectfully makes the following recommendations:

1. EPA should relocate neither sludge dump at the present time.

2. EPA should strictly enforce existing phase-out schedules and deadlines.

3. EPA should immediately initiate the preparation of an Environmental Impact Statement which fully addresses the circumstances under which relocation to both the 60-mile site and the 106-mile site would be justified and the environmental pros and cons of such a course of action. Some of this has been done with respect to possible relocation of New York Bight sludge dumping to the 60-mile site in the DEIS issued last February by EPA Region II. EPA could elect to expand this EIS to cover Philadelphia and the 106-site, but this

should not be done simply through the issuance of an expanded Final EIS. Instead, a supplemental Draft EIS should first be issued with additional opportunity for public review and comment.

4. Monitoring (particularly at the Philadelphia dumpsite) and survey work (particularly at the 106-mile site) should continue, preferably at an intensified rate.

5. Efforts to reduce the hazard potential of ocean-dumped sludge should be given a high priority. These efforts should include particularly further attempts to reduce the microbial content of Philadelphia sewage sludge, and efforts for all sludges to reduce their levels of chemical contaminants (e.g., by pretreatment).

6. Future ocean dumping permits for sewage sludge should specify that EPA reserves the option of requiring relocation to the 60-mile or 106-mile site on 30 days' notice, and if possible should also specify the circumstances (e.g., detection of high fecal coliform or virus levels in shellfish in the vicinity of the dumpsite) which would trigger a relocation order.

7. Future EPA permit renewal hearings should expressly address the possible need for future relocation and should entertain any and all evidence or arguments on this subject the parties wish to call to EPA's attention. The record of the present hearings should also be made part of such permit proceedings. This would obviate the need to hold further hearings when and if it became necessary to proceed quickly with relocation.

8. EPA, the Corps of Engineers, and the concerned states and localities should act expeditiously to reduce or eliminate other sources of contaminant inputs to the New York Bight, including upgrading of sewage treatment works, and control of dredge spoil ocean dumping.

The opportunity to present these views is appreciated.

Footnotes

1/ Capt. James L. Verber, Chief, Northeast Technical Services Unit, Shellfish Sanitation Branch, Bureau of Foods, Food and Drug Administration, Davisville, Rhode Island-- Testimony at EPA adjudicatory hearing on Philadelphia Sewage Sludge, Transcript, Vol. IV, pp. 60, 68, 71 (May 22, 1975).

2/ Capt. James L. Verber-- Personal communication to Kenneth S. Kamlet, May 18, 1977; Prepared Statement Before EPA adjudicatory hearing (May 22, 1975); Statement Before Subcomm. on Air and Water Pollution, Senate Comm. on Public Works, 92d Cong., 2d Sess., Ser. H10, pp. 2101-10 (March 26, 1971).

3/ Capt. James L. Verber-- Personal communication to Kenneth S. Kamlet, May 18, 1977.

4/ Id.

5/ *National Science Foundation/International Decade of Ocean* Exploration, Anoxia on the Middle Atlantic Shelf during the summer of 1976 (Nov. 1976) (Report of a workshop held in Washington, D.C. on October 15 and 16, 1976).

6/ New Jersey Department of Environmental Protection, Report to Commissioner Bardin for Submission to the New Jersey Senate Committee on Energy, Agriculture and the Environment on Ocean Pollution Causes and Remedies in the Atlantic Coastal Area (prepared by the Division of Water Resources Oct. 7, 1976; revised Oct. 18, 1976; transmitted to interested parties, Jan. 26, 1977).

7/ NOAA, Long Island Beach Pollution: June 1976 (Feb. 1977) (MESA Special Report).

8/ Harris, W.H., Spatial and temporal variation in sedimentary grain-size facies and sediment heavy metal ratios in the New York Bight apex, Am. Soc. Limnol. Oceanogr., Spec. Symp. 2: 102-23 (1976) (Proceedings of the Symposium on Middle Atlantic Continental Shelf and the New York Bight, American Museum of Natural History, November 3-5, 1975).

LIST OF EXHIBITS

Exhibit	Subject
A-1	Jannasch, H.W., et al., Microbial degradation of organic matter in the deep sea, Science 171 (3972): 672-75 (Feb. 19, 1971).
A-2	New York Times, Deep-sea dumping raises questions, April 8, 1973, p. 69.
A-3	Jannasch, H.W. and C.O. Wirsen, Deep-sea micro-organisms: in situ response to nutrient enrichment, Science 180: 641-43 (May 11, 1973).
A-4	Wirsen, C.O. and H.W. Jannasch, Decomposition of solid organic materials in the deep sea, Environ. Sci. & Tech. 10(9): 880-86 (Sept. 1976).
B-1	Excerpt from: Proceedings of Ocean Disposal Conference, held at the Woods Hole Oceanographic Institution, February 23, 1971, under the co-sponsorship of the New England Division, Corps of Engineers and the Woods Hole Oceanographic Institution.
B-2	Letter from Ralph F. Vaccaro (WHOI Associate Scientist) to Dennis Hanson (National Wildlife Federation), Sept. 28, 1972.
B-3	Letter from Dean F. Dumpus (WHOI Senior Scientist) to Barbara Reid (NRDC), April 26, 1973.
B-4	Letter from Dean F. Bumpus (WHOI Senior Scientist) to T.A. Wastler (Chief, EPA Ocean Disposal Program), August 7, 1973.
B-5	Conclusions of an EPA-sponsored Workshop at Airlie House on Evaluation of Ocean Dumping Criteria, Aug. 31-Sept. 1, 1973 (workshop committee chaired by Dr. Edward D. Goldberg, Scripps Institution of Oceanography).
C-1	Draft position of National Wildlife Federation on deep-sea ocean dumping, January 2, 1974 (circulated to WHOI scientists for comment).
C-2	Letter from Holger W. Jannasch (WHOI) to Kenneth S. Kamlet (NWF), Jan. 7, 1974 (commenting on the draft NWF position).

List of Exhibits, Cont'd.

Exhibit	Subject
C-3	Letter from Ralph F. Vaccaro (WHOI) to Kenneth S. Kamlet (NWF), Jan. 16, 1974 (communicating comments of Drs. Vaccaro, Grice, Rowe, and Wiebe on draft NWF position).
C-4	Letter from Dean F. Bumpus (WHOI) to Kenneth S. Kamlet (NWF), Jan. 15, 1974 (commenting on draft NWF position).
C-5	Letter from Dean F. Bumpus (WHOI) to Kenneth S. Kamlet (NWF), Jan. 22, 1974 (commenting further on draft NWF position).
C-6	Yayanos, A.A., Book Review: A.G. MacDonald, Physiological Aspects of Deep Sea Biology, Science 192: 363-64 (Apr. 23, 1976).
D	Heirtzler, J.R. and J.F. Grassle, Deep-sea research by manned submersibles, Science 194: 294-99 (Oct. 15, 1976).

RESPONSES TO LETTERS

The following comments are keyed to the preceding letters which have been numbered and coded for easy reference. The first digit refers to the letter number and the second digit refers to the specific paragraph/comment within the letter:

1.1 EPA is fully committed to ensure environmentally sound methods of waste management. As a result of the Agency's efforts to end ocean dumping, most dumpers have been phased out of ocean disposal since 1973. All of the remaining dumpers are required to investigate and develop land-based disposal methods.

5.1 There is presently no plan to use the 106-Mile Site for ocean incineration. A potential incineration site adjacent to the 106-Mile Site is now under consideration and an EIS is being prepared specifically for that site.

6.1 Most of these comments request a level of detail not pertinent to this EIS. This appendix supplies information auxiliary to the main body of the EIS. It is not meant to represent a complete literature review of all subjects mentioned within it.

6.2 The text in Appendix A was changed to include this information.

6.3 This subject received additional attention in the Final EIS.

7.1 The EIS text has been modified to clarify the uncertainties of the biological effects of waste dumping at the site.

7.2 The proposed action treated in this EIS was to designate an already existing ocean disposal site (of prescribed site boundaries) for continued use. Changing the size of the site was not considered

in this document, since a site of such large dimensions is deemed necessary to ensure that wastes are quickly dispersed after dumping. Usage of different quadrants of the site precludes mixing of wastes.

7.3 The section discussing the 106-Mile Site in Chapter 3 begins with a reference to Appendix A and, in fact, states that the material presented in Chapter 3 is excerpted from Appendix A. Continental Slope waters are never described in the EIS as biologically "depauperate". The EIS does say that Continental Slope waters may exhibit reduced productivity in comparison to Continental Shelf waters.

7.4 It is true that larvae of economically important species have been observed at the site; however, the site is not unique as to the occurrence of the said larval forms. The larvae are found all along the mid-Atlantic Continental Shelf and Slope. Dumping operations at the site may kill or otherwise affect larvae in the waste plume, but a noticeable effect on the overall population of any particular species is not expected. It is important to note that larval attrition is naturally high, due to such predation, normal die-off, or changing physical environment.

7.5 Rare and endangered species are treated in additional detail within Appendix A.

7.6 Additional information on the red crab fishery has been provided in the final EIS.

7.7 The primary data base for the EIS is the culmination of more than three years investigation, primarily by NOAA. There are certainly some deficiencies in the data base, primarily because of the difficulties in sampling sufficiently to detect adverse effects at the site. EPA encourages NOAA to continue investigations at the site, but does not feel that action should be delayed until NOAA can complete additional studies.

8.1 Unless otherwise noted, all comments were treated as text changes. The EIS does not debate the relative merits of ocean disposal in comparison with other methods of waste management. EPA's ocean dumping permit program determines the need for ocean disposal on an individual basis for each permittee. There are presently no viable alternatives to ocean disposal for the four permittees dumping wastes at the 106-Mile Site. Thus the main issue in the EIS is to choose the best ocean location at which to dump the wastes, and not whether to designate an ocean disposal site for these wastes.

8.2 No relationship between past munitions and radioactive waste disposal is anticipated in future industrial waste disposal. Industrial wastes are not expected to reach the bottom at the site where munitions and barrels containing radioactive waste were dumped.

8.3 EPA requires permittees to monitor impacts occurring within the period of initial mixing. The agency relies upon NOAA's monitoring and research programs to provide information on effects occurring both during and after the period of initial mixing. NOAA's comments, which although valid, suggest studies that are primarily research studies, and are therefore beyond the limit of reasonable requirements of the permittees. It is hoped that NOAA will be able to do the suggested work.

8.4 The procedure for obtaining "...2 percent additional nitrogen to the site..." involved a worst-case analysis based on several factors:

- A mixing zone comprising one-fourth of the area of the site to a depth of 15 m.
- Background concentrations obtained from NOAA field studies reported by (NOAA, 1977).
- An input based on projected 1981 total volumes of sludge and weighted average concentrations of nutrients reported for ocean dumped sludge by Mueller et al. (1976).

- A 22-day residence time for dumped materials based on the length of time a parcel of water crosses the site diagonal at the lowest speed where a warm core eddy has been observed to transverse the site.

The worst-case analysis was recalculated in the final EIS using an average residence time of 14 days. The residence time was adjusted after a determination that presence of an anticyclonic eddy does not represent a worst-case condition because of the potential for vertical mixing throughout the eddy. Instead an average current speed of 10 cm/sec was used. Recalculations based on this factor yield a 1% increase of nitrate and a 14% increase of phosphate due to sludge dumping.

8.5 See Response 7-7. See comment 8.2 for munitions and radioactive waste discussion.

8.6 Whether or not ocean disposal is less expensive than land disposal, it still means expense to the dumper. This cost represents an irretrievable commitment of economic resource. It is immaterial that the amount of money spent to dump waste in the ocean is less than the amount that would be required to use it for landfill; in either condition an economic resource has been committed.

8.7 The range of pH values reported in Table 5-2 comes from analyses of barge loads. It is not meant to represent solely the pH of the acidic portion of the waste, but rather the acidity of the bulk mixture. It is true that Edge Moor waste often contains extremely concentrated hydrochloric acid; however, this acid is combined with other materials and the resultant mixture is dilute by comparison.

8.8 The added sludge will increase the nutrient levels in seawater at the site by a negligible amount. However, the overall effect of this small nutrient enrichment on the biological productivity of the area is unclear, because of the great diversity of water conditions

at the site - high-nutrient coastal waters mixing with low-nutrient oceanic waters. There are two reasons to discourage nutrient enrichment in any area: (1) conditions may favor a particular planktonic organism and lead to a drastic increase in its abundance, to the detriment of other normally competitive organisms, and (2) a severe bloom can change the water chemistry of an area to such a degree that large organisms are adversely affected. Because of the high dilution of waste materials discharged at the 106-Mile Site, the threat of severe plankton blooms is not a reality for that area.

9.1 A regular monitoring program is one of the requirements of site designation and usage. NOAA plans to continue its research studies of dumping effects.

10.1 There are no existing or proposed units of the National Park System located at or near the proposed waste disposal site.

14.1 The State of Maryland has not informed EPA of any conflicts between designating the 106-Mile Site for continued waste disposal and the state's present plans for economic development.

15.1 The proposed use of the 106-Mile Site for sewage sludge disposal is not intended to be limited to sludge from the New York/New Jersey metropolitan area. The EIS emphasizes sludge because of the potential need to relocate dumping from the 12-Mile Site to another site. If relocation of Philadelphia's sludge dumping from the present site is deemed necessary, the 106-Mile Site will be one alternative considered.

16.1 A complete dicussion of land-based alternatives is included in Appendix D of this EIS. Further discussion is not necessary because the subject of this EIS is to discuss the relative merits of ocean dumping at one location versus another, rather than comparing land and ocean disposal. EPA thanks the State of New Jersey for expressing its views on land disposal alternatives.

16.2 Pretreatment standards are presently being promulgated.

16.3 Organic materials, e.g., organohalogens, are permitted to be dumped only as trace contaminants, in accordance with Part 227, Subpart B of the Ocean Dumping Regulations. The Regulations further state:

> These constituents will be considered to be present as trace contaminants only when they are present in materials otherwise acceptable for ocean dumping in such forms and amounts in liquid, suspended particulate, and solid phases that the dumping of the materials will not cause significant undesirable effects, including the possibility of danger associated with their bioaccumulation in marine organisms [Section 227.6(c)].

Materials which exhibit a tendency to bioaccumulate in bioassays with approporiate sensitive marine organisms are prohibited. In the absence of appropriate bioassay procedures, the Regulations state that organohalogens may be permitted for dumping (except under emergency conditions) only when "the total concentration of organohalogen constituents in the waste as transported for dumping is less than the concentration of such constituents known to be toxic to marine organisms", calculating that these constituents are all biologically available, i.e., are not rendered inert in any manner [Section 227.6(e)]. If an applicant can demonstrate that, upon dumping, the wastes are rapidly rendered non-toxic to marine life, or rendered non-bioaccumulative in the marine environment by chemical or biological degradation in the sea, a permit may be granted for their disposal [Section 227.6(f)].

16.4 During the ocean dumping permit application process, prospective permittees must provide EPA with a complete analysis of all the chemical constituents in the waste.

17.1 Discussion of land-based sewage sludge disposal alternatives is not relevant to this EIS. The chapter on land-based alternatives from the EIS on sewage sludge disposal in the New York Bight appears as Appendix D in this EIS. It has been included to provide supplemental information. Sewage sludge is presently permitted to be dumped in the ocean because there are no land-based alternatives available at this time.

17.2 Industrial pretreatment standards are presently being promulgated.

17.3 EPA must comply with PL 95-153 which states that ocean dumping of harmful sewage sludge will cease by December 31, 1981. The sewage sludge presently dumped in the ocean off the U.S. East Coast cannot comply with EPA's environmental impact criteria; thus ocean dumping of this waste must cease according to law.

22.1 These studies are already part of the research and routine monitoring programs conducted at the site.

22.2 No accumulations of waste constituents are likely to result from dumping; the EIS clearly establishes this point and provides supporting information. Therefore, the great expense associated with collecting benthic organisms and analyzing their tissues is not warranted. EPA feels that it is better to put effort into monitoring the elements of the environment where potential effects are more likely to occur.

22.3 As a result of the practice of assigning dumpers to different quadrants of the 106-Mile Site, a rotation system to another off-Shelf site is not necessary to allow recovery of the dumpsite. NOAA has established that the observable short-term effects are transient; long-term effects are unlikely, considering the volume of the mixing zone and the flushing rates of water at the site.

22.4 The Coast Guard has been assigned the responsibility for conducting routine surveillance of ocean dumping under MPRSA. The present Coast Guard program goal is to observe 75% of all industrial waste dumps and 10% of all municipal waste dumps. Any extra surveillance required by EPA will be conducted at the permittee's expense.

23.1 EPA is strongly committed to enforce existing compliance schedules for the development of land-based alternatives by December 31, 1981.

24.1 The Ocean Dumping Regulations state provisions for determining which materials will be permitted to be ocean dumped, based on the nature of the materials and upon demonstration of adequate need to ocean dump. Only in the absence of land-based waste disposal alternatives can materials be considered for ocean disposal. After ocean disposal permits have been granted, permittees must continue to seek land-based alternatives.

25.1 The period for public review of a draft EIS - 45 days - is prescribed by the Council on Environmental Quality. In the case of this EIS, EPA accepted all comments received until the production of the final EIS, a period of almost 5 months.

28.1 This item was corrected in the final EIS.

29.1 The plan proposed on behalf of the Bergen County Utilities Authority presents an alternative means for disposing of sewage sludge at the 106-Mile Site. Such a proposal is not evaluated as part of the site designation process - the subject of the EIS - but would be properly evaluated in the permit procedure.

29.2 The EIS provides information to the public on the present projected costs of using the 106-Mile Site for waste disposal. Studies on cost-effectiveness of the different methods of using the site are the responsibility of each individual permittee.

29.3 Pretreatment regulations apply nationwide according to law. The regulations apply to all cases unless a waiver is granted (highly unlikely for the New York/New Jersey metropolitan area).

31.1 Concentrations of waste contaminants at the 106-Mile Site do not appear to remain high after initial mixing. Among other data, bioaccumulation in fish is partially dependent on sufficiently long exposure to high concentrations of materials which fish can accumulate. Fish at the site tend to be transient, thus it is unlikely that they will be exposed long enough to permit detectable uptake.

31.2 This subject is addressed in the EIS in Chapters 2, 3, and 4.

31.3 Procedures are not presently available for the fish named in this list. For the present, appropriate sensitive (though not indigenous) species are used for bioassays. As additional bioassay techniques are developed in the future, other organisms will become candidates for study.

32.1 The area of the site, approximately 1,700 km^2, is stated in Chapter 2, within the section entitled "Continued Use of the 106-Mile Site."

32.2 The legal framework of the proposed action is thoroughly discussed in Chapter 1. The reader is referred to the EPA Ocean Dumping Regulations and Criteria for the complete legal details of the site designation.

32.3 The EIS conforms with the CEQ requirements for preparation of EIS's (40 CFR V) and the guidelines on site designation set forth in the Ocean Dumping Regulations (40 CFR 228). Appendices have been added to the format prescribed by CEQ in order to provide more information than normally required, but which EPA deems a pertinent enhancement.

32.4 Sections of the EIS have been modified to aid understanding by the general public. EPA feels that the document provides all the information necessary for decision-making or for gaining a full knowledge of the issues involved in designating the 106-Mile Site.

32.5 The debate is long standing on whether containment or dispersal is the preferred method of managing wastes at an ocean disposal site. At several locations in the ocean surrounding the U.S., toxic wastes have been deposited in barrels which are now on the sea floor. However, in the case of industrial wastes of relatively low toxicity, dispersing mechanisms have been employed to disperse and dilute the material widely and quickly. This is the procedure that has been followed in the past at the 106-Mile Site.

Observations from field studies of wastes dumped at the site have justified the concept of waste dispersal being preferred to containment for aqueous wastes dumped at this location. The rate of dumping for each waste can be gauged to the chemical and physical character of material, to ensure that sufficient dilution occurs to keep waste concentrations below the limiting permissible concentration after the period of initial mixing. Thus there is no reason to change the waste management practices in future use of the 106-Mile Site, given the same kinds of wastes as those presently dumped.

32.6 The information contained in Appendix B is supplemental to the main body of the EIS, but considered to be an integral part of the document. The Appendix is referenced at many places in the body of the EIS: The summary, Chapter 2 (within the sections entitled "Basis for Selection of the Proposed Site: and "Recommended Use of the 106-Mile Site"). Chapter 3 (under "Waste Disposal at the Site:) and throughout Chapter 4. Much of the information contained in Appendix B appears in the main body, e.g., the Summary, Chapter 2 (within the Section entitled "Continued Use of the 106-Mile Site"),

Chapter 4, and Chapter 5. Besides containing relevant data on dumpers presently using the site, the Appendix presents a compilation of data on historical dumping at the site. This information, although not entirely germane to future use of the site, is, however, important as the historical record of the site use.

32.7 Total quantities dumped are listed in Appendix B. Certain subjects, e.g., the assimilative capacity of the site, are still unknown. However, with respect to waste interactions, EPA has developed site management policies which lessen chances of significant impacts as a result of dumping. Examples of these policies include confining simultaneous use to different quadrants of the site, regulating barge speeds and discharge rates to ensure adequate waste dilution, imposing a requirement for monitoring on all dumpers, and including in dumping permits special conditions for controlling dumping which are adequate for each waste. At the same time, NOAA is continuing its research on effects of ocean dumping by studying several aspects of the environment of the site. Due to this level of effort, and concern for using the 106-Mile Site in the safest way, the likelihood of long-term impacts occurring unnoticed is slight.

32.8 The EIS strives to present information in a logical fashion, to make it understandable to government decision-makers and to the general public. Ocean dumping is a complex technical subject, thus all aspects can not be understood by every reader of the EIS. All statements have been carefully documented throughout the text. Areas of incomplete or inconclusive information have been discussed; EPA based its judgment to support site designation on the available information, mindful of subjects where information is yet lacking.

32.9 See response to 32.11.

32.10 Potential waste-concentrating mechanisms operating at the 106-Mile Site have been studied in NOAA's dumping research program. THe EIS discusses these studies primarily within Chapter 4 and Appendix A. The items addressed by NWF are answered individually or collectively as appropriate.

NWF offered many examples of potential waste-concentrating mechanisms believed to receive inadequate attention in the draft EIS. Most of the points raised are research topics best addressed as part of NOAA's ocean dumping research program. The mechanisms of concentrating trace contaminants are complex, and depend upon concentrations of the contaminants in seawater, the length of time elevated concentrations are maintained, chemical state of the contaminants, (i.e., whether bound in complexes or in ionic form), and the ability of organisms to concentrate particular trace contaminants in tissues. The wastes dumped at the 106-Mile Site are quickly dispersed, and not present after mixing in concentrations exceeding limiting permissible concentrations determined by bioassays with appropriate sensitive marine organisms. Floc from mixing of Du Pont-Edge Moor and Grasselli wastes with seawater may persist beyond a day; however the significance of this observation is unknown. The existence of several unknowns related to use of the site is acknowledged, but EPA feels that restricting the use of the site until research studies are conducted is not justified, based upon the information generated by the studies which have already been conducted on effects of waste disposal at the site.

Specific responses follow.

a) The total organic component of the industrial wastes discharged at the 106-Mile Site is minimal: 0.5% to 1% from Du Pont-Grasselli and 1% to 2% from American Cyanamid. Of the 34 million gallons of organic materials estimated to be disposed of in 1978, less than 50% of the waste was water insoluble and a much smaller amount could

be considered lipophilic. Some of the latter may be converted to solubility by surfactants contained in the waste. Generally, however, the lipophilic organics - oil and greases - can be considered negligible since NOAA studies have failed report visible sheens.

b) Laboratory studies have been conducted on the flocs which form when Du Pont-Edge Moor and Grasselli wastes mix with seawater, to determine if waste constituents adsorb to the particle surfaces. This subject is discussed within Chapter 4 in the section entitled "Water and Sediment Quality."

c) For discussion of concentrations of toxic waste constituents with particulates, see Chapter 4, "Effects on Water and Sediment Quality."

Association of pathogenic micro-organisms with particulate material has been discussed in Chapter 5 (Survival of Pathogens). Particulate associated pathogens suspended in the water column are vulnerable to predators, toxins, effects of solar radiation and other factors which contribute to inactivation and reduction of these organisms.

d) It is true that bluefish and yellowfin tuna have been reported to be attracted to acid wastes disposal at the New York Bight Acid Site (Westman, 1958). However, Westman acknowledged it is possible that increased turbidity in the water after a dump disguises fishing gear, thus making certain fish more easily caught. Therefore ocean dumping may not, in fact, attract fish. No fish attraction has been reported from studies at the 106-Mile Site, or at any other ocean disposal site.

e,j) The significance of waste particulates being associated with pycnoclines is unknown, a point that is acknowledged in Chapter 4 of the EIS. Many organisms are found in association with thermal and density gradients, and there is potential for ingestion of particles where organisms and particles are found together.

No assumption is made in the EIS, as NWF asserts, that "trapping of constituents at the thermocline will avoid concentration of toxic wastes by preventing significant deposition on the ocean bottom." What the EIS does say in Chapter 4, is that density gradients in the water column prohibit the downward movement of waste particles, so that accumulation on the seafloor is unlikely.

f,i) Concentration of elements from water into tissues of organisms is dependent on a number of factors: the amounts of input elements in comparison to values normally present in the water, the length of time that elevated concentrations are retained, the chemical state of the elements (whether present as free ions or in complexes) and the proclivity of organisms in a waste plume to concentrate elements. Transfer of trace contaminants by vertically or horizontally migrating organisms is feasible, but difficult to test. Investigations of similar questions are part of NOAA's continuing research on dumping effects at the site.

g) The EIS discusses in Chapters 2 and 4 the potential for 106-Mile Site wastes impacting fisheries. Fishing near the 106-Mile Site is variable and dependent on the occurrence of water masses or eddies which affect fish abundance and distribution. Shelf fisheries are sufficiently far from the site, so that wastes will be adequately diluted before reaching the location of any significant fishing.

h) The potential for concentration and enhancement of persistence and toxicity of organic constituents as a result of diminished biodegradation in the deep ocean is discussed in Chapter 5, specifically as regards sewage sludge. The organic component of most of the industrial waste dumped at the site is minimal. The only dumper with significant organic waste is American Cyanamid; however, the organics in that waste are principally nonpersistent organophosphate pesticides.

k) Gulf stream eddies occupy the site about 20% of the time. Their roles as potential waste-concentrating mechanisms have never been studied. Eddies move through the site at approximately 3 cm/sec, whereas the normal mean current-speed is approximately 10 cm/sec. Therefore horizontal flushing rates at the site may be less than normal where an eddy is present. However, eddies can change the vertical characteristics of the water column, disrupting physical features which normally inhibit downward movement of wastes (e.g., thermoclines and pycnoclines), providing more water than normal in the vertical dimension for mixing. This subject is addressed in Chapter 4 of the final EIS.

l) Short dumping is possible at any ocean disposal site, no matter how close to shore the site may be. However, it is true that the possibility of short dumping increases with distance from shore. Most important mid-Atlantic fisheries are in the coastal waters over the Continental Shelf. The alternative sites for the 106-Mile Site are located in the Shelf area where commercial and sport fisheries are prevalent; thus, the potential adverse effect of short dumping at the alternative sites is great, and may be greater than the effect of short dumping in transit to the 106-Mile Site.

32.11 The EIS bases its evaluation of the proposed 106-Mile Site designation on five of the six major factors cited by Asst. Administrator Jorling: environmental acceptability (Chapters 2 and 4), ability to monitor impact (Chapters 2 and 4), surveillance of dumping activities (Chapter 2), economic burden (Chapter 2), and logistics (Chapter 2). The sixth factor - the effect of using such a site on the ability of dumpers to meet the December 31, 1981 deadline for the termination of harmful sewage sludge dumping - was not addressed for two reasons: (1) the deadline does not apply to industrial waste disposal, and (2) relative to sewage sludge disposal this factor was already addressed in the EIS on sewage sludge disposal in the New York Bight, EPA, 1978. Sewage sludge dumping would only be permitted at the 106-Mile Site to relieve adverse environmental conditions at the 12-Mile Site. Therefore economics would not be an issue.

EPA's decision to propose the designation of the 106-Mile Site for continued use, documented by this EIS, does not conflict with Asst. Administrator Jorling's decision, wherein he stated (in reference to the Toms River Hearing):

> I am impressed by the concern expressed by many reputable scientists about the potential for adverse environmental impacts from sludge dumping at the 106-Mile Site. Nevertheless, I would not regard these concerns as preventing use of the 106-Mile Site if a sound predictive judgement could be made concerning the impact of dumping at the site and an effective monitoring program could be established (Jorling, 1978).

The basis of the ultimate decision to discourage relocation of New York/New Jersey sludge disposal was the conclusion of the Toms River Hearing Officer (Breidenbach, 1977), who indicated that there was a "potential for irreversible, long-range, and therefore unreasonable degradation of the marine environment" which was coupled with the unfeasibility "of designing an effective monitoring program to evaluate the impacts of sludge dumping at the site."

The decision to discourage relocation of sludge dumping from the Philadelphia Sewage Sludge Site to the 106-Mile Site was based on the speculative nature of the state of knowledge available at that time, and on the prohibitive cost of mounting an effective monitoring program (estimated by NOAA to be about $2.5 million per year) compared to the resources available between 1978 and January 1, 1981, when Philadelphia will cease ocean dumping.

During the evaluation of the 106-Mile Site designation, the Toms River Hearing testimony, Report of the Toms River Hearing officer, and Asst. Administrator Jorling's decision were considered. At the time the EIS was prepared (two years after the Tom's River Hearing, and one year after Jorling's decision was published), additional information was available with which to evaluate the impacts of waste disposal at the 106-Mile Site. After careful consideration of this additional information and the previously available information, EPA decided that continued use of the 106-Mile Site was feasible and clearly preferable to all available alternatives.

32.12 At the time of the Toms River Hearing little information existed on which to base sound predictions of the fate and effects of sewage sludge dumped at the 106-Mile Site. Thus, much of the testimony presented at the hearing was speculative. Since the hearing, additional information has become available on the fate of materials dumped at the site, as new procedures for tracking these materials have been tested. The most promising technique appears to be the acoustic monitoring method, which can track some sizes of particulates in waste. This technique has been used successfully for sewage sludge (Orr, 1977b) and industrial waste (Orr, 1977a). The most significant observation in these studies was retention of waste material in all cases in waters above the permanent thermocline/pycnocline (100-150 m) and, in come cases, in waters

above the seasonal thermocline/pycnocline (10 to 50 m). Thus, horizontal dispersion may be a greater factor than vertical dispersion, and wastes are not expected to sink to the bottom of the site in detectable amounts.

Residence of wastes in surface and near-surface waters is relevant to some of the major concerns expressed at the Toms River Hearing, especially the effects of the material on benthic organisms, and the potential for inadequate biodegratdation of the waste organic fraction. However, if wastes do not reach the bottom in significant amounts, adverse effects on the benthos should be negligible. Retention of wastes in the upper water column increases the potential for dispersion through mixing and biodegradation.

It is important to note that EPA is not proposing to relocate sludge disposal from any existing disposal site to the 106-Mile Site. The Agency has already determined that the advantages to be gained by this action do not sufficiently outweigh the risks. However, in considering the 106-Mile Site for limited sewage sludge disposal under the conditions described in the draft EIS, the Agency retains an important alternative location for dumping this material off the Continental Shelf. The only other alternative is to relocate sludge disposal to another shallow water site on the Continental Shelf.

The documents appended as Exhibits 1 and 2 were carefully examined during preparation of the draft EIS. Since Exhibit 1 (Report of the Hearing Officer) consists of a summary of the comments raised in Exhibit 2 (NWF testimony), the latter reference is addressed in this response. Many points presented in these references were found to relate solely to relocation of sewage sludge disposal. The EIS did not evaluate the 106-Mile Site in relation to other sewage sludge sites, but instead evaluated the site on the basis of its individual merits as an ocean disposal site; therefore these points were not applicable.

The remaining points raised in the NWF statement were treated in the EIS:

- The directive of MPRSA to designate ocean disposal sites off the Continental Shelf whenever feasible (NWF, p 3; EIS, Chapter 1).
- The lower biological productivity in Continental Slope waters in comparison with Shelf Waters. (NWF, p. 4; EIS, Chapter 4 and Appendix A.)
- The potential for interactions between different wastes dumped at the site (NWF, p. 18; EIS, Chapter 4, Chapter 5, Response 32-16).
- The potential for entrainment of wastes in the Gulf Stream (NWF, p. 18; EIS, Chapter 4).
- The feasibility of monitoring the site (NWF, p. 20; EIS, Chapter 2, and Chapter 4).
- The likelihood of short-dumping upon use of the site (NWF, p. 24; EIS, Chapter 2, Chapter 4, Response 32-10 [e]).

32.13 Appendix B provides information on all wastes presently dumped at the 106-Mile Site, and limited information on historical dumping at the site. The information was generated primarily from EPA permit files. Individual barge analyses were tabulated to provide quarterly estimates of waste constituents loading. The chemical characteristics of the wastes, physical, toxicological, and dispersive characteristics are all discussed. This material is referenced at several places in the EIS (e.g., Chapters 2, 3, and 4) and additional information is included in the text of the DEIS. Information is excerpted from the Appendix and used in sections within Chapter 4 (Environmental Consequences).

The fate and effects of dumping the present wastes are treated extensively in Chapter 4.

Management of dumping operations at an ocean disposal site is the responsibility of the EPA management authority. As such, determination of separation distances for dumpers is not a subject addressed in an EIS on site designation, but is properly addressed as part of the ocean disposal permit and site management processes.

32.14 The properties of all wastes presently expected to be dumped at the site are thoroughly discussed in Chapter 4 and Appendix B, particularly with respect to toxic effects.

Persistence under worst-case conditions is addressed in Chapter 4, wherein the total waste loading at the site is evaluated in relation to a minimally-dispersive environment.

Susceptibility of wastes to bioaccumulation is assessed for individual wastes as part of the ocean dumping permit process. The Ocean Dumping Regulations state that wastes containing constituents which may be bioaccumulated are prohibited except as trace contaminants.

> "These constituents will be considered to be present as trace contaminants only when they are present in materials otherwise acceptable for ocean dumping in such forms and amounts in liquid, suspended particulate, and solid phases that the dumping of the material will not cause significant undesirable effects, including the possibility of danger associated with their bioaccumulation in marine organisms" [Section 227.6 (b)].

32.15 The meeting at which NOAA scientists estimated the minimum assimilative capacity of the 106-Mile Site, was held at the same time the draft EIS was issued. Thus, this estimate was not available to the EIS preparers. The estimate put forth at the meeting has yet to be verified.

32.16 Waste disposal operations at the 106-Mile Site are managed in a manner to avoid the possibility of waste interactions. Based on present knowledge, the large surface area provides ample space for simultaneous large dumps, with slight potential for mixing of different waste plumes.

The potential for 106-Mile Site wastes interacting with an incineration area to the south, is presently being evaluated in the EIS under preparation for the incineration site; thus it is not discussed in the present EIS. However, interactions between wastes at the two sites would be expected to be minimal, because of the extreme dilution of the wastes, especially the residues produced by incineration.

32.17 The comment on Du Pont-Grasselli bioassay data resulted from a mistake in the text which has been corrected in the final EIS.

It is true that oceanic organisms may be more sensitive to ocean dumped toxicants than estuarine or nearshore organisms. The final EIS discusses this subject in Chapter 4. However, bioassay methods for oceanic organisms are not available at this time. When methods are developed, the bioassay requirement will be modified accordingly. Meanwhile, NOAA is supplying information on the sensitivity of the organisms indigenous to the site as part of the ocean disposal research program.

32.18 The text in the final EIS was modified in response to this comment.

32.19 The depth of the permanent thermocline is variable in the literature, hence the seeming inconsistency in the EIS. For discussion purposes, the final EIS adopts a depth ranging from 100 to 150 m for the permanent thermocline.

The final EIS was changed in response to the comment on inconsistency in distances.

32.20 The draft EIS deals primarily with the use of the site for industrial waste disposal. The EIS treats potential sewage sludge disposal as a special case because there are presently no plans to dump sludge at the site; instead, the site would be considered as an alternative location for sludge disposal should adequate need arise. For industrial waste and sewage sludge disposal the evaluation is based on environmental acceptability, feasibility of monitoring, surveillance, economics, and logistics.

32.21 If the site were not designated for continued use, disposal would terminate with the end of the interim designation on December 31, 1981. This alternative is rejected because of the need to ocean-dump some waste materials, and the suitability of the 106-Mile Site for such purposes.

During the permit application process, Du Pont-Grasselli adequately demonstrated a need to ocean-dump, based on the lack of available land-based alternatives. The waste complies with EPA's environmental impact criteria, thus the Agency will permit it to be dumped in the ocean until land-based alternatives are developed. As a condition of the Du Pont permit, the company must continue to seek land-based alternatives.

32.22 The EIS demonstrates that surveillance and monitoring are feasible at the 106-Mile Site. The associated costs are acknowledged to be high, primarily due to the distance of the site from shore. However, the environmental effects of continued use of the site are estimated to be slight in comparison to alternative nearshore sites (see Chapter 4).

32.23

a) The size of the 106-Mile Site is an advantage in comparison to the alternative sites. The ample area (approximately 500 nmi^2, roughly 3% of the total area of the New York Bight), permits rapid waste dilution without impinging on fisheries or other uses of the ocean and accommodates long barge tracks, thus further enabling dilution of the dumped wastes within the site along track lengths. A similar site would not be possible in coastal waters because its use would conflict with other uses of the waters. The excerpt from the Ocean Dumping Regulations applies to sites where materials which contain large amounts of solids are dumped. At such sites, the objective is to localize the wastes, thus the area of the site is limited. However, such size limits do not apply at sites receiving aqueous wastes of low toxicity which are intended to be diluted quickly.

b) The "emergency conditions" quoted from the EIS text and the cover letter refer to the adverse environmental conditions in the New York Bight, which would require emergency relocation of the sludge dumping operations to another site.

c) This typographical error was corrected.

d) The text has been changed in response to this comment.

e) Only wastes expected to be dumped at the site have been evaluated in the EIS. The environmental effects of new wastes would be assessed on a case-by-case basis during the permit application process.

f) See Response 32.11.

g) The "undocumented assertions" referenced to on these pages cannot be identified.

h) The heavy metal content of NL Industries' waste is not pertinent to this EIS.

i) The text has been changed in response to this comment.

j) The text has been changed in response to this comment.

k) The information described in this comment was unavailable while the EIS was under preparation. However, the EIS has already made a strong case for not relocating 106-Mile Site wastes to the New York Bight.

l) (Awaiting information from EPA Region II.)

m) No response.

n) The information was provided to inform the public. Based upon further evaluation, information on aliphatic hydrocarbons was deleted in the final EIS because oil pollution is not relevant to discussions of waste dumping at the 106-Mile Site.

32.24 Every EIS on an ocean disposal site discusses unique issues, because each disposal site is different. While one EIS may act as a model for another in format or approach, EPA's ultimate decision on whether to designate a site for ocean dumping is made on a case-by-case basis.

HEARING RESPONSES

The following comments were excerpted from the statements presented at the hearing held on August 31, 1979, at Mercer County Community College, New Jersey.

COMMENT: **The EIS conclusion that sludge dumping is feasible at the 106-Mile Site should not be interpreted as sanctioning continued indefinite ocean disposal of sewage sludge (NJ Public Advocate).**

Response: Congress has mandated that ocean dumping of harmful sewage sludge will cease by December 31, 1981 (PL 95-153). Use of the 106-Mile Site for sludge disposal would be limited by this date, as would use of any other ocean site for disposal of sewage sludge. EPA is exercising a firm commitment to enforce compliance with this law.

COMMENT: **A major flaw in the EIS is that it fails to examine the environmental and legal necessity of using the 106-Mile Site for sewage sludge disposal as opposed to the existing site (NJ Public Advocate).**

Response: Comparison of use of the 106-Mile Site for sludge disposal with use of the existing site is not warranted in this EIS. The 106-Mile Site would only be used if use of the 12-Mile Site were terminated. EPA has already established that relocating disposal operations from the 12-Mile Site to any other site would not cause significant improvement in conditions at the existing site because of the existence of more significant sources of contamination, e.g., contaminants entering the Bight via the Hudson River outflow and land runoff. (Breidenbach, 1977; Jorling, 1978)

COMMENT: **EPA should not evaluate use of the site for sludge dumping on a case-by-case basis (NJ Public Advocate).**

Response: Use of any site for waste disposal is evaluated on a case-by-case basis in accordance with the Ocean Dumping Regulations. Thus, applications to dump sludge at the site would be treated the same as applications to dump any other waste and would be evaluated individually.

COMMENT: The EIS states that sludge disposal at the 106-Mile Site is feasible. Thus, EPA has no discretion under the MPRSA to allow continued use of the 12-Mile Site (NJ Public Advocate).

Response: It was established at the Toms River Hearing that there is presently no advantage to be gained by moving sludge dumping from the existing 12-Mile Site to any other location. By evaluating and designating the 106-Mile Site for potential sewage sludge disposal, EPA is providing one more alternative location for disposing of sludge. Designation of the site for sludge disposal does not imply that EPA must use the site; rather, it is available for use if adequate need arises.

COMMENT: The EIS should discuss the economic impact of sludge dumping on renewable living resources at the 12-Mile Site. (American Littoral Society)

Response: Discussion of the economic impact of dumping sludge at the 12-Mile Site is not relevant to an EIS addressing designation of another site. Irrespective of the economic impact of sludge dumping at the existing site, the 106-Mile Site will only be used for sludge dumping if a public health hazard, or a significant decrease in water quality at the 12-Mile Site or any other ocean disposal site, requires relocation.

COMMENT: The EIS should discuss less expensive alternative methods of transporting wastes to the 106-Mile Site. (American Littoral Society)

Response: The subject of this EIS is designating the 106-Mile Site for continued use. Alternative methods of waste transport to the site are not evaluated in an EIS on site designation, but are best evaluated by the prospective dumpers who must bear the costs of the dumping operation.

COMMENT: The EIS should discuss less expensive alternative methods o. surveillance at the 106-Mile Site. (American Littoral Society)

Response: The U.S. Coast Guard is responsible under MPRSA for surveillance of ocean disposal sites. In exercising this mandate, the Coast Guard evaluates alternative methods of surveillance and uses the most appropriate method - whether patrol boat, helicopter, or shiprider - for each disposal site.

COMMENT: The EIS should provide more financial information. (American Littoral Society)

Response: This comment is too general to permit a specific response. The EIS provides all available economic information which is relevant to the proposed action.

COMMENT: The EIS implies that sewage sludge dumping was the cause of the 1976 fish kill in the New York Bight. (American Littoral Society)

Response: The EIS states that there was no relationship between barged sludge disposal and the occurrence of hypoxic conditions leading to the fish kill.

COMMENT: The EIS seems to state that the effects of sludge dumping on the environment of the 106-Mile Site are well known. (American Littoral Society)

Response: The EIS acknowledges that several aspects of waste disposal at the 106-Mile Site are unknown (see Chapter 4).

COMMENT: The EIS implies that sludge dumping at the 12-Mile Site would significantly increase productivity and that one advantage of moving sludge dumping to the 106-Mile Site is that it would decrease the likelihood of plankton blooms occurring in nearshore waters. (American Littoral Society)

Response: The EIS does not address effects of sewage sludge dumping at the 12-Mile Site. The nutrients added to the Bight from sewage sludge dumping are a small fraction of the total nutrient loading. Moving sludge dumping from the Bight to the 106-Mile Site would have no noticeable effect on occurrence of plankton blooms in coastal waters.

COMMENT: **The criteria for an EPA case-by-case determination are ambiguous. It is not clear what severity of need must be shown to direct one dumper, and not another, to the 106-Mile Site. (NJ Public Advocate)**

Response: The Ocean Dumping Regulations (Part 227) outline the criteria for evaluating applications for ocean dumping permits. The MPRSA requires that EPA consider the environmental impact of proposed dumping, the need for ocean dumping, non-ocean dumping alternatives, and the effect of the proposed dumping on esthetic, recreational, and economic values, as well as on other uses of the ocean. Since individual circumstances vary, EPA cannot grant permits on other than a case-by-case basis.

COMMENT: **It is unclear whether the EPA-designated 60-Mile Site on the Continental Shelf remains a viable alternative to use of the 106-Mile Site. Use of such an alternative would not be in compliance with the MPRSA (NJ Public Advocate).**

Response: The designated Alternative Sewage Sludge Disposal Site (60-Mile Site) is still considered by EPA to be a viable alternative to the 12-Mile Site. Designation of the 106-Mile Site for sewage sludge disposal does not preclude the possibility of using the 60-Mile Site. The MPRSA does not require that ocean disposal sites be located beyond the Continental Shelf; instead the Act merely encourages use of such sites "whenever feasible."

COMMENT: **EPA's conditions for stopping disposal at the 12-Mile Site ignore the fact that the marine environment at, and surrounding the 12-Mile Site is being severely degraded. In addition, EPA's plan to take action only when a public health emergency exists presents an unacceptable risk to**

the health and welfare of New Jersey residents, and to the State's tourist and fishery industries which support our economy. The MPRSA imposes a duty upon the EPA to protect against such happenings, not merely to act once damage has occurred. Pursuant to that, EPA must move the present disposal site before such catastrophic events occur. (NJ Public Advocate)

Response: EPA based the decision to reject relocation of sludge dumping from the present site to another location on several factors, which are summarized in the published decision (Jorling, 1978). Central to the decision, was EPA's belief that the 12-Mile Site is sufficiently impacted by other sources of pollution that only slight improvement in water quality would occur if sludge dumping were terminated at the site (Breidenbach, 1977). Thus, there would be no environmental benefit to be achieved by relocating sludge dumping from this site.

EPA acknowledges the potential for a public health hazard developing as volumes of sludge dumped at the 12-Mile Site increase between now and 1981. Accordingly, the Agency has taken steps to monitor the situation closely, and thereby safeguard public health. The Agency has implemented a two-part program for assessing ambient water quality conditions during peak summer months, the period of least dispersion. The assessment includes sampling and evaluation of microbiological parameters and dissolved oxygen depletion rates, both of which can be related to existing and legally enforceable Federal and State water quality standards. Designation of the 60-Mile Site for sludge disposal, and proposed designation of the 106-Mile Site, are additional precautions against any possible public health effects that might result from overloading the existing disposal site. If monitoring indicates that significant health hazards exist with use of the 12-Mile Site, EPA will move the dumping operation to another location.

COMMENT: EPA is not rigorously enforcing permit schedules for development of environmentally sound, land-based disposal methods (NJ Public Advocate).

Response: EPA is rigorously enforcing permit schedules for implementation of land-based alternatives. The Agency has initiated legal action in several cases to enforce compliance. For example, the City of New York has been referred to the Justice Department, and the City of Philadelphia is under a court order to cease ocean dumping by December 1980.

COMMENT: Pretreatment programs must be implemented by EPA on an expedited basis, in order to ensure that sewage sludges from the highly industrialized New York/New Jersey Metropolitan area do not pose a threat to the environment and public health when disposed of on land. (NJ Public Advocate)

Response: Pretreatment standards are presently being promulgated.

COMMENT: EPA must designate the 106-Mile Site for interim ocean disposal, and further direct its use by all permittees as soon as possible, and in no event later than 1981 (NJ Public Advocate).

Response: When the 106-Mile Site is designated for continued use, permits will be granted after a case-by-case evaluation of individual applicants, based on need and potential impact. In accordance with PL 95-153, disposal of harmful sewage sludge at any ocean disposal site will not be permitted beyond 1981.